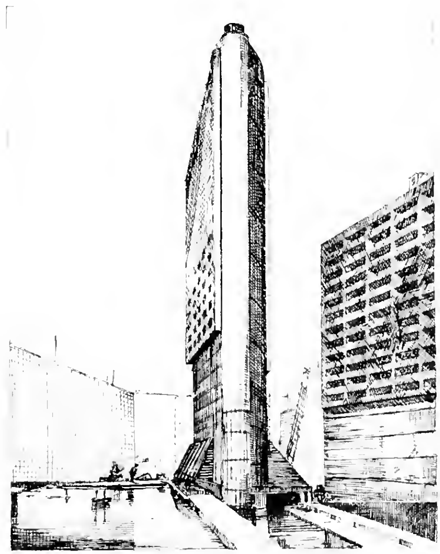
THE TECHNOGRAPH

UNIVERSITY OF ILLINOIS



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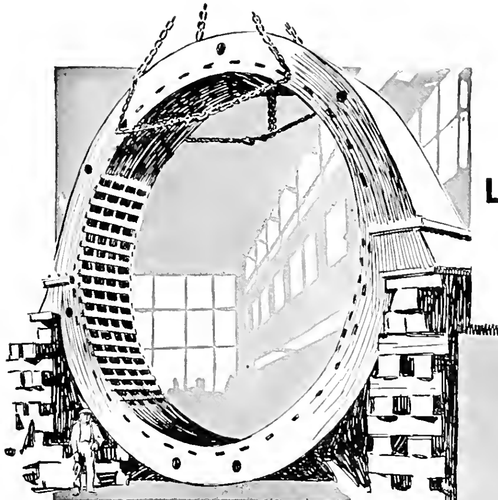

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The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

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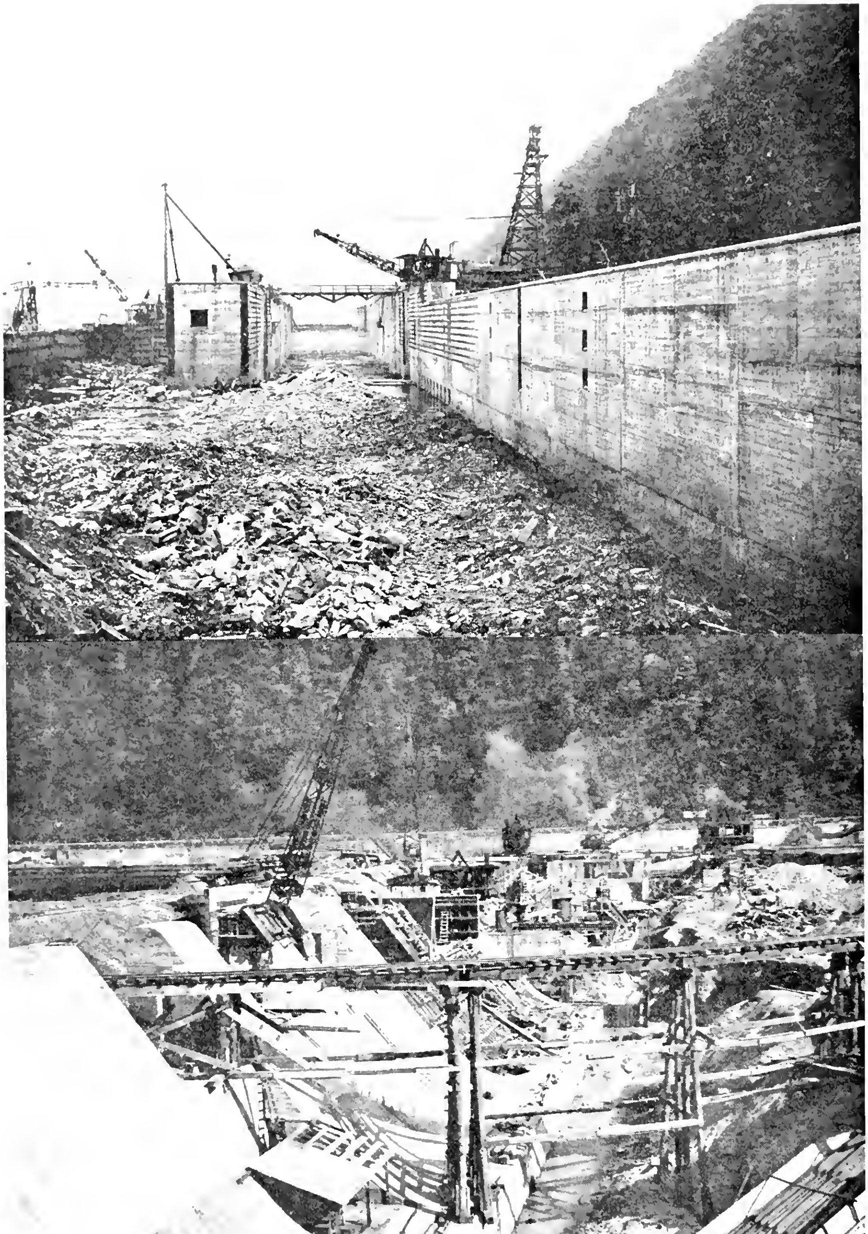

Construction views of the lock and dam project on the Allegheny river above Pittsburgh.

Above: The lock, as it appeared before flooding.

Below: The dam, as it appeared from the abutment, looking toward the lock. The trestle in the foreground was used in building the earth dike.

THE TECHNOGRAPH

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

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Some Phases of the Construction of Lock and Dam No. 8, Allegheny River

BERTRAM W. HOARE

FOLLOWING its policy of providing a 9-foot waterway throughout the Ohio river and its tributaries, the War Department in 1928 authorized the construction of Lock and Dam No. 8, 54 miles up the Allegheny river from Pittsburg. In February of the following year, the contract for their construction was let to United Engineers and Constructors, Inc.—The U. G. I. Contracting Company Division. The completion of this work opens the river for navigation for a distance of 70 miles and affords a water outlet for large quantities of sand and gravel, coal, fire clay, and brick, some of the largest brick plants in the United States being located along the river within the limits of water transportation.

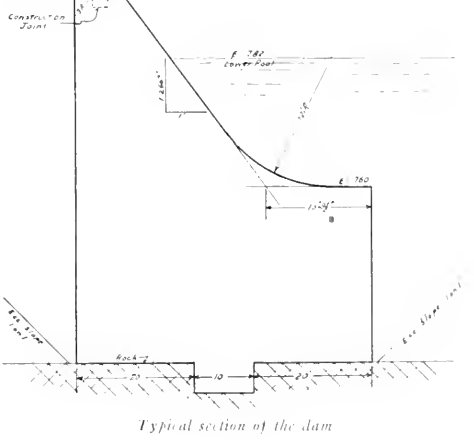
Operations at the dam site, which is located in a comparatively deep valley, were begun with the erection of temporary buildings to be used as an office, as machine, carpenter, and electrical shops, and for the storage of supplies. Due to the precipitate slope of the east bank where the lock was built, all these buildings were placed on the west bank. On this bank, also, a gravel washing plant, a central concrete mixing plant, and two cableways for transporting concrete and other materials across the river, were set up.

In June of 1929, actual work on the lock was begun. The lock is the standard single lock with a chamber 500 feet long and 56 feet high, equipped with electrically operated steel leaf gates. With its upper and lower guide walls the lock is 1,220 feet long. A general view of the lock is shown in the frontispiece opposite this page. All foundations were carried to rock which is at a maximum depth of 6 feet below low-water level. The electricity for the operation of the lock is generated in a small power house built integrally with the land wall. Water is led from above the dam through ports in the upper guide wall into a small canal between the land wall and the bank and thence to a small turbine in the power house, from which it is discharged by a similar canal into the river below the dam.

In constructing the lock, an Ohio river type box cofferdam 25 feet wide and 1,725 feet long was built to an 11-foot stage, enclosing the entire lock area. Excavation was carried out by Whirley derricks set up on the top of the cofferdam. Concrete was brought from the west bank by the cableways in dump buckets of 2 cubic yards capacity and was placed in the forms by the use of hoppers and "elephant trunks."

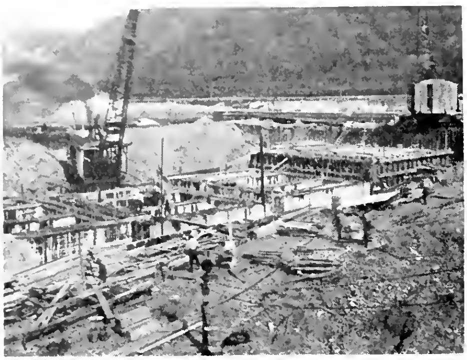
The dam, shown on the frontispiece opposite, is the gravity type, 948 feet long and 50 feet wide at the base, and is designed for 15-foot head. A typical section is shown in figure 1. It is carried to a bed-rock foundation, and extends from the lock on the east bank to an abutment on the west bank. Work was begun on the west side of the river by throwing out a horse-shoe shaped earth dike half-way across the channel to serve as a cofferdam. To prevent scour in high water periods, a row of 35-foot steel sheet pile was driven along the middle of the dike. A pump boat equipped with six electrically-driven, direct-connected, 12-inch, centrifugal pumps was used for the initial de-watering of the cofferdam. The procedure as planned was to carry the excavation for the foundation to rock in an open cut, using Whirleys equipped with clamshell buckets and working from a trestle on the upstream side of the dam, for removing the material. According to the original government soundings, this plan appeared feasible in spite of the fact that the site was a gravel bar of a loose character with about a 50 per cent sand content, excepting for a small area covered by a strata of hard pan approximately 10 feet thick.

However, as soon as excavation was begun, the elevation of the rock as given by the government was found



Typical section of the dam

seriously in error, the rock being actually from 7 to 27 feet lower than anticipated. The material being excavated also proved to be coarser and more porous than expected, so that the volume of water running through the dike necessitated a modification of the original plan. The first device to overcome the flow of the water was this: Two rows of steel sheet pile, one 2 feet upstream from, and parallel to the upstream face of the dam and the other parallel to the first and 12 feet downstream from it, were driven. Cross bulkheads were driven at intervals, and the material between the two walls excavated. As the material was removed, its bracing effect



Caissons in the making

was replaced by rings of heavy timbers. Forms were placed between the walls, and concrete was poured in the dry with the aid of auxiliary pumps. A similar wall was built on the downstream side of the dam; likewise, cross walls of similar construction at about 90-foot centers. The inner rows of piles were then pulled and the series of "bath tubs" thus formed by the concrete walls pumped out and excavated, a channel 5 feet deep and 10 feet wide for the keyway cut in the rock, and the space filled with concrete to the elevation of the side walls. From this elevation, concrete was placed in 8-foot lifts, the full width of the dam, to the crest.

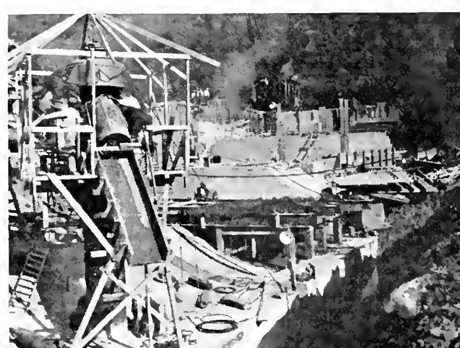
The method outlined above was used in placing the concrete in the shallower portions of the river. As construction progressed, however, it became increasingly hard to keep the excavation dry, and as a result, it was decided to continue the dam by sinking successive caissons. Figures 2 and 3 show steps in the sinking of the caissons.

The caissons were of reinforced concrete, 50 feet 6 inches long by 36 feet 6 inches wide, with two transverse bulkheads in the interior. They were placed normal to the length of the dam with a space of 4 feet 6 inches between caissons. In constructing them, the material inside the cofferdam was excavated to water level, leveled off, and the steel cutting edge consisting of a 1-inch by 14-inch plate and a 3-inch by 3-inch by ¾-inch angle set up. The cutting edge was fastened to the concrete by ½-inch by 1½-inch steel straps attached to the angle iron and bent up a 45-degree angle. Forms were built above the cutting edge and the reinforcing steel placed. The forms provided for three dredging wells, which at the bottom of the caisson joined to make one chamber the entire size of the caisson.

The reinforcing steel was 1-inch round stock, and was attached vertically to the angle of the cutting edge, through holes at 1-foot centers. Alternate rods were bent down at a 45-degree angle, while the remainder were allowed to run vertically, parallel to the outside walls of the caisson. Those rods bent at an angle followed the shoulders and the inside walls of the dredging wells. To these 1-inch rods were wired ¾-inch rods running horizontally, and placed at intervals varying from 3 to 18 inches, those near the shoe being the closest together. In each corner of the caisson, a steel sheet pile with one flange exposed was placed. When all steel was in place, the concrete was poured in three lifts of approximately 12 feet each, the thickness of the second and third lifts varying according to the elevation of the cutting edge above rock. Each lift was allowed seven days in which to harden before adding the next lift.

The caissons were open dredged by steam Whirleys as far as possible, and then were sealed and airlocks were set up on them. In sealing the dredging wells, concrete plugs were cast in the openings. The forms for the plugs were suspended by steel rods from I-beams laid in wood blocks across the top of the caisson. In the upstream and downstream plugs, the various inlet and outlet pipes for aid, as well as a section of 3-foot flanged, steel pipe were cast in the concrete. On these last named pipes were mounted the material locks. In the middle well, the plug had a square hole, 9 feet by 4 feet, through its center. Around this hole were placed 6-inch by 10-inch seal timbers, with anchor bolts extending from the plug up through the timbers. A ⅞-inch steel cover plate was fastened down over the hole by the anchor bolts running through the timbers, and was further secured by two 18-inch I-beams running across the top of the plate, which were in turn fastened to the plug by other anchor bolts. On this plate were mounted the man-lock and the air intake and outlet pipes.

To help sink the caissons and to keep them level as they went down, blocks of concrete, 2½ cubic yards (weight about 5 tons) to the block, were cast and placed on the side of the caisson that sank the slowest. This usually was the downstream or apron side, since that



Caissons being sunk

side did not have as much weight as the others. The distances the caissons had to be sunk under air ranged only from 7 to 15 feet, but a great deal of difficulty was encountered, due to the nature of the river bed. The gravel was mixed in places with large boulders which had to be drilled and "shot" lightly until they were broken into fragments that could be removed through the air locks. At times it was necessary to cut through

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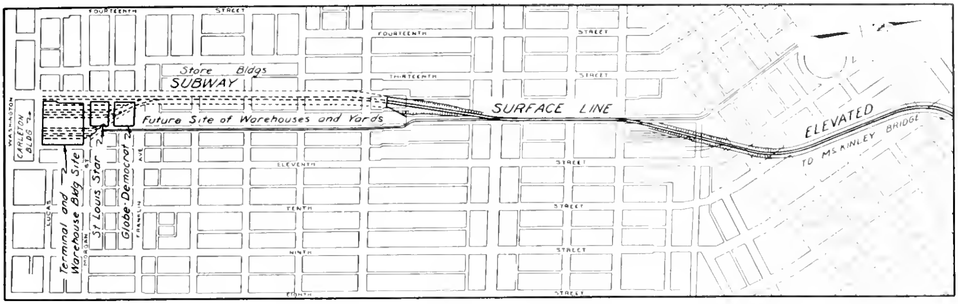

Figure 1: Plan of the Illinois Terminal Improvement in St. Louis

Illinois Terminal Improvement in St. Louis Nears Completion

WALTER HELLMICH '33

YEAR after year the American railroads have been investing additional capital at the enormous rate of more than one-half billion dollars per year so that freight may be transported economically and with greater safety. The greater portion of this expenditure has gone for the extension of terminal facilities to meet the exigencies and necessities of industrial expansion and municipal growth. It has been the aim of the railroads to increase the ton miles of freight per train hour, and the achievements along this line have been noteworthy.

In the past it has been characteristic of American railroad management to anticipate transportation demands. Since no transportation agency has yet been developed to substitute for rail transportation in the mass movement of goods or as a line of national defense, our rail management continues to proceed normally in its established policy so far as adequate financing permits.

The increase in speed and tonnage of road haul movement brings about the necessity of increased terminal facilities. Also, the demands developed by industry and commerce in the methods of transportation have created a new era of terminal activity and facility, not only in the movement of cars of freight alone, but in expeditious and economical handling, storage, delivery, and reshipping of goods after the car has been unloaded. Aside from the extension of classification yards, interchange facilities and suitable motive power for the new service demands, more and more attention is being given to the breaking of bulk cars at terminals with warehouse and reshipping facilities.

Because of the normal growth and municipal development, many terminals, especially in larger industrial cities, have become bottled in, with the result that extension of yards and trackage is becoming increasingly difficult and costly. These limitations are being met today largely through electrification. The capacity of a given terminal track facility can be practically doubled under electric operation without a corresponding increase in operating expense. Aside from this there are other substantial advantages in electrification, especially that of the tendency to enhance the value of adjacent property through its greater availability and adaptability for either commercial or civic development, which is not the case in steam operation districts.

In St. Louis certain phases of present terminal operations are unique, especially those relating to less-than-carload traffic, and about which there has heretofore been great discussion. Generally speaking the rail lines entering St. Louis from the east have no direct less-than-carload facilities in St. Louis, but break bulk on the east side of the Mississippi river and transfer freight over bridges by team and motor truck.

Figure 2: A portion of the elevated structure

The Illinois Terminal Railroad System (incorporating what was formerly known as the Illinois Traction System or McKinley Lines) entered St. Louis in 1912 over its own bridge (McKinley) across the Mississippi river and operated over a circuitous surface route, congested in vehicular traffic, to its terminal at Twelfth street and Lucas avenue. At that time it sought passenger business primarily and accepted from the cities on both the east and west sides of the Mississippi, franchises so circumscribed by limitations as to preclude any very satisfactory freight operations. Passenger trains were operated on hourly schedules to and from points in Illinois and relatively little attention was given to movement of freight in and out of St. Louis proper.

With the advent of paved roads and the private automobile and the consequent decline in passenger revenues the then Illinois Traction System began to give serious

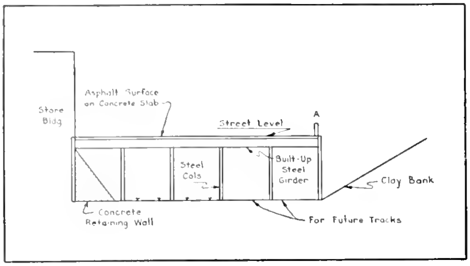

Figure 3: Profile sketch of the subway

thought to the intensive development of freight traffic. The physical limitations in the satisfactory movement of freight trains was gradually overcome. This involved the belting of cities such as Venice, Madison, Granite City, Edwardsville, Springfield, Decatur, Champaign, and Urbana, thus eliminating the necessity of a laborious movement through the congested districts of these cities, the reduction of grades and curvatures, the strengthening of bridges, installation of new and heavier rail and better ballast, and the acquiring of more powerful locomotives and additional substation capacity for electric operation. Then came the consolidation of the Illinois Traction System with the Illinois Terminal Company and other steam lines serving a highly concentrated industrial district on the east side of the Mississippi river, all of which resulted in the present Illinois Terminal Railroad System.

The operation of these consolidated properties and the resultant business developed through the St. Louis gateway taxed to the utmost the already improved terminal facilities in St. Louis and on the east side of the Mississippi, so that in 1929 the Illinois Terminal Railroad System embarked upon its gigantic electric terminal improvement and warehouse project, which is now nearing completion.

This projects consists of two main parts. First is the new improved roadway from the McKinley bridge to downtown St. Louis by way of elevated and subway constructions. The second part consists of the new terminal buildings which are being built directly over the subway part of the road. Then in addition are other enterprises which are being constructed as a direct result of the building of the new roadway and terminal buildings. (See figure 1).

The Illinois Terminal project was conceived in 1927, but actual construction did not start until 1929. The first step in the program was the development of increased facilities on the east side of the Mississippi river. This consisted for the most part of elevated structures to eliminate the delays caused by surface lines in the congested industrial areas on the Illinois side of the Mississippi.

The next part of the project consists of a new high-speed double-track electrified route, a combination of elevated, surface, and subway lines, from the McKinley bridge to Twelfth boulevard and Washington avenue, a distance of 2.58 miles, right to the heart of downtown St. Louis where wholesale and retail shopping districts meet, and adjoining the St. Louis civic center development. This new route in St. Louis eliminates 29 grade crossings and reduces rail crossings at grade from eight to one. See figure 1 for a plan of the project.

The elevated portion of the new route extends from the McKinley bridge to a point just north of Twelfth boulevard and Howard street. The structure is a combination of reinforced concrete and structural steel. A section of the new elevated route is shown in figure 2.

The Terminal route follows the street surface on Twelfth boulevard from Howard to a point about two blocks south, where the subway part begins. The subway constitutes the remainder of the new route, from this point south to the new terminal buildings at Twelfth boulevard and Washington.

Attention is called to figure 3 for a sketch of a section of the subway. As shown in the sketch, the subway is directly under Twelfth boulevard, which is supported on steel columns which have their footings between the tracks of the subway. On the west side of the subway, the first line of columns is used as foundation supports for the old store buildings which were already located on the west side of Twelfth boulevard. Then a concrete retaining wall was poured. The other steel columns support the street itself, which is of reinforced concrete construction supported on transverse beams which in turn are supported by the columns. The slab is covered with an asphalt surface. The east side of the subway is open throughout most of the route, but as other enterprises become interested, it is expected that buildings will be built flush with the edge of the street. The new St. Louis Globe-Democrat building and the St. Louis Star building are each located on the east side of the subway

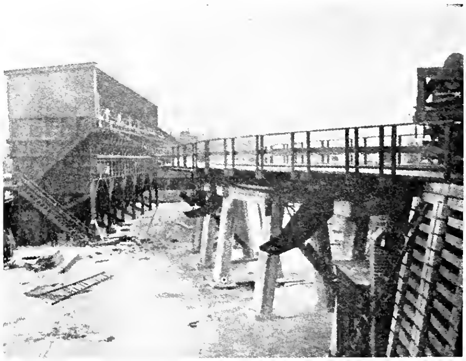

Figure 4: New coal yard served by the Illinois Terminal

and are built flush with the street. (See figure 1). Where the subway is still open on the east side a concrete wall has been built, as indicated by point A on the sketch. The two west tracks are being installed now, and the remaining two tracks will be laid when needed.

The elevated portion of the new route, totalling 1.61 miles, was put into operation July 4, 1931, for main-line passenger operation. It resulted in a reduction of seven minutes running time between the McKinley bridge and

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Brick Manufacturing Problems

Ralph Kent Hursh
Professor Ceramic Engineering, University of Illinois

WHEN one considers the amount of hand labor involved in the production and utilization of brick, the progress from the primitive brick yard does not seem great. While there are technical difficulties to be solved, the most serious manufacturing problem of the brick industry at the present time is in the elimination of hand labor. Much has been accomplished in this respect in some phases of the processing but the man power required from the machine to the stock pile or the car is still too great. It is generally considered good plant practice if the number of employees does not exceed one per thousand daily production of brick. It has been possible in some of the common brick plants where production is great to manufacture from two to three thousand daily per man employed but the product is crude and the methods are unsuited to the production of face brick and high quality.

Technical Problems

The technical problems of the brick industry are many and varied. Clays and shales are common but they are as individualistic in character as are people. Like people, they are good, bad and indifferent. Clays result from the weathering of rocks of feldspathic character but of varied composition. Most clays have been transported by wind, water or ice, mixed with a variety of other clays or mineral substances and subjected to varied geologic conditions which affect their physical characteristics. While certain minerals are common or typical, few clays are of simple constitution mineralogically and most of those used in the brick industry are decidedly complex. Not only do they vary chemically but the physical character is of even greater importance. It is a common happening to find two clays of practically identical composition by chemical analysis which differ widely in working properties and adaptability to manufacturing operations. The physical characteristics are, therefore, the most important guide in their valuation. Hardness as it affects grinding; fineness of grain and plasticity as they affect the forming, handling, shrinkage and drying of the ware; mineral constitution as it affects color and the behavior in burning; these are of vital importance in utilization.

Excavation or Winning

Most of the brick clays are in more or less stratified deposits and are excavated from surface workings or pits, although in some districts underground mining is necessary for clays of the fire clay type used for buff, gray and flashed colors in face brick. In the surface workings there is likely to be considerable variation in the character of the strata with sandstone, limestone, concretions of calcium and iron carbonate, pyrite and gypsum as highly undesirable constituents. Faulting and undulations in the strata introduce additional difficulties. In many cases selection and sorting of the materials must be carefully done. More often, provision must be made for thorough mixing in order to insure uniformity of the material as used in the plant. Variation in the character of the mixture affects every operation in manufacture; grinding, screening, tempering, molding, drying, and firing. Variation results in off-shades of color, size variation and, often, cracking or warping. To insure uniformity of mixture it is often necessary to provide large storage capacity for raw clays, introduce additional handling of the material, or provide an extensive installation of mixing equipment.

Excavating methods must be selected with consideration of adequate selection or mixing of material as well as economy of labor and power. In order to handle the occasional large lumps of clay, shovels or other machines of excessive capacity must be used. To properly sort or select materials or to remove undesirable strata two or more excavating machines may be required. The idle time of excavating equipment is often excessive because of these facts and the resultant overhead charges are greater than would seem justified.

The steam shovel replaced hand labor in clay digging as plant capacities increased. Rapid developments in this equipment, particularly the use of caterpillar treads instead of tracks, reduced the pit labor. The electric shovel and the drag line excavator have superseded the steam shovel in many cases.

In hauling clay from the pit to the plant the mule was formerly standard equipment but the gasoline age has brought the gasoline locomotive into this service in 50 per cent or more of the plants.

Grinding and Screening

Raw clay storage of lump material is essential in many plants to aid in mixing or to insure continuity of production in wet weather when pit operation is impossible. To rehandle from covered storage 100 to 500 tons of lump clay per day efficiently is a problem, not as yet, satisfactorily solved.

Much development has taken place in the design and production of grinding equipment but the brick industry, generally, depends on the time-tried dry pan or edge-runner mill. Machines of greater mechanical efficiency are obtainable but they do not effectively grind clays over the wide range of conditions that are encountered in the brick plant. Few machines can reduce lumps as large as a man to a fineness to pass a 10-16 mesh screen in one operation. The dry pan does it. It also grinds dry clay, moist clay, and frozen clay in some sort of way and keeps the plant going in all seasons. Grinding costs vary with the season. A pan which effectively produces 10 to 20 tons per hour of screened clay in dry weather often delivers 3 to 5 tons per hour in wet or winter weather. Labor requirements vary accordingly with a summer output of 5 tons or more per man hour to a winter production of possibly 1 to 2 tons per man hour. Mechanical methods of feeding the grinders and preliminary crushing have done much to improve grinding room efficiency.

Screening or sizing of the crushed or ground clay introduces enough problems to keep more than one man busy. Under good conditions the grinder may handle two to three tons of material per ton of screened product. More often the amount will be six to ten tons per ton of product. Moist clay clogs the screens rapidly and continual cleaning is necessary. Steam heating of the screens helps to some extent. It would seem a simple matter to dry the clay before grinding and thus secure maximum grinder and screen efficiency. On a brick plant of moderate capacity, 50,000 per day, this would require the evaporation of 6 tons or more of water with a large fuel requirement and an excessive cost of equipment. The most serious difficulty, however, is in the fact that the heating of the raw clay is likely to have a deleterious effect on its plastic properties and introduces difficulties in the molding or forming of the product.

Ground Clay Storage

To insure continuous production when grinding capacity is reduced by weather conditions or in case of break-downs in the grinding department, a storage of ground clay is frequently provided. It is also used as a means of further mixing by layering the material into the bin, then removing it by vertical cutting of the pile. A problem is introduced by the tendency of the clay to pack in storage, requiring hand labor to keep a uniform feed to the reclaiming belt. In some cases, too, the segregation of particles of varying size in the bin causes variation in the fineness of material delivered to the molding machine.

Uniform mixture of shale strata is aided by use of a planer

An interesting phase of the storage problem is the effect of ageing or weathering of moist clay. When pyrite is present, as it is in most shales and fire-clays, storage induces a chemical action which produces some sulphuric acid. This attacks the calcium carbonate, which is also present in varying amounts, to form calcium sulfate which causes scum or whitewash on the ware. The acid condition may also affect the colloidal matter of the clay to cause a distinct change in its working properties. In one case this effect was so marked that it was found impossible to use the stored clay in manufacture.

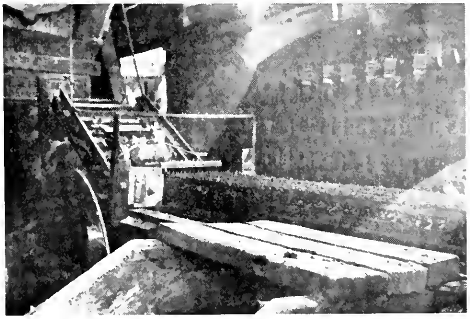
Tempering and Pugging

The clay is made plastic and workable by addition of water in the tempering or pugging process. The regulation of the water content must be within close limits. A variation of 1 or 2 per cent will distinctly affect the working properties and may make a difference of 20 per cent in the power requirement of the brick machine. Weighing or proportioning devices for clay and water are used to some extent but variation in the moisture content of the raw clay often makes this regulation difficult. In the main, the regulation of tempering is determined by the feel of the clay by the pug mill operator. A skilled man will readily detect small differences in moisture content or temper of the pugged clay. Much work has been done in an effort to secure a simple and accurate device or method to replace the individual judgment of the pug mill operator but so far without entire success.

Molding

From the technical standpoint the molding process has received comparatively little study, although numerous problems are encountered in this phase of the processing. The laws of flow of plastic masses are not well defined. The fundamental principles of die design and the effect on flow have not been determined. It is a complex problem with innumerable variations because of the great differences in physical characteristics and behavior of clays and the variety of shapes, rates of production and types of product involved. Much has been accomplished in individual plants in adaptation of machines, dies and methods but general studies of the problem have not been made, principally because of the large amount of work and expense involved. It is not a problem which can be solved by experiments on a laboratory scale but the solutions must ultimately be obtained in commercial rates of production and with standard sizes of product.

The clay column leaving the brick machine may crack or tear if the clay is too stiff or if the mixture varies toward a less plastic character. Under other conditions it may swell or ruffle on the surface. Laminations caused by unequal rates of flow in the clay column are a constant source of unsatisfactory structure. A dozen or more operating factors are involved which are all difficult to control. Along with this the design of the die must be carefully adjusted to the particular clay used and to the rate of production desired. Even slight changes in the mixture, the water content or the rate of production may result in unsatisfactory operation of a die which normally produces good ware. In addition to these difficulties the size of die opening must be closely regulated to produce a product of standard size, allowing for the shrinkage which takes place in drying and firing. The shrinkages vary greatly with changes in mixture and wear of the die necessities frequent replacement. In a plant making a variety of shapes or using different materials the die problem becomes acute.



Extruding the clay column from the brick die

Drying

Approximately a pound of water must be evaporated from each brick in the drying process. In a plant of average capacity this will amount to 20 to 30 tons of

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Engineering Societies on the Campus of the University of Illinois

THE College of Engineering at the University of Illinois, unlike many others of its size and standing, is located in an essentially non-industrial community; hence there is little opportunity for its students to see engineering works in process of construction or to associate with practicing engineers while carrying on their collegiate studies. Again, the college is too large and its program of studies too strenuous to permit of much intermingling of the students in the four classes during regular class periods even within the departmental group. The engineering societies bridge these gaps to a marked degree. They contribute greatly to the inspirational and professional stimulus of the embryo engineer in the period when such encouragement is most needed.

Many prominent engineers are glad to come to the campus and speak of their practical experience and describe important engineering works because they themselves are members of the national societies which in a real sense are the parents of the student chapters and branches. The experienced engineer recognizes the duty he has of assisting the younger man in his educational and technical preparation for a successful engineering career. No better opportunity is afforded him to do this than through the engineering societies in the colleges and schools.

The acquaintanceships formed in the society meetings and functions are invaluable. A graduate's success in getting positions of responsibility and trust depends in large measure upon the friends he makes among those who are his colleagues in student days. Faculty and professional contacts are promoted to a large degree in the business and social meetings of the societies. Opportunity for leadership in committee and official duties is unexcelled by any other activity. A spirit of professional solidarity is engendered in the engineering society that cannot be obtained in any other way.

PROFESSOR H. H. JORDAN,
Assistant Dean of the College of Engineering.

University of Illinois Student Branch of the American Ceramic Society

H. D. FRANKEL, JR., *President*

In the early fall of the year 1910, a mere handful of ceramic engineers met in the seclusion of a Green street lodging house and organized the first Ceramic club in the country. At the time, there were 20 students enrolled in the newly organized department of ceramics and these pioneers felt, even at this early date, the need of an organization of professional brotherhood. They seemed to feel a need of a club or society of such a nature that they could be linked by the bonds of their profession. The Ceramic club that was formed has been and is in its present-day form the link that joins the students of this profession.

Five years later the Ceramic club became the adopted son of the American Ceramic Society through provisions made in the constitution of the parent organization. In the fall of 1915, the club was presented a charter and was thereafter known as the University of Illinois Student Branch of The American Ceramic Society. This organization started its career with 25 members, all students of the department of ceramics. At the time, there was only one other student branch in this country, at Ohio State University. Today there are chapters in every college and university that sponsors a ceramic department. The Illinois student branch of today boasts 78 members out of 78 undergraduate students enrolled in the department of ceramics.

The history of the parent organization is of the same nature. At a meeting in Columbus, Ohio, in 1899, were 21 men who answered the call for a ceramic brotherhood. In 1905 the organization found it necessary to incorporate under the laws of the state of Ohio and today has over 2,000 members.

The journal of the A. C. S. is published by the society and is the most important ceramic periodical in the country today. Members of any student branch may secure the journal at nominal prices.

The local student branch sponsors smokers and get-togethers for the students and staff. These are of a social nature but engross lectures by the faculty, professional men, and others connected either directly or indirectly with the ceramic field. Moving pictures of ceramic plants have become a part of every meeting within the last two years. The major social function of the student branch is the annual spring pig roast at which may be seen students, graduates, faculty members, and guests from the parent society. At this affair, which is spread in the long hall of the ceramics building, the traditional telling of Charles Lamb's "Dissertation on a Roast Pig" in true ceramic style is carried on.

The organization has as its primary function the original purpose of the old Ceramics club, that of brotherhood among the departmental students. It also engrosses other functions which are of equal importance. The society brings about closer contact between students and the faculty, students of the different classes, and students and professional men of the field. It also offers instructional information, social events, and is an exchange for student problems in ceramics.

This year represents the "coming of age" of the old Ceramic club. In its 21 years of existence, it has seen many men come and go. Some of these are leaders in their field today and all of these owe their success, in some measure, to their membership in the Student Branch of the A. C. S. at Illinois.

Officers: President, H. C. Frankel, Jr. '32; vice-president, Wayne A. Deringer '32; secretary-treasurer, Robert Whitesell '33.

The Student Chapter of The American Society of Civil Engineers

E. W. BALDWIN, JR., *President*

The American Society of Civil Engineers is the oldest national engineering society in the United States. It was instituted in 1852 for the purpose of advancing engineering and architectural practice, maintaining a high professional standard among its members, encouraging intercourse between men of practical science, and establishing "a central point of reference and union for its members." Student chapters of the American Society of

Civil Engineers are similar in aim. Activity in the student chapter organization of the A. S. C. E. will go a long way in enabling the graduate in civil, architectural, or general engineering to get ahead in his profession.

Students of engineering often finish their first two years and in many cases are even further advanced in their academic work without realizing what they are training for, and knowing very little about the kind of work they expect to engage in after graduation. They quite often wonder what will be done with the knowledge gained at the university, or if they will ever have any use for much of it. Each year there is a large number of graduates entering engineering work without an adequate conception of what is expected of them, or what to expect from their employers.

The University of Illinois student chapter is attempting to supply this important information for engineering students by bringing to them the foremost engineers and educators in the United States to speak of their experiences, and express their ideas and ideals at the meetings of the society.

The programs are arranged to include practically every phase of civil engineering, and the speakers are typical examples of successful engineers of the United States. These men have learned by experience the more important "do's" and "don'ts" of their profession, which they pass on to the audience during their talks.

The student who takes advantage of hearing these men naturally has a better knowledge of his chosen profession, and it gives him a better idea of the more important fields of engineering outside the one in which he is specializing. It also gives him a better chance to make use of his summer employment in furthering his general knowledge of engineering.

One of the most important functions of the society, in bringing engineers of prominence to this campus, is to show these men the excellent facilities provided by the university for the education of its student engineers. In many instances eminent engineers have been so impressed by the laboratories and equipment of the university that they have established policies giving preference to Illinois graduates in their respective business concerns. This has materially aided the university in placing its graduates.

The Illinois chapter of the A. S. C. E. has made wonderful progress in the last two or three years. There is no doubt that that progress is being watched by men high in the engineering profession, especially those men who have attended our meetings and have addressed us. This year the student chapter has a list of excellent speakers and it is the aim of the society to make good its boast of being the most active organization of its kind on the University of Illinois campus.

Officers: President, E. W. Baldwin, Jr.; vice-president, W. W. Anderson; treasurer, W. R. Fickett; secretary, J. R. Cullings.

The American Institute of Electrical Engineers

BENNETT BURGOON, E. E. '32, *President*

The American Institute of Electrical Engineers was organized in 1884 in New York City with the purpose of the advancement of the theory and practice of electrical engineering and of the allied arts and sciences and the maintenance of a high professional standing among its members. Its growth was rapid after the first 10 years and in 1902 the plan for local group organizations in electrical centers and also groups of engineering students in universities and technical schools was adopted. The former groups are called sections, of which the Urbana section, consisting of members of the faculty, is an example, and the latter groups are called branches, of which the Illinois student branch is an example.

The student branch was organized last year, succeeding the Electrical Engineering society which had been the student organization for electrical engineers for many years. Like the E. E. society its aims are to stimulate extra-curricular activities among students interested in electrical phenomenae and also to function as a branch of the national organization.

Being thus affiliated with the national organization enables the branch to present considerably more interesting programs and it gives the student the opportunity to become a student member of the national organization. After graduation the student member becomes an associate member and may participate in the activities of the section where he is located.

The student branch was organized last year rather late in the semester and consequently its growth was handicapped throughout the year, but this semester much enthusiasm has already been shown as displayed at the mixer given for all electrical engineers on September 30.

Every second year the electrical engineering department presents an electrical show, which is composed of electrical exhibits, stunts, and entertainment furnished by the students and faculty. The American Institute of Electrical Engineers takes a very active part in presenting the show and it is hoped a large number of freshmen and sophomores will join the branch in order that they may be of assistance on the electrical show. The experience will be to their advantage when the time comes to present the next show.

Officers: Chairman, Bennett Burgoon; vice-chairman, R. L. Dowell; secretary, D. L. Pettit; treasurer, R. R. Wood; counselor, C. E. Skroder.

The Student Branch of the American Society of Mechanical Engineers

G. LEUTWILER, *President*

The American Society of Mechanical Engineers recognizes the necessity of having young men, while receiving their training in preparation for practice in the engineering profession, gain a proper perspective of engineering work, by enabling them to become acquainted with the personnel and to become familiar with the problems of the profession. Therefore, its by-laws provide for the organization of student branches of the society by students in colleges of accepted engineering standing. There are at present 108 student branches of the society.

The branch at the University of Illinois was one of the first to be organized. It had its origin in a combined mechanical and electrical engineering club which existed from the beginning of the College of Engineering at the University. The mechanical engineers in this club accepted the opportunity of joining the national society shortly after it was founded. From the start, the present organization has developed. Now the student branch has a membership of well over 100 men, who meet every two weeks in the mechanical engineering laboratory to benefit from the entertaining programs given there.

It has always been the policy of the group to form programs of general interest to the mechanical engineering student. These programs take the form of motion picture films showing manufacturing or research processes, or consist of interesting talks by experienced men from the world of industry, or by students or faculty members from the university. Each of these meetings is conducted in such a way that the aims of the society are never lost sight of.

The principal objects of the student branch are all beneficial to the mechanical engineering student whether he be of freshman, sophomore, junior or senior standing in the university. These may be generalized as follows:

1. To give the student some acquaintance with the practical side of the field of mechanical engineering.
2. To furnish the student the principal publications of the society and to keep him in touch with engineering progress.
3. To develop the student's initiative and ability to speak in public, and to familiarize him with the parliamentary procedure and organization of learned societies.
4. To enable the student to establish fraternal contact with his fellow students in engineering and to meet older men actively engaged in mechanical engineering.
5. To permit the student to attend as a welcome guest the general meetings of the society.

The programs and functions of the organization are completely handled by the student officers. Besides the semi-monthly meetings, the school year includes a student-faculty smoker to begin the year, a banquet held in the spring to climax the year. A large number of student members have the opportunity of serving on committees in preparation for the above mentioned events. The regular meetings and business of the branch is taken care of by the officers who are elected yearly.

The society encourages and welcomes visitors to its meetings. The mechanical engineering student, however, is especially urged to attend the meetings because important parts of his work at the university are those of making helpful and friendly personal contacts, and of keeping abreast of progress in the profession. The Student Branches of the American Society of Mechanical Engineers observe these ends efficiently.

Officers: President, G. Leutwiler; vice-president, P. D. Morgan; secretary, C. A. Davis, Jr.; treasurer, A. C. Hottes.

The Mining Society

Henry Berg, *President*

The Mining society of the University of Illinois is an affiliated society student branch of the American Institute of Mining and Metallurgical Engineers. The national society is the second oldest engineering society of its kind in the United States. It was founded in 1871 as the American Institute of Mining Engineers, but in 1919 changed the name to its present one.

Several world-famous men have been members and officials of this engineering society. The most prominent at present is President Herbert Hoover. President Hoover was vice-president of the A. I. M. & M. E. from 1914 to 1916, director in 1921 and 1922, and president in 1920. He still maintains his membership and interest in the society.

The object of the Student Mining society is to supplement the study of mining engineering and also give students who are not enrolled in the mining school some knowledge of mining. In attempting to reach its objective the society encourages the presentation of papers and talks of mining interest at its meetings. Both faculty members and students do this and occasionally prominent outsiders are brought in to give talks. The most far-reaching means of giving mining information to all students is the presentation of motion pictures which can be seen by anyone who cares to attend the meetings. There is never any charge for this instructive entertainment.

There are 50 affiliated student societies of the A. I. M. & M. E. The Illinois student branch has just celebrated its twenty-second birthday, having been founded here in 1909. It is perhaps the most cosmopolitan of all engineering societies. Its men come from all parts of the world and frequently letters are received from Canada, Russia, Japan, South America, Europe, and, of course, all parts of the United States.

Officers: President, Henry Berg; secretary, Robert Scheerer; faculty adviser, Ass't. Prof. Mitchell.

Phi Alpha Lambda

J. H. Westerberg, *President*

Phi Alpha Lambda is the general engineering honorary society. It was founded in 1925 by a group of general engineers to bring them into a closer relationship with each other, to create a feeling of fellowship and cooperation, to represent the general engineering school, and to uphold its interests on the campus.

Membership is confined to general engineering students in their third or fourth year, who have maintained an average scholarship within the upper one-third of their class, and who have been active in their school work and on the campus.

Phi Alpha Lambda each year sponsors a smoker for general engineering students, at which prominent men of the engineering college speak, the purpose being to enable the students to get acquainted with the other men who are headed for the same goal and have much in common.

The organization has recently received a unique honor. In the last two years, the two student colonels of the university brigade, namely Severin Langhoff and Jean Lattan have been members of Phi Alpha Lambda.

Assistant Dean Jordan and Frank Stubbs of the department of civil engineering are two of its well-known members.

Officers: President, J. H. Westerberg; vice-president, E. J. Yocum.

Engineering Physics Society

Richard J. Duffin, *President*

The science of physics has unquestionably provided the essence out of which modern engineering has evolved during the nineteenth century. Out of the laboratory technique of the physicist of the nineteenth century has come the engineering practice of the engineer of the twentieth. Just as certainly will the laboratory experiments of the present provide the basis of the engineering practice of the future. Today, the most progressive branch of electrical engineering has to do with communication by high frequency currents and radio waves. Man's ability to broadcast information into millions of homes simultaneously and to talk across the Atlantic ocean with no intervening wires is due to his knowledge of the motion of electrons inside of highly evacuated discharge tubes. These same tubes are being used automatically to control huge quantities of electrical power. The techniques involved represent the combined achievement of many scientists and engineers during the last two decades. The knowledge revealed by the physicist is being applied daily in the advance of engineering. Never before has the liason between the pure scientist in his research laboratory and the engineer been so immediate. Television, which will soon be as common as radio, involves discoveries and developments made by physicists in the last five years as well as refinements in the art of telephone communication. Engineers not well versed in the recent discoveries as well as in the classical concepts of physics can contribute little to the development of such

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Engineering Curricula Changed to Keep Step with Progress

William E. Schulz, Jr. '32

WHEN we consider such features of engineering history as the fact that it has been only since about the middle of the last century that the stresses in trusses could be analyzed, we begin to realize the tremendous progress being made in the engineering profession. Since we have not the perspective on present events that is furnished by the lapse of time, our attention is not forcibly attracted to all the brilliant accomplishments of the contemporary; but subconsciously, nevertheless, we are impressed with the fact that engineering is progressive.

And engineering, ever progressive, is universally progressive. It must be modern in all its phases—in its educational department as well as in its research and investigation departments, or the results of the latter two would never be successfully given to posterity.

Cognizant of the changing demands of the times, the College of Engineering of the University of Illinois, a unit in the educational department of the profession, has revised several of its curricula.

In civil engineering the foreign language requirement is now omitted. While engineers recognize the importance of being well-versed in Spanish, French, and German, they feel, nevertheless, that only one year of a language is hardly profitable.

The omission leaves room in the sophomore year for courses that stimulate interest in engineering and keep the student absorbed in pursuing his curriculum. Of such a type are the courses in highway construction and bridge and building construction, the latter of which has been a popular course in the past. These are descriptive, not theoretical, and so involve no great difficulty for the student.

Geology is now required in civil engineering. Flexibility, however, is introduced here by allowing a substitution of foreign language for geology to ameliorate the status of students from other colleges who transfer here with no geology but considerable language, and whose graduation would on that account be deferred appreciably if the geology requirement were rigidly adhered to.

The importance of this arrangement is recognized when we consider how many transfers enter the College of Engineering. A clue to their number is found in the statement of Professor W. C. Huntington, head of the Department of Civil Engineering, that "of the 108 freshmen enrolled in civil engineering not over 50 will graduate." Yet the present senior class numbers about 85.

"The extras," he explains, "are made up by transfers from junior colleges."

The new system of numbers used for civil engineering courses groups the subjects in a logical fashion and lists them in such a manner that the titles of all the courses bearing a close relation are visible at a glance. Thus the highway engineering courses are numbered from 20 through 29; those in sanitary engineering 40 through 49. Such an arrangement saves time and has a pleasing psychological effect on the thousands of persons who every year scan the university's bulletin and would otherwise have to scrutinize it more carefully.

At present the subscript "a" is added to those course numbers which were used in the old system to designate other courses. These subscripts will be dropped in 1934-35. Thus water supply engineering is number C. E. 40a to distinguish it from the old C. E. 40, highway construction.

I cite that example with a suggestion of regret, the feeling those poetically-inclined people have towards standardization, as exemplified in the way some persons condemn the thirteen-month calendar as too prosaic. To those who have taken C. E. 71 and C. E. 72 there is associated in their minds with those courses a sort of tradition. To them it may seem that there is a dignity and grace to a 71 that can never be assumed by an erratic 40. And so maybe they will mourn the passing of 71 and 72.

In ceramics there has been a change increasing the amount of inorganic chemistry required in the freshman year. Eight hours of French or German are required, because many of the books dealing with ceramics are available only in those languages.

In the department of theoretical and applied mechanics the changes in numbering are just now coming into full effect. New courses were installed last year.

In electrical engineering, mechanical engineering, and engineering physics there have been no changes; nor has the curriculum in general engineering been changed much.

In gas engineering, however, there has been a great change. The principal effect is to make the freshman year the same as in civil engineering, as is the case in the first year of all other engineering curricula except ceramics. Formerly German was required for admission to the curriculum. Also, the specialized gas engineering work formerly specified in the senior year has been broken up into several courses given separate numbers.

Concerning the transfer of the department of architecture to the College of Fine and Applied Arts, H. H. Jordan, assistant dean of the College of Engineering, remarked:

"The College of Engineering has herein lost one of its largest departments. Between a fourth and a fifth of our enrollment was formerly architects and architectural engineers."

L. R. Twyman, m.e. '30, is doing research and development work for the Ingersoll Milling Machine company, Rockford, Ill.

W. S. Harris, m.e. '30, is working in the Pyrofax research division of the engineering department of the Prest-O-Lite company.

O. C. Haier, Jr., m.e. '30, is working at present for the Chicago By-Product Coke company in the service department as a heating engineer.

Research on Tennis Court Surfaces Conducted at Illinois

John L. Swarner '32

ONE of the things that impressed the author most on his return to the campus this fall was the amount of work that had been done on the university tennis courts during the summer. New facing, concrete drains, and improved appearance was most noticeable. A work of general interest to everyone had been undertaken and a good job had been done. Just what was done and some of the reasons for it are included in this article.

As any one interested in tennis knows there are almost as many kinds of courts on the University of Illinois campus as there are materials for surfacing them. Besides the well known clay, concrete, and asphalt playing surfaces there are three new courts which are finished with something entirely new and different, at least to this campus. These last mentioned three are in the experimental stage.

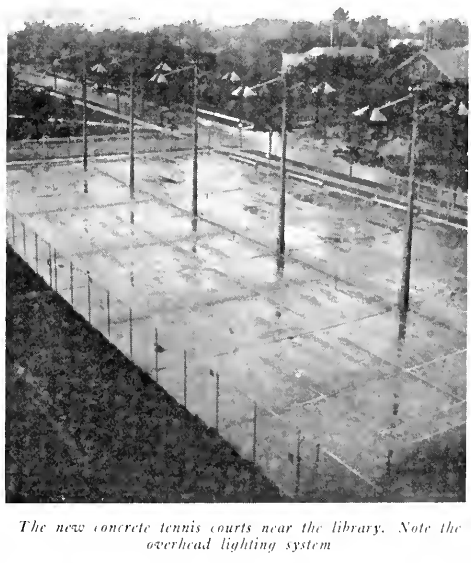
The initial cost of the common clay court is small but this type of court is the most expensive to maintain in good playing condition. If a clay court is used a great deal, as is true here, the markings should be renewed every day. On the university courts there is a total of three and one-half miles of lines and it takes from 25 to 30 gallons of dope for one application. Assuming that the courts are kept in first class condition at all times this item of cost would be quite large. It is hard to keep the clay from getting dusty. Wetting down with water is very unsatisfactory since the effect lasts only a very short time. Instead of water the university uses calcium chloride. Twice a year 800 pounds is used. This chemical works much better than water and the effect of one application will last six months. Even this does not keep the courts in the best of condition and free from dust.

Until the spring of 1931 all the courts made of clay drained into one corner of the group. This meant that one side of a group would be dry soon after a rain while the other side would still be wet and unfit to play on. To eliminate this fault concrete drains were laid around each set of courts and each court was made to drain separately into this common drain. The slope of the concrete drain is 8 inches in 120 feet.

On the campus there are two groups of concrete courts. One group is located near the new library and the other is at the west entrance to the stadium. The biggest disadvantage to this type of court is the initial cost. The cost of construction will range from $800 to $1,000. But this initial expense is offset by the decreased cost of upkeep, which is practically negligible. Figuring on the basis of cost and maintenance of clay courts a concrete court will pay for itself in five years.

A few of the advantages of this type playing surface are that it can be used almost immediately after a rain, it can be drained easily, and the condition of the surface remains constantly good without attention. It cannot be denied that playing on concrete is hard on the feet, but this ought not to affect the average student who plays only a little while each day. The ball will have an abnormal bounce if considered by tournament play, but again this is offset by the fact that the courts were designed for the enjoyment of the student and not the tournament player.

One thing that should be of interest to tennis players all over the world and to anyone interested in the building or maintaining of courts is the experimental group of courts at this university. It is a new field of research, the results of which, it is hoped, will be beneficial in many ways. There are three of these courts, and on each side of the net of each court a different surfacing mixture is used. The location of this experimental group is at the corner of Fifth and Armory streets in Champaign.



The new concrete tennis courts near the library. Note the overhead lighting system

The surface of the south half of the east court is made up of a mixture of cinders and clay, 50 per cent of each. The material presents a firm playing surface, free from dust. It drains easily and holds moisture much better than clay. It has the disadvantage of being sticky after a rain.

The north side of the net on this same court is finished with a mixture of stone dust and cinders. The cinders act as a binder for the stone dust. This is a 50-50 combination of the materials.

From present appearance, the surfacing of the center court, on the south side of the net, is the best one of the group. It drains very well, is free from dust and makes

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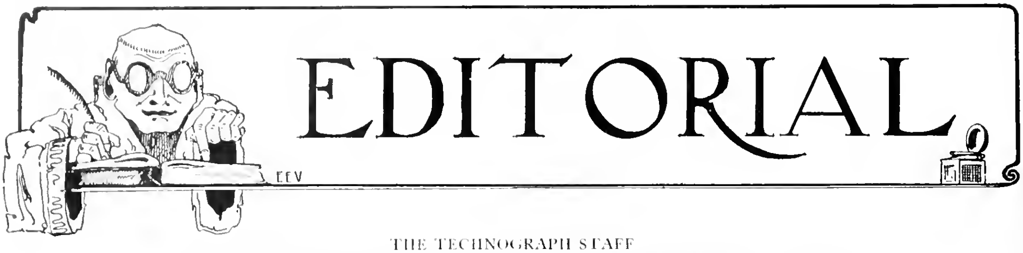


Looking Back

Congratulations and thanks are due to the members of the Technograph staff of 1930-1931. They did a remarkably good job of publishing the magazine. Chief among their accomplishments was the elevating of the Technograph from a quarterly to a monthly publication. Until last year the Technograph appeared so infrequently that engineering students almost forgot of its existence between issues. Last year with its more frequent appearance on the scene engineers became conscious of its presence, and it began to show some of the "power of the press" of which we hear so much.

To enumerate just a few of the accomplishments of last year, we mention the predominance of student-written articles in the Technograph, the selection of what we believe to be an attractive and appropriate cover design, and a thoroughly intelligent job of editing.

Again our congratulations and best wishes for success.

Looking Ahead

After lauding our predecessors to the skies, it behooves the members of this year's staff to attain a similar degree of excellence in publishing the Technograph. Much has been accomplished toward making it a publication worthy of a place on the Illinois campus, but much still remains to be done. The staff this year is entering on its task with a full realization of the size of the job, but with a firm determination that the job will not prove too big.

Since all incoming office-holders are possessed of a large number of ideas concerning the way in which they plan to conduct their offices, and improvements which they plan to put into effect, it is only fitting that we have our share of schemes for this year's issues of the Technograph. So we are setting forth below a few of the planks in our platform for 1931-1932.

First, we plan a continuance of the practice of using student-written articles wherever possible. We believe that the only excuse for the existence of a magazine of this type is the manner in which it can serve the members of the group it represents. And while the Technograph hopes to make its columns interesting enough that engineering students, faculty, and alumni will read it with pleasure, we believe that one of the best ways it can be of service is by giving student engineers the opportunity and impetus to write technical articles. More and more frequently we hear that if an engineer wants to get anywhere in his profession he must learn to write and talk. And while the Technograph offers no opportunity for becoming proficient in the latter art, it is willing and eager to provide training in writing to all engineers who are ambitious enough to grasp the opportunity.

Second, we hope this year to obtain a fairer representation of all the engineering schools in our columns. Certain departments in the College of Engineering have long held a grudge against the Technograph on the grounds that they were never represented. When the editor happened to be a civil engineering student it seemed that in the natural course of events articles concerning civil engineering predominated in the magazine. This statement is meant to be general, not an indictment on any particular editor or editors. This year we plan to select the subjects for feature articles in an approximate proportion to the number of students studying the branch of engineering under which the various subjects would be classed. That is, if the number of ceramic engineers makes up a total of, say, six per cent of the total number of engineering students, approximately six per cent of the feature articles will concern ceramics. Naturally this in an ideal which cannot be exactly attained, but an effort will be made in the direction. In the departmental and alumni pages of the Technograph we hope each month to have a complete representation of every engineering department.

Campus engineering activities will be given their share of publicity in the Technograph. We feel that one of the best ways for student engineers to get a practical idea of engineering design and construction is by personal observation of engineering activities, and by being presented at the same time with an authoritative explanation of the particular bit of engineering under observation. The campus of the University of Illinois offers an unusually large field for study of this kind. Within the last year a new women's gymnasium has been built, an ice-skating rink is now under construction, a new water purification plant was completed this summer, and a great deal of experimental work on surfacing of tennis courts has been carried on, to mention only a few. An article telling of the new tennis courts appears in this issue of the Technograph and later issues will deal with other items of engineering news at the university.

The university Engineering Experiment Station is known as one of the finest in the world, yet the average engineering student hardly knows anything more about it than that it exists. Studies of engineering problems are constantly being carried on at the station, the results of which are used almost immediately by engineers the world over. This issue of the Technograph presents, in the departmental notes, an outline of an investigation of multiple-span concrete arch bridges now being carried on. Results of this investigation will be printed in the Technograph as soon as they are available, and as other investigations are carried on accounts of them will be published.

It is hoped that the Technograph can run a series of articles this year dealing with the probable future developments of the various branches of engineering. A series of this kind should be of value to the students in enabling them to shape the course of their studies toward fields wherein will lie the greatest possibilities. If this idea proves workable, each issue of the Technograph will contain an article dealing with some one field of engineering.

A start was made last year toward presenting something of the background of modern engineering practices by reviewing some of the history of engineering. An effort will be made this year to continue this practice.

Engineering students will find in their junior and senior courses that instructors are continually harping on the subject of engineering finance. This subject is becoming more and more important to student engineers as the tendency is for practicing engineers to be consulted on the financial as well as the construction end of almost all projects. The Technograph plans to do its part in providing for the students' education along these lines by emphasizing wherever possible the economics of engineering.

These are a few of the definite policies of the 1931-1932 Technograph. Very likely some of them will prove not workable, and since we are human some of them may be forgotten. However a diligent effort will be made by the staff to follow the outline as given above.

In conclusion, the staff wishes to emphasize the fact that the Technograph is a publication of the engineering students of the university, and as such its chief aim is to serve these students. The Technograph hopes to serve as a bulletin board for the engineering school by holding its columns open for all university news pertaining to the school. Announcements and write-ups of technical meetings will always have a place in its columns, and officers of engineering organizations are urged to make free use of the Technograph for this purpose.

Professional Societies

Attention is called to the feature article in this issue written by the presidents of the engineering societies of the university. It may seem to some that this part of university life is given an emphasis in excess of its value. It is often said that the Illinois campus is over-organized. This criticism, in its general application we believe to be a just one, but we believe that the technical organizations of the engineering school should be supported wholeheartedly by students. As stated by Dean Jordan in his introduction to the article mentioned, the curricula of the engineering school are too full to allow its students much opportunity for coming in contact with subjects which do not pertain at least indirectly to engineering. Intercourse between freshmen and sophomores and members of the higher classes is almost impossible in the strictly curricular activities of the school. The technical societies offer a means for removing all these disadvantages of a large school. At meetings freshmen are given the chance to meet the upper classmen and to benefit by their experiences. The opportunity for meeting members of the faculty is alone valuable enough to serve as a reason for attending the meetings. And many of the organizations on this campus are large enough and influential enough, partly through themselves and partly through the faculty, to secure as speakers for their meetings men who have gone to the top in the profession.

Membership in the technical organizations will prove well worth your expenditure of time and money.

The Cover Design

The cover design for this issue shows a view of one leaf of the lock in the new river entrance to Liverpool, England, as the leaf is being moved into position on timber launchways. This leaf weighs 500 tons. The gates in the lock will be closed by wire rope attachments, and will be the largest in the world. The view is from the floor of the canal.

The selection of this subject for the cover design is in keeping with the policy of the Technograph this year to run a series of views of modern engineering projects. Use of a lock as the theme of this cover is timely again in that the first article in this issue tells of the construction of a lock and dam system on the Allegheny river. Readers of last year's issues will recall that ancient engineering works were used as the subject for the cover drawings for that year.

Tau Beta Pi

W. P. JONES, *Vice-President*

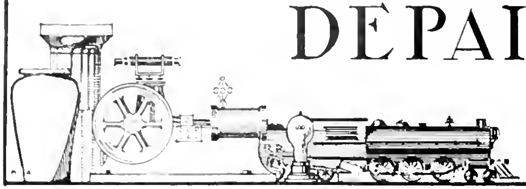
"To mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship and exemplary character as undergraduates, or by their attainments as alumni; and to foster a spirit of liberal culture in the Engineering schools of America"; this, according to its constitution, is the purpose of Tau Beta Pi.

Tau Beta Pi is the oldest engineering honorary and the second oldest honorary of any sort. Phi Beta Kappa, founded at Lehigh University is the oldest. Tau Beta Pi was established in 1885 at Lehigh University by Prof. E. H. Williams. Prof. Williams felt, rightly, that an honorary was needed for engineers, for Phi Beta Kappa objected to taking in technical men. The new organization developed rapidly, and there are now chapters in practically all of the leading engineering schools of the country.

Our local chapter, Alpha of Illinois, has ordinarily about 30 active members. Eligibility for membership is based mainly upon scholastic standing, although not entirely. The candidate's character is also taken into consideration. One man is elected to membership during the first semester of his junior year. In the second semester, however, a varying number of juniors, usually from 15 to 20 are declared eligible for membership. Another group of from 10 to 15, or thereabouts, is initiated in the first semester of the senior year. No seniors are taken in during their last semester.

The present officers of Alpha of Illinois are as follows:

President, W. V. Wuellner; vice-president, W. P. Jones; recording secretary, C. A. Davis; corresponding secretary, J. F. Whisenand; treasurer, A. C. Hottes; master of initiation and cataloguer, F. M. Deerhake.



DEPARTMENTAL NOTES

Engineering Experiment Station

An extensive laboratory investigation of multiple-span reinforced concrete arch bridges is being made in the materials testing laboratory. This program will supplement the investigation of single-span arches that has been in progress for a number of years.

The behavior of the multiple-span differs from that of the single-span arch in that the latter is supported on abutments which fix the ends of the arch rib whereas, with the former, while the bases of the intermediate piers are fixed, the elastic deformation of a pier permits its top to move, thereby moving the ends of the arch rib as the bridge is loaded. And this movement of the ends affects the stress in the rib due to the load.

Each specimen will consist of three 27-foot span arches supported on abutments and piers 20 feet high, so that the experimental structure will be approximately 100 feet long and 35 feet high. The arches will be loaded to destruction with concrete blocks of known weight distributed in the same manner as loads are assumed to be distributed in the design of an arch for a highway bridge.

Tests will be made to determine the strength of the arch and also to determine the elastic deformations due to load, particularly the movements at the tops of the piers due to the stress in the piers.

The entire structure will be mounted on weighing machines, two machines being provided to measure the horizontal and two for the vertical reactions for each pier and for each abutment.

Five multiple-span structures are to be built and tested. The first will consist of ribs without decks, a structure that can be analyzed algebraically, taking into consideration the elastic deformation of the piers. Each of the other four structures will consist of a rib with deck similar to the open spandrel arch bridges frequently used for highways. Each of these latter structures will have a different deck, the decks differing from each other in the number and location of expansion joints and in the height of the deck above the crown of the arch rib.

A single-span arch rib will be built and tested previous to the tests of the multiple-span structures. The object of this preliminary test is to try out the apparatus, all of which is being built special for this work, and to determine the behavior of the single-span rib with fixed abutments to be used as a basis of comparison in determining the effect upon the multiple-span structure of the movement of the ends of the ribs due to the elastic deformation of the piers. The single-span rib will be poured early in October and tested in November. The other structures will be built and tested as soon thereafter as possible. The whole program will require two or three years for its completion.

The tests of the multiple-span arch bridge is being made by the Engineering Experiment Station at the University of Illinois in co-operation with the United States Bureau of Public Roads, assisted by the American Society of Civil Engineers and the Engineering Foundation. The Universal Atlas Portland Cement Company and the Illinois Steel Company have made contributions covering the cost of the cement and reinforcing steel. The investigation constitutes a part of the work of the Engineering Experiment Station of which Milo S. Ketchum is the director, and of the Department of Civil Engineering, of which W. C. Huntington is the head. The work is being planned and directed by W. M. Wilson, research professor of structural engineering; assisted by Ralph Kluge, special research assistant; and Glenn Murphy, F. B. Metterhausen, and J. N. Pirok, graduate research assistants. The Bureau of Public Roads is represented by Thomas H. MacDonald, chief of bureau; E. F. Kelly, chief of division of tests; Albin L. Gemeny, senior structural engineer. The Engineering Foundation is represented by Alfred D. Flinn, director; and the American Society of Civil Engineers is represented by its research committee on concrete and reinforced concrete arches, the members of which are—Professor C. T. Morris of Ohio State University, chairman; Professor G. E. Beggs of Princeton University; Professor W. M. Wilson of the University of Illinois; and A. C. Janni and E. H. Harder, consulting engineers of New York City.

T. and A. M. Department

This department has buckled in its belt, thrown out its chest and is already for a vigorous plunge into this year's work; a plunge which should certainly implant in the minds of many embryo engineers a working knowledge of mechanics, hydraulics and the "good old little particle" which must always be considered first.

In all seriousness, however, the department has hard work ahead of it this coming semester with the heaviest enrollment in T. and A. M. ever recorded at Illinois. It was necessary to bring in four members of the department of engineering drawing to help the staff handle its teaching duties.

The entire third floor of the east wing has been remodeled, forming nine new rooms. These new rooms, which will be devoted to research, will house two new concrete laboratories, chemical and metallographic laboratories and other testing equipment for the Engineering Experiment Station.

Two new torsion testing machines of 5000 inch-pound capacity, designed by Prof. H. F. Moore, have been installed during the summer months. These machines have many new features not found on the ordinary torsion testing machine. They were built by Hayes and Company of Urbana under the personal direction of Prof. Moore. A new 60,000-pound Southwark Emery Universal testing machine has also been installed. This machine, with its hydraulic method of weighing, is much more sensitive than the ordinary beam weighing type. To top off this new equipment all the laboratories have been given a new coat of paint to begin the new year, as it were, with new and shining faces.

Prof. F. Richart in September gave two lectures at the Portland Cement association college short course at Chicago. Prof. Richart also attended a meeting of the rail steel committee of the highway research board at Ann Arbor the same month. This committee is determining the feasibility of using old rails and rerolling into reinforcing bars.

Prof. and Mrs. M. L. Enger have been in St. Paul attending the semi-annual meeting of the A. S. C. E.

Prof. H. F. Moore has returned to the campus after a six-weeks' tour of Europe where he attended a meeting of the International Association for Testing Materials. This meeting was held at Jurich, Switzerland. During the trip he visited the British national physical laboratory at Teddington, Middlesex, and also many other laboratories in Europe. Our own laboratory here at Illinois, however, is one of the best equipped academic laboratories in the world.

Work on the investigation of transverse fissures in rails was carried on during the summer by Prof. Thomas and his assistants. The investigation is being conducted in the interest of the railroad industry and allied concerns.

C. E. Department

The university's new water filter plant was put in operation this summer. Water is pumped from the raw water basin behind the electrical engineering laboratory into the filter plant behind the foundry laboratory by four centrifugal pumps into rooms comprising 187 square feet of filter area. It is then pumped into the new clear water basin with a capacity of 250,000 gallons, enough to supply the university with water for six hours under normal conditions.

Approximately one million gallons of water a day are consumed by the university.

A more complete description of the plant will appear in a later issue of the Technograph.

E. E. Department

Prof. E. B. Paine, head of the electrical engineering department, spent most of the summer touring England.

Prof. H. A. Brown, who for several years has been conducting a co-operative research with the Utilities Research Commission on cable testing, spent several weeks in the early part of the summer in New York City where he tested cables in several large manufacturing companies by his radio detection bridge method. Prof. Brown also completed his book on "Radio Frequency Electrical Measurements."

Mr. Carl E. Skroder spent the summer in Chicago with the Illinois Bell Telephone company calculating the residual currents due to ground faults on high voltage power systems to determine the peak induced voltages in telephone lines exposed to these systems.

Mechanical Engineering

At the beginning of the school year it might not be amiss to review our aims and ideals underlying the courses required for graduation in mechanical engineering. These courses are not chosen to ultimately develop draftsmen, mechanics, corporation president or secretaries but to lay the foundation for the future chief engineer. This chief engineer is the one who will design, build and operate the future super-power plant or super-manufacturing plant.

The personnel and equipment this year is very much the same as last year. Mr. A. F. Hubbard who received his B. S. degree from the University of Texas in 1931 has been appointed a research graduate assistant in mechanical engineering.

Tennis Court Research

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a firm playing surface. This mixture is 50 per cent shale and the remainder stone dust.

The center court on the north side of the net has a surface of brick dust and shale in equal amounts. The brick dust is from very hard brick and is finely ground.

On the west court south of the net the topping consists of three things, 15 per cent brick dust, 35 per cent black gumbo, and 50 per cent cinders. The north side of this court is finished with a combination of 25 per cent brick dust, 50 per cent shale, and 25 per cent black gumbo.

There is still some doubt as to how the fourth court will be made. However it is thought that one side will be made up of black dirt and blue clay and that this will be topped with burnt moulder's sand. The other half will probably be made of stone dust and rotted cinders.

All the qualities of the materials used are still much in doubt since the courts must undergo the weathering of winter before any definite results may be obtained. From present observations the courts all drain better and can be played on much sooner after a rain than can a clay court. Each of the courts drains separately. It is hoped that by next spring the definite qualities of the different materials used can be determined. Benefits will be derived both by the players, who are interested in the quality of the courts, and by the athletic association, which is concerned with both quality and expense. The aim of the athletic association is to find something which will be economical to construct and which will require very little upkeep.

All the courts on the campus have been numbered. This was done to facilitate the recovery of wildly hit balls and to help those waiting for courts. Owing to the fact that most of the courts are on corners they have been fenced on all four sides. This removes all danger of balls being continually knocked into the roadways.

The combining of the beautiful with the practical has been accomplished with great success on the group of courts west of the library. They are of concrete, fenced on four sides, and lighted at night by an excellent system.

Beauty was considered more than cost in the construction and lighting of these courts. Each of the poles supporting the lights is valued at $250. There are seven of these poles which support a total of 24 lights, each of which lights cost $40. Assuming that the cost of construction of each court was $1,000 and knowing that each steel net cost $40, the total cost of the courts and lighting equipment was $8,950. This price does not include any of the smaller items of expense. The lighting equipment that would ordinarily be used would cost much less.

There is an interesting point connected with the night lighting system. The lights shut off automatically at 11

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CONTEMPORARY ENGINEERING NEWS

Hoover Dam Versus St. Francis Dam

Following the authoritative appearance of the Hoover dam in the October, 1930 issue of Civil Engineering, discussion of the enormous project was carried on in the magazine for quite some time. In the July, 1931 issue the question of "Ample Security for Hoover Dam" was brought to light by M. H. Gerry, Jr., consulting engineer for the city of San Francisco. He states that in a general way the designs of the Hoover dam are similar to those of the ill-fated St. Francis dam which failed without the slightest warning and caused heavy losses to both life and property.

Following this radical announcement came replies in the August edition of Civil Engineering by Elmwood Mead, Commissioner of Reclamation, and by Professor H. M. Westergaard, consulting engineer for the Bureau of Reclamation. Mr. Mead states: "Nothing could be more misleading than the comparison of the St. Francis and Hoover dams and the drawing of the conclusions therefrom. The St. Francis dam was 16 feet thick at the top, 176 feet thick at the base of the maximum section, and approximately 700 feet long at the crest. The Hoover dam will be 45 feet thick at the top, 650 feet thick at the base of the maximum section, 727 feet high at the location of the maximum section, and approximately 1,180 feet long at the crest. The central angles at the higher elevations in the Hoover dam, where arch action will be most important, will be considerably greater than those at corresponding elevations in the St. Francis dam. The St. Francis dam was essentially a gravity dam; the Hoover dam will be essentially an arch dam. The St. Francis dam was not provided with construction joints; the Hoover dam will be provided with construction joints and the joints will be thoroughly grouted under high pressures after the heat of setting has been dissipated. The St. Francis dam was not provided with an adequate drainage system, within the great mass of concrete as well as at the base of the structure.

"Some of the abutment material at the St. Francis dam site can be crushed in the fingers when dry. It disintegrates and falls to pieces when placed in water. The abutment material at the Hoover dam site, when placed in an accurate testing machine, withstands a compression of 8,000 pounds per square inch, a pressure more than 18 times as great as the maximum stress in the concrete. Some eminent and conservative geologists in the country have examined the rock at the Hoover dam site, and have approved the material as satisfactory for the foundations and abutments of a dam of the size specified. In the Hoover dam, about two-thirds of the total water load will be carried by arch action. There is no question regarding the transfer of load by arch action in such a dam. The arches must act."

Professor Westergaard reports: "According to the notion expressed by Mr. Gerry, a gravity dam in a canyon is a simple, indeterminate structure. Thought on the subject will readily show that such is not the case. Twists and shears are transformed in a horizontal direction, and this transfer is not always a friendly influence. There will be bending of the horizontal slices, and enclosed arches will form. This complex action may be investigated by the extended method of trial loads. The required analysis is of about the same complexity as that of an arch dam. Statical indeterminateness does not in itself mean uncertainty and is not undesirable; but there would be, to begin with, an uncertainty about the action of a gravity dam in the Hoover site. It is not rational to put a gravity dam in this arch-dam site."

Engineers Pay Tribute to Michael Faraday

During the week of September 22, members of engineering societies, led by the Institution of Electrical Engineers and by the Royal Institution of Great Britain, gathered in London to participate in the activities commemorating the 100th anniversary of the greatest discovery by the great English chemist and physicist, Michael Faraday. Tribute was paid in the form of public addresses by leading individuals and a public display of the works of Michael Faraday, whose crowning discovery of the induction of electric currents had no little part in increasing the wealth and production of the world.

Michael Faraday was born at Newington Surrey on September 22, 1791, the son of a poor blacksmith who had migrated from Yorkshire to London. The father died when Michael was only nine years old, leaving the family in destitute circumstances. Later Faraday, at the age of 13, was put to work in a book shop, and a few years later he was apprenticed as a book binder. He continued to work in this capacity until March, 1813, when he was appointed assistant in the laboratory of the Royal Institute of Great Britain on the recommendation of Sir Humphrey Davy, whom he accompanied on a tour through France, Italy, and Switzerland from October, 1813 to April, 1815.

On his return from Europe, Faraday occupied himself with the laboratory routine and conducted some chemical experiments of his own. He soon began to publish bulletins and documents, and to give lectures based on his investigations, at the same time building up a reputation as a consulting scientist. In 1825 he was appointed director of the laboratory, and in 1833 he was given the Fullerian professor of chemistry in the institution for life, without the obligation to give lectures. Faraday's early chemical works followed closely that outlined by Davy, to whom he acted as assistant. He made a special study of chlorine, discovering two new chlorides of carbon. He succeeded in liquifying several gases, investigated steel alloys, and produced several new kinds of optical glasses. One of these glasses became historically important as the substance in which Faraday detected the rotation of the plane of polarized light when the glass was placed in a magnetic field.

But Faraday's chemical work was soon overshadowed by his electrical discoveries, beginning in 1821 with the study of electromagnetic induction. In 1824 he had attempted to obtain an electric current by means of a magnet. On August 29, 1831, he obtained the first evidence that an electric current can induce another in a different circuit. During this early period of discovery, Faraday established the identity of electrification produced in different ways, the law of definite electrolytic action of a current, and the fact that every unit of positive electrification is bound in a definite manner to a unit of negative electrification.

Faraday had for a long time kept in view the possibility of using a produced ray of polarized light as a means of investigating the conditions of transparent bodies when acted on by electric and magnetic forces. After further experiments, Faraday actually constructed the forerunner of the modern electric generator, a laboratory model of the dynamo. So little was he concerned with the rewards of his discoveries that when they reached the patented stage, he immediataely lost interest in them.

Faraday so gave himself up to the service of science, that in 1840 his health began to fail. He gave up his work for a four-year rest, and then returned to carry on for another 18 years, when he completely lost his memory. He died at Hampton Court five years later, on August 25, 1867. The funeral was private and unostentatous, in keeping with the simplicity of his natural life.

Model Testing Well Advanced for San Francisco Bay Bridge

The September 10 issue of the Engineering News Record describes the tests well under way for the proposed San Francisco-Oakland bridge. The investigation at present has included the construction and testing of several accurate and structural bridge models on a 1 to 100 scale representing the 4,200-foot main span crossing between San Francisco and Yerba Buena (Goat Island), which illustrates the important problem of span and clearance. Present studies are being made in the new engineering materials laboratory of the University of California for the California Toll Bridge Authority.

The models are built of cold-drawn wire and rolled steel giving almost the same physical properties as will be found in the actual bridge. The supporting structure of the steel channels eliminates the need of correcting for room temperature variations in the model, and provision to introduce temperature stresses and deflections equivalent to actual field observations is made by moving the towers and cable anchorages. For various conditions of temperatures and loading, stresses in cable and stiffening truss, deflection of towers and stiffening truss and in changes in grade of roadway are determined. By the usage of an elaborate system of nomographs the observations on the model can be translated into terms of the actual structure by simple inspection.

The present investigation has been carried on under the guidance of Prof. R. E. Davis, director of the laboratory. The actual design and testing of the models falls under the personal direction of Prof. G. E. Beggs of Princeton University. The work follows to a great extent the pioneer work Prof. Beggs did last year on the Mount Hope bridge model. The latter model was the first structural model of a suspension span built primarily for accurate stress analysis, and the results obtained by that investigation caused the Toll Bridge Authority to engage the present model study as a part of the design procedure for the proposed San Francisco Bay bridge. C. H. Purcell, chief engineer for the Authority, is in charge of the entire project.

Manhattan's Lightning Rod on the Empire State

All of Manhattan has little to fear regarding lightning storms, now that the Empire State building reaches nearly a quarter of a mile into the sky. It is itself Manhattan's lightning rod. And being well grounded by the massive steel work, the building itself has no further worry from the charged lightning bolts.

Experiments have been carried on with 5,000,000-volt bolts of laboratory lightning in the research department of General Electric, showing that the world's tallest building affords lightning protection to all buildings within a considerable radius of it, with the possible exception of one or two buildings nearby. New York's skyline in miniature was used in the tests ,and bolt lightning was thrown earthward. Each time the tower of the Empire State building was touched. No damage resulted, the model itself being well grounded as is the original structure.

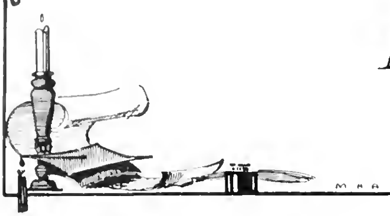
This neutral volume is cone shaped, such as would be included by a line drawn from the top of the building to a radius of about a mile high. The protected area plan has already been put to use in the safeguarding of oil storage tanks in the oil fields of Southern California. There tall rods placed near the big oil reservoirs provide overlapping protected areas, thus lessening the possibilities of fire hazards from lightning flashes.

A few weeks after this experiment was conducted, the Empire State building was actually struck three times in a severe electrical storm, to prove again the worthiness of the name, Manhattan's lightning rod.

Scrap Metals

The recovery, treatment, and salvaging of waste materials in the United States represents a half-billion dollar industry, as stated in a recent report of the U. S. Bureau of Mines, published in the September issue of Chemical and Metallurgical Engineering. The secondary metals such as those recovered from scrap metal, sweepings, skimmings, and drosses, have become extremely important in past years. Over 500,000 short tons of copper is recovered annually from brass and other copper-bearing metals. Secondary lead production amounts to approximately 300,000 short tons, equal to 40 per cent of the total lead produced. Battery plates and slime, lead cables, lead pipe, and lead lining of acid tanks supply large quantities of secondary lead in addition to that obtained from babbit, solder, tube metal, brass, and white metal drosses.

Secondary tin recovery in the United States equals about 41 per cent of the tin imported as pig metal, and in normal periods is valued at $30,000,000 to $35,000,000. Almost all detinning in the United States is carried on by electrolytic processes or cloring process. Many of the plants are equipped to handle 40,000 tons of old tin-coated containers, but have until present operated below a full capacity. Even when the price of tin was much higher than at present, only small quantities of old cans had been worked over.



ALUMNI NOTES

PROF. A. N. TALBOT, c.e. '81, has recently been awarded another honor, namely, the George R. Henderson medal of the Franklin Institute. The citation reads, "In consideration of his practical development of the railway transition spiral and for his creative guidance of the American Railway Engineering Association's tests on structural and track materials for railway building and maintenance, which resulted in a wide extension of the knowledge of such materials and in the promotion of safety in railroading."

Announcement has been made of the marriage of E. J. LAWSON, c.e., '30, to VIOLA LITTLE ex'32. The ceremony took place May 30, 1931. Since his graduation Ed has been working for the Illinois State Highway Commission, his work being in the northern part of the state. Rumor has it that Ed shows up each day on the job with a freshly laundered shirt and trousers.

DON JOHNSTONE, c.e. '31, is at present employed at the United States Engineer Office in Kansas City. This office has charge of navigation control, flood control, and power studies of the Missouri river and all its tributaries. Don is working in the power section, and will be making studies of power possibilities of the Knife river, the Yellowstone river, and other tributaries, in addition to the Missouri itself. Don was particularly known on the campus as editor of the Technograph and winner of the Ira O. Baker prize for civil engineers in 1931.

H. L. HAWORTH, c.e. '31, is with Sam Nanini, paving contractor. At present he is in Rockford, Illinois, superintending the laying of a Pre-cote pavement, a new type of asphalt emulsion pavement.

JAMES F. CHANDLER, c.e. '31, is in the U. S. Engineer Office at Paducah, Kentucky, engaged in Ohio river improvement work.

GEORGE M. WOOD, c.e. '31, is apprentice engineer with the Bethlehem Steel Co. at Bethlehem, Penn.

EDWARD C. FRANZEN, c.e. '31, has the position of junior engineer with the War Department at Rock Island.

H. E. HUDSON, c.e. '31, is with the water purification department of the city of Chicago.

F. S. BROWN, c.e. '31, is student engineer in the U. S. Engineer Office at Rock Island.

EDWARD A. HILL, c.e. '31, is with the Illinois State Highway Commission, working out of Marshall, Ill. He is doing pavement repair work, now, on U. S. route 40 between Marshall and the Indiana state line.

LESTER DORR, c.e. '31, is working on the Missouri river project in the U. S. Engineer Office at Kansas City, Mo.

C. E. SARGENT, m.e. '86, pioneer in the design of complete expansion gas engines, has joined the engineering and research staff of the National Transit Pump & Machine company at Oil City, Pa., which is about 75 miles north of Pittsburgh.

Mr. Sargent's achievements have been many and distinguished in the field of internal combustion engines and other kindred machines on which he has taken out more than 25 patents. He built the first complete expansion tandem double-acting gas engine, the fore-runner of all large gas engines now in use. This original was presented to the Ford museum at Dearborn by him several years ago. Before taking up his present work at Oil City, he had been for several years a consulting engineer for Westinghouse at the Wilkinsburg plant.

Mr. Sargent's most recent patent is a complete expansion automobile gas engine—an engine which will drive a car 60 per cent to 70 per cent further per unit of fuel than the throttle engine with the same piston displacement. Patent rights for this new engine have been sold in England, France, Italy, and Germany, where an economical engine is desirable since the price of fuel is high.

HAROLD D. THOMPSON, c.e. '31, is with the Baltimore and Ohio Railroad, Chicago, Ill.

L. E. VAN EPPS, c.e. '31, is inspector at the Elgin office of the Illinois State Highway Commission.

JOHN CHESTER, c.e. '91, has been appointed on a committee of five members of the Western Pennsylvania Engineers' Society to study the technical set-up and methods of the Pittsburgh Department of Public Works, with a view to possible improvement. His selection was commented on approvingly by a Pittsburgh paper.

WALTER MUELLER, c.e. '05, whose fine record as a contractor and a builder is well known around Detroit, owns the W. H. Mueller company. His chief work has been the construction of public buildings, having completed 20 school buildings in Detroit and vicinity. He has also done a great deal of work for the Detroit water commission, public lighting commission, and department of public works. During the winter months he vacations in Bermuda, Cuba, Honolulu, California, or Florida.

ARTHUR C. BRAMING, c.e. '31, is employed by the Illinois State Highway Department.

H. D. PEOPLES, c.e. '31, is with the Kansas State Highway Department, headquarters at Garden City, Kan.

M. S. KETCHUM, JR., c.e. '31, is taking graduate work at the University of Illinois.

CLARENCE O. WIES, c.e. '31, has a position with the Illinois Division of Highways at Elgin, Ill.

A. A. Stevenson, c.e. '83, has retired but is still an active member of technical organizations. He started in as a draftsman in July, 1881 for the Southwark Foundry and Machine company and was there until the spring of 1886. During his last year there he was foreman of the drafting room.

In 1886 he went to the Cambria Steel company, where he was in the engineering department for a year and a half. The following year he was foreman of the forge and axle plant of the same company.

In 1888 he entered the employ of the Standard Steel Works company as a traveling engineer. He was with them for 41 years. He raised himself to the position of vice-president of the company and served in that capacity for 21 years until he retired. For a great many years he has been interested in a number of technical organizations, among them the American Society for Testing Materials, in which he held various positions, finally the presidency.

He has been interested and still is in the work of the American engineering standards committee and was its second chairman. For a number of years he was a member of the Association of American Steel Manufacturers. He was vice-president for two years and president for three years.

He has kept in close touch with the simplification work of the Department of Commerce, which was started by President Herbert Hoover when secretary of that department, and is a member of the planning committee for the division. He is the present chairman.

Frank G. Frost, e.e. '01, is superintendent of the electric department of the New Orleans Public Service, inc. Before assuming his present position he was with a string of utilities in the South.

Several engineering alumni received new degrees at the 1931 commencement exercises. Elwyn Lorenzo Clarke '02, Sidney Griswold Martin '12, and Wallace Monroe Lansford '24, all received the degree of C. E. which is a professional engineering degree. Ernest Lawrence Stouffer '18 received the professional engineering degree of M. Arch. The degree of M. S. in mechanical engineering was received by Peinhold Fridtjof '23. Edgar Elmer Ambrosius '28 also received an M. S. in mechanical engineering. Joseph John Weiler '26, received an M. S. in architectural engineering. Kenneth Clem Tippy '27 received an M. S. in civil engineering. Stuart Wellington Lyon '24, received an M. S. in theoretical and applied mechanics.

Ernest V. Lippe, m.e. '02, is consulting engineer on the Medical Research building in Chicago.

Marion Kays, c.e. '06, is superintendent and chief engineer of the Lake Worth drainage district, West Palm Beach, Florida.

L. V. James, e.e. '06, of the midland division of the National Lamp Works recently donated to the electrical engineering department of the university a $300 gift of two bracket cabinets arranged with transparencies to illustrate various methods of electrical street lighting and flood lighting installations.

Larry Brugman, m.e. '30, is an assistant examiner in the U. S. Patent Office at Washington, D. C. He is also attending the George Washington University night school where he is entered in the school of law. He has decided to get his L. L. B., pass the bar and become a patent attorney.

T. D. Yensen, e.e. '07, has recently produced a new metal, which he calls hipernik, to be used as cores for transformers. At a recent meeting of the Harvard club of New York he showed his metal to be more highly magnetizable than the purest iron. His purification process was not accidental but was the result of long years of patient investigation of melting iron in a vacuum. He began his experimenting while he was still a student in the university.

Prof. Yensen, who was born in Norway in 1884, was graduated from Illinois in electrical engineering in 1907. He was, in the same year, awarded the Edison medal by the American Institute of Electrical Engineers. In 1907-1908 he worked in the testing department of General Electric.

In 1908 he returned to the university as an assistant in electrical engineering and remained until 1909, when he took a position with the Shawinigan Water & Power company, Montreal, Canada. He returned to the university in 1910 as assistant in the Engineering Experiment Station. In his five years of service he experimented extensively with transformers. His experiments ultimately resulted in the production of hipernik which if put into use promises a saving of power to the extent of some $10,000,000 a year.

Courtesy The Archi

Lester H. Christen '18

Lester H. Christen, c.e. '18, of Richmond, Va., has held the position of sales manager for the Virginia Steel company since 1925. During the war he was with the U. S. Shipping Board, and later he became an iron works designing engineer. Following that he went to Norfolk, Va., first with the Lock-Joint Pipe company, then to take charge of the Norfolk water supply. He then stepped into his present position.

Lester T. Davis, m.e. '30, is an engineer with the L. H. Prentice Co., heating contractors in Chicago.

B. Leighton Wellman, m.e. '30, is an instructor at the Worcester Polytechnic Institute, Worcester, Mass.

Edward Dieterle, m.e. '04, is treasurer of the Chicago Illini club for the current year. He is a consulting engineer for the Peoples Gas building.

Engineering Societies

(Continued from Page 13)

arts. To the prospective engineer, therefore, contemporary physics is also important, as well as much more stimulating than the conventional physics of the past. While the latter is the basis of standardized engineering practice, the former will undoubtedly determine the practice that will succeed it. The greatest opportunities lie in undeveloped fields; and the key to these fields is to be found in contemporary science. In the trend of modern physics lies the future of engineering. From consideration of this idea it was seen that there was a need for an engineering curriculum which would give the student a wide and basic knowledge of physics and mathematics.

The curriculum of engineering physics, the answer to this need, is designed as a preparation for the investigation of the more technical problems arising in industry. Modern business has discovered that great dividends are reaped from the use of laboratories, where trained research scientists are employed to develop new devices or improve old. In the engineering physics course one receives a thorough training in laboratory procedure, giving one a sound basis for industrial laboratory work. But, physics is such an inclusive subject that it is necessary for the student to specialize, to some extent, both in the theoretical and experimental work. In this respect the curriculum is quite liberal, there being 42 hours from which to choose electives and technical options. At present there are about twenty enrolled, but this small number is accounted for, no doubt, by the comparative newness of the curriculum. Within a short span of years the course will become better known. Then, perhaps, the enrollment will compare favorable with the other departments of engineering.

The Engineering Physics society was formed last year because of the need felt for a student organization in the department of physics. The organization is modeled after the other engineering societies. The aims are to acquaint the students with one another and to hold regular discussions. There are no dues nor insignia. Anyone interested in physics is urged to join.

Officers: President, Richard J. Duffin; senior representative, John Nash; junior representative, John Ryde; sophomore representative, Byron Darling.

The University of Illinois Railway Club

LIB PANICHI, *President*

It was back in 1912 that the students in the railway school at the university realized the need for an organization which would promote fellowship among railway engineering students and afford an opportunity for discussion of topics other than those offered in the regular curriculum. Ten students, assisted by the members of the faculty at that time, organized what is known as the University of Illinois Railway club. The faculty at that time consisted of Prof. A. M. Buck, Prof. E. C. Schmidt, Mr. A. C. Comstock, Prof. J. M. Snodgrass, and Mr. H. H. Dunn.

The first meeting was held on March 16, 1912. Dean Goss of the College of Engineering spoke on the subject of steel car wheels. The meetings which followed offered discussions and lectures pertaining to every phase of railway work; organization, rates, etc., and became quite popular. Many of the programs and discussions were provided entirely by members of the club. This custom was continued and the many years that the club has been in existence prove that its organization was justified.

The writer remembers last year's meetings of the Railway club, at which were presented speakers from the faculty of the railway department and programs consisting of moving pictures and slides furnished by commercial companies. Plans for the present year will bring similar programs and it is hoped that students enrolled in the department of railway engineering will avail themselves of the opportunity to become members of the club.

The railway club is not a national organization since there are very few schools offering courses in railway engineering. However this fact does not affect the liveliness and popularity of the organization.

Officers: President, Lib Panichi, R. E. E. '32; vice-president, S. L. Nauman, R. E. E. '32; secretary, J. S. King, R. E. E. '32; treasurer, S. H. Pierce, R. E. E. '32.

Lock and Dam Construction

(Continued from Page 6)

a layer of hardpan before reaching rock. The sinking process was so hard to the caissons that in several cases the steel cutting edges were torn from them in large sections. Progress was very slow, the caissons sinking only from a few inches to a maximum of 2 feet in 24 hours.

Air for the caissons was supplied from a compressor plant on the west bank and was piped out to them along the Whirley trestle. The maximum pressure used was 16 pounds per square inch.

On reaching rock, the two side chambers of the caisson were filled with concrete up to the top of the shoulders and a 3-foot concrete wall of the same height was poured along the ends of the middle chamber. The air was left on the caisson for 24 hours more, after which time all the airlocks were removed. The concrete walls of the middle chamber kept out at least 75 per cent of the water that would have run in and the seepage was easily handled with a single 3-inch Pulsomotor pump. A channeling machine was then lowered into the center well, a cut taken, and the rock excavated for the keyway. After cleaning up the bottom of the chamber, concrete was poured in up to the top of the shoulders. From that level it was poured in four lifts up to within 6 inches of the bottom of the plug. This 6-inch air space was left to take care of expansion and contraction in the concrete. The square hole through the plug was then filled with concrete. The two side chambers were poured in one lift and the concrete in them tamped in order to fill them completely.

The spans between caissons were cut off at the ends by steel sheet pile arches, the piles in the arches engaging with the piles cast in the corners of the caissons. The arches were braced and the material between caissons excavated, a keyway cut in the rock, and concrete poured up to the elevation of the tops of the adjoining caissons. From that point, the concrete was poured in 8-foot lifts to the crest of the dam.

In all, 656 feet of the dam was built by the caisson method, and 292 feet by the "bath tub" method. The former represents 16 caissons sunk. There were approximately 70,000 cubic yards of concrete placed in the dam and its abutment as compared with the 40,000 cubic yards in the lock. The lock and dam were both completed in December, 1930.

Illinois Terminal Improvement

(Continued from Page 8)

downtown St. Louis. The subway portion is still under construction and is expected to be finished in 1932.

The new terminal buildings will consist of two units: the Industrial Terminal building, which is to be entirely new, and the remodeled Carleton building. The Industrial Terminal building will cover the entire block between Lucas avenue and Morgan street, facing on High street, and will consist of twelve main stories, each with a useful floor space of over 75,000 square feet. It will be of steel and concrete construction with brick facing. A seven-story tower will surmount the main building and will be used as offices for the Illinois Terminal Railroad System and for tenants of the building. The Terminal building is being constructed directly over the end of the subway, and affords convenient shipping facilities for tenants of the building. The lower floors will be reserved for storage and handling of freight and the upper floors for manufacturers and distributors. High-speed freight elevators will serve all floors to and including the twelfth. A row of stores will face High and Morgan streets.

The second unit will be the remodeled Carleton building at High street and Washington avenue. The west portion of this building will be reduced to conform with the city's High street widening project. This building is ten stories in height and will have a useful area of about 16,500 square feet per floor. It will be refaced on both the Washington and High street sides to conform with the architectural lines of the main building. The principal passenger entrance will be on Washington avenue and the passenger concourse will be at street level. Ramps will lead to the subway level and passenger loading platforms.

This terminal project, by its new route, throws open to industry a territory heretofore not served by rail transportation. In addition, that portion of the old route, on Twelfth street between Cass avenue and Branch street, already double-tracked, will be retained for freight service. This conforms with the zoning of the city plan commission and will permit the commercial development of the area.

The advantage and possibilities of electrified operation are exemplified in two major industrial projects already under construction on the line of the Illinois Terminal Railroad System. First is the new plant of the St. Louis Globe Democrat, a $2,000,000 investment, which is located directly adjacent to the right-of-way facing Franklin avenue and covering an entire city block. This plant will be served by the Illinois Terminal and gives the newspaper trackage facilities to its stock rooms. The second major industrial project is that of the St. Louis Star, another newspaper which is building its new plant just one block south of the Globe-Democrat and facing on Morgan street. This building is being constructed on "air rights"—the first such project in St. Louis. A portion of the Star plant is being built over the yard leads. Other "air right" projects are in contemplation although there is available a substantial territory north of Franklin avenue for adjacent-to-right-of-way industry with either subway or street level rail facilities.

Aside from the freight advantages made possible by this new development is a substantial improvement in passenger service to and from Illinois points. Heretofore the main line train movement between St. Louis and Granite City was scheduled on a running time of 30 minutes. With the completion of the program and the use of the east side belt lines this will be reduced by one-third or ten minutes.

The entire terminal project is scheduled to be completed by April 1, 1932. The direct cost will be in the neighborhood of $16,000,000, with collateral investment of an additional 5 or 6 millions, all of which it is believed will be fully justified by the increased volume of business developed by these modern facilities and the enhancement of adjacent properties. Aside from these tangible advantages it is felt that the project will lend greatly to the civic development of this section of St. Louis.

Brick Manufacturing Problems

(Continued from Page 10)

water to be vaporized every 24 hours. The heat requirement is equivalent to 150 to 300 pounds of coal per 1,000 brick dried. Most of this heat, however, is usually obtained by drawing air through cooling kilns and delivering the heated air to the dryer. Direct expenditure of fuel for drying is thus avoided but the power requirement for fans to handle the large volumes of air necessary is often equal to that used for all other plant operations. Effective distribution of air in the dryer and efficient utilization of heat are extremely difficult of realization.

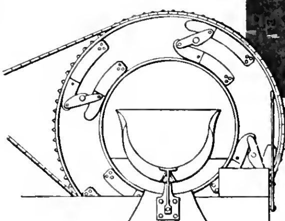
High losses may result from unsatisfactory dryer operation due to cracking of the ware. In rapid drying, especially with plastic and fine-grained clay bodies, the rate of evaporation may exceed the rate of diffusion of moisture from the interior of the body during the shrinkage period. The stresses set up by the unequal moisture distribution or shrinkage of the body cause cracking and warping. Control of temperature, humidity and the rate of air movement are essential to safe drying and the conditions must be carefully adjusted to the character of the clay body or the type of ware being dried.

An additional drying problem is found in the scumming or whitewashing of the ware by sulfates, mainly of calcium and magnesium. Soluble salts in the clay may be brought to the surface in solution and deposited as a scum when the water evaporates. These can be made insoluble and scumming due to this cause prevented by addition of barium salts in proper amount to the clay before or during the tempering. When waste heat from cooling kilns is used or when combustion gases enter the dryer, sulphur fumes in even very small concentrations react with lime in the clay to form sulfates on the ware. This source of scumming is more difficult to prevent but can be controlled with proper care and regulation.

Burning

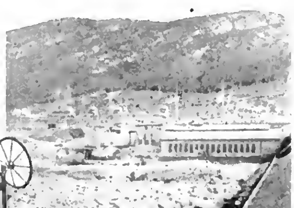
In the firing process the clay passes through a series of physical and chemical changes. Some hygroscopic water remains after drying which must be expelled in the early stages of firing, known as the water-smoking period. Chemically combined water begins to pass off at or below a red heat and at the same time oxidation of carbon in the clay and of various iron compounds is proceeding. This is known as the oxidation period and extends up to 1200-1600 degrees Fahrenheit. The shrinkage or vitrification period is the final stage of the firing operation. The more fusible constituents of the clay melt and an increasing quantity of glass forms in the body. Due to its surface tension, the mass shrinks and the void space or porosity decreases. The finish is determined by color change, by hardness, the character of fracture or by the amount of shrinkage of the ware. The

Ransome — PIONEERS in BIG MIXERS

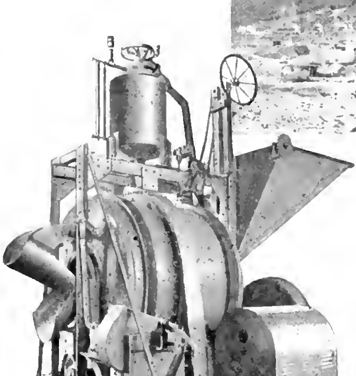


1902—Spier Falls Dam and Power Plant, Spier Falls, N. Y. Two #5 (2 yd.) Ransome Mixers used

Cut of Ransome #5 Mixer



1930—Spier Falls Dam and Power Plant Enlarged with the aid of two Ransome Big Mixers — 28-S



A modern Ransome Big Mixer

Having pioneered the first concrete mixer in 1850, as far back as 1902, Ransome sensed the vital need for mixers of *giant* size and capacity.

Among the first jobs on which Ransome Big Mixers were used, was the Spier Falls Dam and Power Plant at Spier Falls, N. Y. in 1902.

In 1930, when the New York Power & Light Corporation enlarged this same project, two Ransome 28-S Standard Building Mixers were used by the Allied Engineers, Inc.

Ransome Big Mixers have performed satisfactorily over a period of twenty-nine years on important construction jobs and—in recent years—the repeat orders received from operators of Central Mixing Plants have proven the value of Ransome Big Mixers in this field.

WRITE FOR BULLETINS DESCRIBING RANSOME BIG MIXERS

Ransome Concrete Machinery Company

1850—Service for 81 Years—1931

Dunellen New Jersey

rate of temperature rise and the atmospheric conditions in the kiln must be closely controlled in each stage to produce a satisfactory product.

The firing process represents nearly half the cost of manufacture. The fuel requirement is high, from 1,000 to 1,200 pounds of coal being normally used per 1,000 brick or 300 to 500 pounds per ton of burned product. Efficient use of fuel and economy of time in this process are, therefore, of paramount importance. Effective heat transfer and uniformity of heat distribution through the kiln, together with effective control of firing conditions and temperatures are individual problems in each kiln installation.

Much attention is being given to the adaptation of the continuous car-tunnel kiln in the brick industry. As a fuel and labor saver it offers great possibilities. Its practicability has been definitely demonstrated in some of the ceramic industries where its use is extending rapidly. A number of installations are giving excellent results in brick burning but its application generally is somewhat limited by its initial cost and by the greater flexibility of the periodic kiln in the production of colors by regulation of firing treatments.

Color and Texture

The smooth faced brick of solid color has, in recent years, given place almost entirely to a product of varied color and in a wide range of textural effects. Numerous devices are used to scratch or roughen the column of clay as it leaves the brick machine or to apply sanded surface effects. The result in the wall is a soft texture with a minimum reflection of sun light and, to some extent an effect of age. Combined with color variation and color blending and with varied methods of laying, mortar joints of greater thickness and with colored mortars, a great range of architectural effects is possible. Brick walls have achieved an individuality not attainable with other building materials.

There is a present tendency to changes in the size of brick units, partly for architectural effect, partly to reduce costs of laying by the use of larger units. To some extent mixed sizes are coming into use in the "random ashlar" construction which gives an effect similar to stone but with a great range in colors and surface textures.

Color production has been a subject of much study and development in recent years. Normally the brick clays may burn to a red or to a buff color, depending upon the quantity or character of the iron minerals present. By changes in the firing treatment, alternately oxidizing and reducing conditions, ferric and ferrous oxides are produced in varying proportions to give shades of color ranging from buff to red to brown and black, and sometimes green. Further color variation has long been attained by addition of manganese oxide to the clay body in varying amounts and particle sizes, resulting in grays, speckles and black colors. To some extent manganese salts are vaporized in the kiln to give dark colors. In recent years there has been an extensive use of zinc vapors in the kiln to produce shades of green and buff with normally red burning clays. Much attention is now being given to the use of stains, made by fusing or calcining various metallic oxides, added to the clay body and by surface treatments with such coloring agents.

Glazed Bricks

Glazed bricks are returning to favor with the architects in this age of color and much development is taking place in this line. Their advantage in large buildings is that the glazed surface does not catch and retain dirt to the extent that stone and ordinary brick do and they are washed relatively clean by rains. Also, these brick lend themselves well to flood lighting effects in large structures.

A novel development is found in the use of metallic surface coatings on brick. These are applied by electric plating or by spraying molten metals on the burned bricks.

Light Weight Products

Light weight structural units are being studied and developed by several agencies. Not only are these an advantage in reducing the weight of steel required in large buildings but they are of interest from the standpoints of heat and sound insulation, as well as fire resistance. The hollow brick or building tile has been only partly satisfactory in this connection. The present effort is to produce a solid unit with a large proportion of small voids. Products have been made of one-fourth to one-half the weight of dense clay bodies of equal size. In this connection the light weight burned clay aggregate for concrete is of interest. Its development and application has been carried further than has the light weight unit of burned clay.

The light clay unit is being experimentally produced by three general methods, (1) addition of sawdust or combustible material to the clay mix, which burns out in firing to leave voids, (2) bloating of the clay-water mixture by action of added chemicals which form gases, similar to yeast raising of bread or action of baking powder, (3) bloating of the clay body by rapid firing, the gases from combustible carbon and sulphur in the clay and possibly water vapor from the chemically combined water of the clay causing the voids. In normal firing these would be expelled before the clay became softened by heat but rapid firing softens the body before these gases are entirely gone.

The industry is rapidly passing from rule-of-thumb methods to manufacture under technical control. Much further development is to be expected within the next few years in the mechanical equipment and in the methods of processing.

Tennis Court Research

(Continued from Page 19)

o'clock, but at 10:50 they momentarily are extinguished in order to warn the players so that they may collect their personal belongings before the lights are shut off for the night.

The athletic association has taken a very definite and forward step in regard to the tennis courts, and much credit is due to George A. Huff as director of athletics and to Ben F. Crackel who is in direct charge of the building and maintaining of the courts. Mr. Crackel is very enthusiastic about the work and has given it much thought. He hopes to have drinking fountains installed on all the courts soon, and to have the benches for those waiting for courts put on the outside of the fence in order to clear the enclosure of everyone except players.

In conclusion, the trend at Illinois seems to be toward better and better tennis courts. If the results of the above mentioned experiments prove satisfactory, and a suitable cheap material can be found, the present clay courts will, in time, be converted into other types which will be much more satisfactory and cheaper to maintain.

C. E. Markland, m.e. '31, is working in the plant maintenance department under Superintendent Morrow at the University of Illinois.

Irate Parent: "I'll teach you to make love to my daughter sir."

Young Man: "I wish you would sir. I am not making much headway."

* * *

"No use crying over spilt milk," soliloquized the unromantic farmer as the express train severed the torso of his favorite cow.

* * *

Spinster: "Do you know what happens to little boys who draw pictures on the sidewalk?"

Boy: "Yes they go to college and take architecture."

* * *

Hometowner: "Where have you been these last four years?"

College Stude: "At school taking medicine."

Hometowner: "Did you finally get well?"

* * *

Alice: "Gee, some dance."

Dick: "Yeah—and some don't."

* * *

A bunch of jokes I compiled for this magazine once were rejected as no good, but I threw them into the fire and it just roared.

* * *

In the game it's grit, in spinach it's terrible.

* * *

The problem of the modern family is whether to have a baby or a Frigidaire.

* * *

Tourist to Papoose: "So that big bad man busted your doll."

Educated Indian Maiden: "The philosophy of my forbears forbids any but a stoical appearance, but I'd certainly like to make the son-of-a-gun fix the damn thing."

* * *

"Golly, but I certainly swayed the audience," cried the whale as he collided with the show boat.

* * *

"This is how the story ends," yodeled the bricklayer as he put the last brick of the 23rd floor in place.

* * *

"I'm a heluva good fighter, but my feet don't like to stand around and see my body abused."

—*U. C. L. A. Claw.*

* * *

Our idea of a dirty trick would be to throw a couple of pennies at September Morn and tell her to catch one in each hand. —*Pennsylvania Punch Bowl.*

Another dumb co-ed thought the Pied Piper was a drunken plumber. —*Idaho Blue Bucket.*

* * *

There's no scents of humor in tear gas.

—*West Point Pointer.*

* * *

He: "Are you hungry? What do you say we eat up the street?"

She: "No thanks. I don't care for asphalt."

—*S. C. Wampus.*

* * *

A sensible looking girl is not as sensible as she looks because a sensible girl has more sense than to look sensible. —*Purdue Engineer.*

* * *

For years and years the two sexes have raced for supremacy, but at last they have settled down to neck and neck. —*Purdue Eng.*

* * *

Prof.: "Is that your cigarette stub?"

Stude: "Go ahead, you saw it first."—*Purdue Eng.*

* * *

A Chemical Definition of Woman

An Element: "Women."

Symbol. W. A member of the human family.

Occurrence: Can be found wherever man exists. Seldom occurs in the freer native state. Quality depends on the state in which it is found.

Physical Properties: All sizes and colors. Always appears in disguised conditions. Surface of the face seldom unprotected. Most usually covered by a coat of paint or a film of powder. Boils at nothing and may freeze at any moment.

Chemical Properties: Extremely active. Possesses a great affinity for gold, silver, platinum and precious stones of all kinds. Violent reaction when left alone by a man. Great ability to absorb all kinds of expensive foods at any time. Sometimes yields to pressure. Some turn green when placed next to better appearing samples. Ages very rapidly. Fresh variety has magnetic properties. Highly explosive and very likely to be dangerous in inexperienced hands. —*Tennessee Engineer.*

* * *

"How do you like O. Henry?"

"I can't stand it. The peanuts stick in my teeth."

—*Tennessee Engineer.*

* * *

Efficiency Expert: One who paints flies with luminous paint so that you can swat them at night.

—*Armour Engineer.*

Engineering Council

The Engineering Council elected officers at the first meeting held in Prof. J. S. Crandell's office Thursday, October 1. E. W. Baldwin ce'32 was elected chairman; B. Burgoon ee'32, secretary; and W. J. Everhart me'32, treasurer.

The council is composed of the presidents of engineering societies including for this year: American Society of Civil Engineers, E. W. Baldwin; American Institute of Electrical Engineers, B. Burgoon; American Society of Mechanical Engineers, G. Leutweiler; American Ceramic society, H. D. Frankel; Phi Alpha Lambda, J. Westerberg; Engineering Physics society, R. J. Duffin, Railway club, L. Panichi; Mining society, H. Berg; and the Technograph, W. J. Everhart.

The purpose of the council is to promote the general welfare of the engineering societies and act on subjects of mutual interest, to manage social functions of the engineering student body, to establish a code of ethics among engineering students, and to select men to represent the College of Engineering on the Illinois Union Council, and in other organizations where the engineering student body is to be represented.

Last year the council sponsored the engineers' dance and the engineering open house. This year the organization intends to take further advantage of the opportunities it possesses as the representative council of the engineering student body. At the next meeting plans for a revision of the constitution will be considered which may increase the representation in the council to include representatives from honorary and professional engineering organizations.

Freshman Lecture

"The successful man in life is the man who can command men."

This, and many other expressions of like nature flavored the talk of Dean Ketchum of the College of Engineering when he was re-introduced by Dean Jordan to freshmen engineers on Wednesday, September 30, in the auditorium.

Dean Ketchum delineated vividly the engineering field from the days of slave labor when everything was constructed by hand up to the present day with its mechanized efficiency.

"Ruins," he said, "indicate the presence of engineering men. But the records are unfortunately no longer extant. And the advance of science has been a re-learning and a probing into new knowledge."

He enumerated the names of men who have been outstanding in the engineering world. Among those whom he mentioned was Eads. In covering briefly Eads' life and his phenomenal career which started with his ingenious diving bell with which he salvaged wrecks on the Mississippi river and ended with his greatest achievement, the bridge in St. Louis which has been named after him, he pointed out that Eads had never gone to college.

"Why go to college?" Dean Ketchum asked. He answered himself by stating that Eads belonged to another generation, a generation in which it was possible for a man of more than ordinary ability to seek his position, but that today the large position sought the man.

"Every profession," he said, in closing, "has its code of ethics. Engineers are professionals and they have their code of ethics. An engineer must have knowledge—knowledge of mathematics, business, law, and men; above all, he must be unselfish."

Theta Tau

J. S. King '32, *President*

On the University of Illinois engineering campus there are several professional engineering fraternities, one of which is Theta Tau. As a national professional fraternity, the organization consists of 21 chapters located among the better engineering colleges of the United States and distributed from the eastern to the western coasts.

Nationally Theta Tau is governed in the same manner as are the national social fraternities; that is, by an executive council which conducts regular meetings, including a bi-annual national convention.

The fraternity was founded at the University of Minnesota on October 15, 1904, and has steadily and carefully increased its number of chapters since that time.

Theta Tau is not an honorary fraternity, but it does hold scholarship as being essential to the success of an engineer. Rather, it is a professional fraternity with the object of developing and maintaining a high standard of professional interest among its members and uniting them in a strong bond of fraternal fellowship.

Theta Tau is a member of the professional inter-fraternity conference and sends a representative to its regular meetings.

Locally, the fraternity is limited to 40 active members of sophomore, junior, and senior standing in the College of Engineering. The pursuit of courses taken by the members is varied so that all the engineering courses on the campus are represented in the active membership. Not only are they represented by the active members, but by the faculty members as well, who represent practically every engineering department on the campus.

Sigma Tau

Robert MacClinchie, *President*

Sigma Tau is an organization of an honorary and professional nature for which students in the College of Engineering are eligible. The three ideals of the society are: scholarship, practicability, and sociability.

Men who are in the upper one-third of the class (which requirement usually means about a 4.0 average) are eligible, and from these the further selection is made on a basis of practicability and sociability.

Honorary membership may be granted to members of the engineering faculty or to prominent practicing engineers.

The organization was founded in 1904, and since then chapters in schools throughout the country have been added until the roll now shows a roster of 20 chapters.

The management of the national organization is handled through a national council much in the same manner as the organization of a social fraternity.

Meetings of the local chapter are held about twice a month and are usually dinner meetings. The undergraduate membership is about 30 men with a faculty membership of about 27.

Officers: President, Robert MacClinchie; vice-president, C. A. Davis; recording secretary, H. F. Lovell; corresponding secretary, W. A. Deringer; historian, C. F. Eklund.

New Crane steel welding materials
. . . *a complete line*

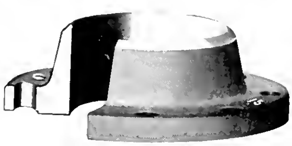
Now Crane Co. offers a complete line of steel welding materials, designed to meet all needs for welding installations in pipe lines and plants. When you make up welded joints for higher pressures and temperatures, you will find in this line the fittings exactly adapted to modern needs.

Included in it are 90° and 45° elbows, tees, return bends; also welding neck flanges and Cranelap welding nipples.

The materials are of open hearth steel tubing or steel plate, depending on the article or the manufacturing process used. Each item has been carefully designed, tested, and proved for its service and for the pressures at which it is recommended. Satisfaction and dependability are assured by the 76 year Crane reputation.

Sizes 1 to 6 inches of the 90° elbows are made from seamless tubing; sizes 8 to 10 inches are forged in halves and welded. Sizes 1 to 8 inches of the 45° elbows are of seamless tubing. Tees are made of forgings. Return bends are made of seamless tubing in the following sizes and centers: 2″ with 4″ center, 2″ with 6″ center, 3″ with 6″ center, 3″ with 9″ center, 4″ with 8″ center, 4″ with 12″ center.

Combination of No. 574 Cranelap welding nipple and No. 572 Cranelap Flange.



No. 568 Series 15 Welding Neck Flange.

Welding neck flanges are made of forgings, in four classes: Series 15 for 150 pounds pressure, Series 30 for 300 pounds pressure, Series 40 for 400 pounds pressure, and Series 60 for 600 pounds pressure.

Cranelap welding nipples in standard and extra heavy pipe thickness are supplied for use in combination with forged steel Cranelap flanges. These nipples have a Cranelap on one end and are beveled for welding on the opposite end. All nipples 1″ to 12″ in diameter are 12″ long. Cranelap forged steel flanges in Series 15, 30, 40, and 60 can be supplied with them. Write for full information.

No. 353-E Tee. 1″ to 10″

No. 352-E 90 Elbow. In 1″ to 10″ sizes.

No. 355-E Return Bend. In 2″, 3″, and 4″ sizes.

No. 354-E 45° Elbow. In 1″ to 8″ sizes.

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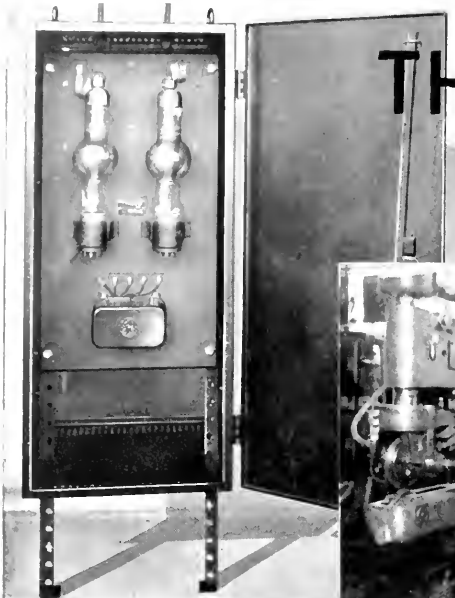
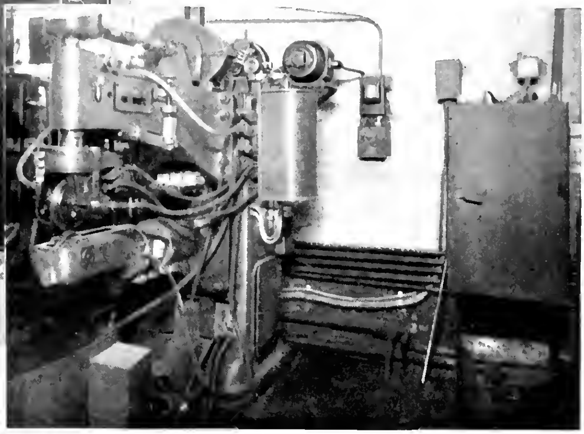
THYRATRON

THE OPEN DOOR





Close-up of a Thyratron control panel for high-speed welding applications

G-E Thyratron control equipment (in case) operates this line welder through a reactor

THE new electron tube, the Thyratron, is the most versatile servant developed in recent years. Already it has a host of applications. It will open windows, count anything that will interrupt a beam of light, operate welding machines, sort beans or buttons, operate drinking fountains as you bend over them, light buildings, windows, and theaters, and measure the intense heat of furnace interiors. And it has a thousand other applications.

Thyratron control has made possible high-speed welding machines, for no contactor-actuated resistance welder can approach the speed of several hundred interruptions per minute that are required. High-current Thyratrons interrupt the current in the welding transformers and swing the impedance from high to low, the welding rate depending on the speed of these changes. Thyratron control can be used for as many as one thousand interruptions per minute.

The name Thyratron comes from a Greek word which means "door". Not only does this tube act as a door, or valve, for electricity, but some scientists say that its possibilities are so great that its use will revolutionize the electrical industry. If these predictions are correct, the Thyratron is an open door of opportunity for young men now in college and for graduates already in the employ of the General Electric Company

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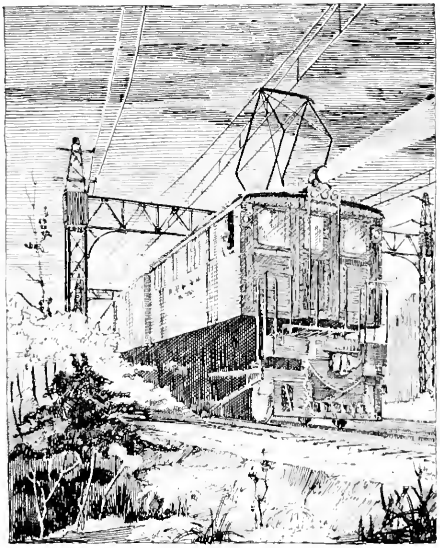
THE TECHNOGRAPH

UNIVERSITY of ILLINOIS



NOVEMBER 1931

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

Member of the Engineering College Magazines Associated

VOLUME XLVI | URBANA, ILLINOIS, NOVEMBER, 1931 | NUMBER 2

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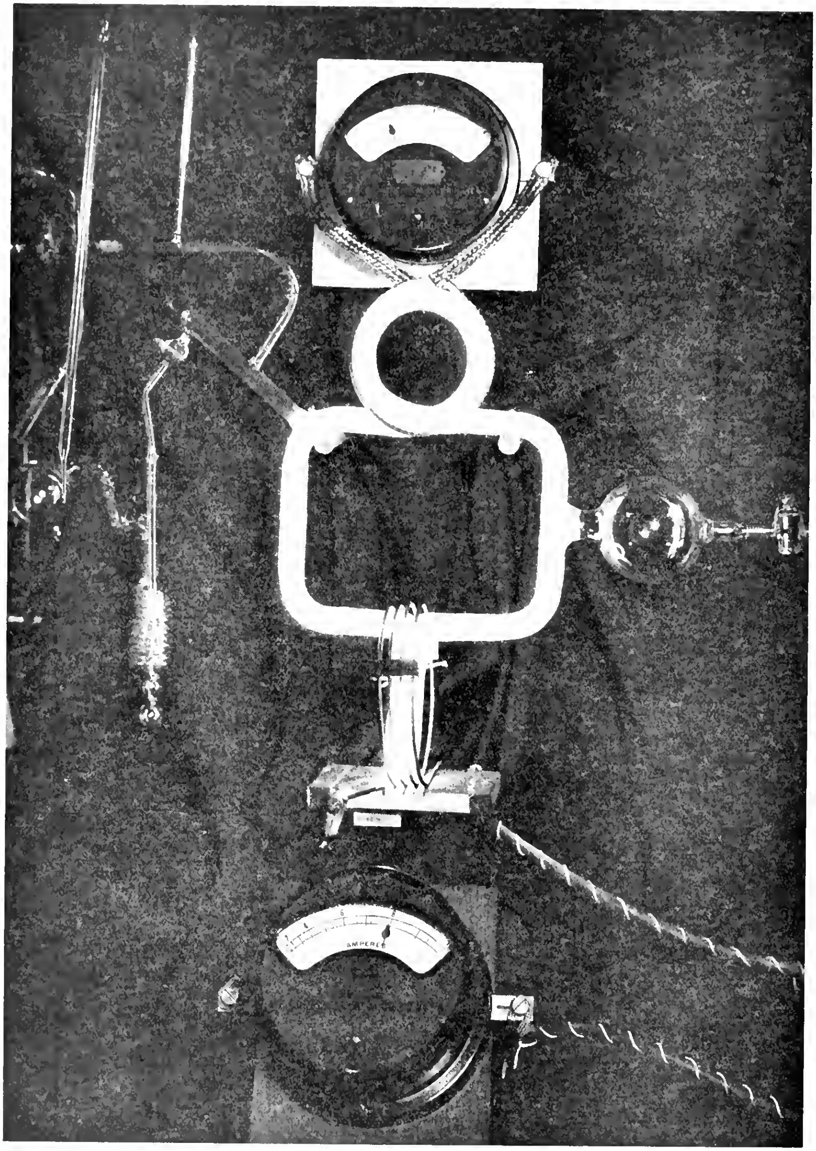


Photograph of the re-entrant electrodeless discharge completely formed by using an energizing coil of four turns. Residual air, pressure about 0.2 mm. Hg. The energizing current through mounted ammeter shows 8 amperes, while the upper ammeter shows the induced current, due to the gaseous current acting as primary, as 2.6 amperes. The discharge does not enter the expansion chamber.

THE TECHNOGRAPH

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

VOLUME XLVI | NOVEMBER, 1931 | NUMBER 2

An Inductive Method for Measuring Current in the Electrodeless Discharge

CHAS. T. KNIPP
Professor of Experimental Electricity

WE ORDINARILY think of an electrical discharge tube as a lecture table demonstration piece designed to exhibit electric phenomena at reduced gas pressures. More specifically a discharge tube in its simplest form consists of a glass tube a meter or so long, about 3 or 4 cm. in diameter, and having a disk aluminum electrode sealed through the glass at either end. In order to pass a current through such a tube it is necessary to pump out the air and at the same time apply a very high potential to the electrodes. This potential may be either from a direct or an alternating current source. Such a discharge tube when connected to a pump enables one to perform many beautiful and instructive experiments.

Sir J. J. Thomson* in 1891 described another type of discharge tube that is both of scientific and practical value. He called it an electrodeless discharge tube, and the brilliant discharge within he referred to as the electrodeless ring discharge. This tube is usually in the form of a ring (or toroid), is of glass and is electrodeless. The question naturally rises, how can a discharge be set up in a tube when there are no electrodes for the current to enter and leave? The answer is that the discharge within is an *induced* discharge. It is similar to the current that flows in the secondary of a transformer when an alternating current is impressed on the primary. Thus it is at once apparent that in order to operate an electrodeless discharge tube we must use a high potential alternating current. It would be impossible to energize an electrodeless tube by direct current, while, as stated above, either a direct or an alternate current will operate the discharge tube first described, i. e., a tube with electrodes.

The electrodeless tube may also take the form of a simple exhausted bulb. Indeed it is constructed in this form more often than in the form of a toroid. The three forms of discharge tube are sketched in Fig. 1.

Prof. Chas. T. Knipp

Professor Charles T. Knipp is actively engaged in research work in physics at the University of Illinois, and is known internationally for some of his discoveries. He has taken out few patents, for the ethical reason that his experiments are carried out in the university physics department. He is the author of nearly one-hundred publications describing his experiments.

Prof. Knipp is on the advisory committee in physics for the world's fair to be held at Chicago in 1933. One of the exhibitions being prepared for the fair is an apparatus devised by Prof. Knipp to demonstrate molecular bombardment, the underlying principle of the mercury vapor vacuum pump.

To excite the discharge within *b* or *c* it is only necessary to surround either with a coil of a few turns through which a high-voltage high-frequency discharge is surging. In *b* these turns (but one is shown) should lie in the same plane as the toroid. The induced gaseous current appears in the toroid filling it with a brilliant light. In *c* these turns (a coil of four turns is shown) surround the bulb without reference to any particular plane. The induced gaseous current, of course, will lie in the plane of the exciting coil whatever may be the position or orientation of the bulb. This gaseous current does not fill the entire bulb, but rather the circular region nearest the exciting coil. The color and brilliancy of the discharge depend on the kind of gas within the vessel, and on its pressure. The beautiful color of neon signs on business streets is familiar to all.

It was early recognized that the induced gaseous current within an electrodeless tube may rise under favorable conditions, to a high value. Thomson and others in Europe and also in America speculated on this but no direct laboratory method was forthcoming. Any inductive method that one might plan would seemingly be out of the question because of the larger inductive effect coming directly from the exciting coil. This difficulty, however, was recently overcome in this laboratory** by constructing a tube of special design. (Fig. 2). This discharge tube consisted of a reentrant tube 2 cm. in diameter which described a discontinuous circle just inside of the exciting coil (their planes being parallel to each other and perpendicular to the paper) and then left the coil and described one turn in a

*J. J. Thomson, Phil. Mag. 32, 321, 450, 1891.
**C. T. Knipp and J. K. Knipp, Phys. Rev. 38, 948, 1931.

plane perpendicular to that of the exciting coil (i. e., in the plane of the paper). The total length of the discharge tube was about 155 cm. A heavy copper braid made one turn round the upper circle of the glass tube and was connected to a Weston radio-frequency ammeter. The discharge tube is shown connected to a 500-cc expansion bulb and on through a liquid air trap to a McLeod gauge and to a mercury vapor pump. Gases were let in from the other side. Small gas samples in bulbs were connected as shown while gases in tanks under pressure were let in through the intake I and allowed

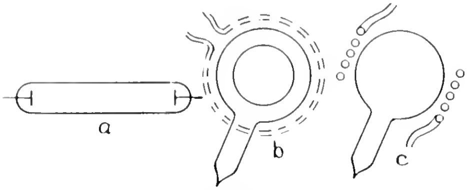


Figure 1
a—A single discharge tube with electrodes.
b—Electrodeless tube in form of a ring or toroid.
c—Electrodeless tube in form of a bulb.

to bubble through sulphuric acid and a liquid-air trap before entering the discharge system.

As an energy source a motor-generator high-frequency set was used, operating at a frequency of about 600 kilocycles. The oscillations were highly damped. The energizing coil used was of 4 turns of copper tubing. Another ammeter is shown connected in a non-inductive shunt for determining the heavy current that passed through the energizing coil. Currents as high as 57 amperes were used. The photograph on the frontispiece page shows the actual deflection of each of the two ammeters as the discharge passed.

The general procedure in producing the discharge was as follows: The energy was led in to the energizing coil through the heavy leads shown wrapped with white

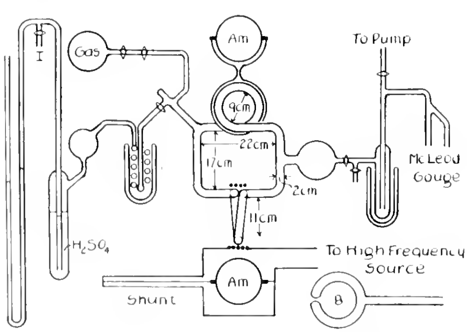


Figure 2: Sketch of special re-entrant electrodeless discharge tube with connections. The planes of the two glass circles are at right angles to each other. Thus the inductive effect of the energizing coil of four turns on the upper ammeter circuit is eliminated.

string to make them more visible. A Weston radio-frequency ammeter (the shunt not showing) was included. The induced gaseous current shows an intense white in the photograph and traversed throughout the entire length of the re-entrant tube. The two glass turns with their planes at right angles to each other is clearly shown. By this arrangement the inductive effect of the energizing coil on the upper glass turn *is eliminated.* We thus have a high-frequency gaseous current of one turn placed off to one side quite away from the inductive effects of the energizing current. This single turn of gaseous current was used as the *primary* of an *inductive coupling* the secondary of which consisted of a single turn of heavy braid conductor, the ends of which were connected directly to a radio-frequency ammeter. The coupling factor of the upper turn of the discharge tube with the copper braid was investigated by substituting a similar tube filled with about 40 small insulated copper wires with their ends soldered together. It was thought that the wires thus placed would approach the distribution of the gaseous current through the tube. On sending known currents through this improvised primary the coupling ratio, which proved to be strictly linear, was found to be 2.84. Hence the formula for the current in the primary became

$$I_p = 2.84 \times I_s,$$

where I_p is the gaseous induced current, i. e., the current constituting the electrodeless discharge. Thus the

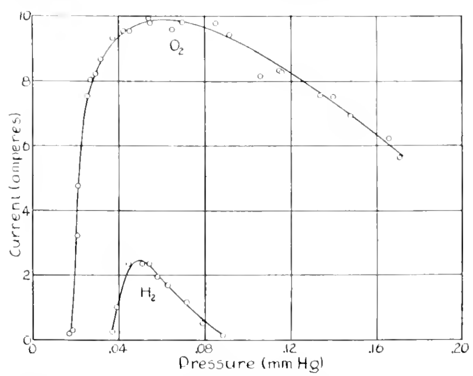


Figure 3: Currents in the electrodeless discharge in oxygen and hydrogen as a function of the pressure. Exciting current 57 amperes.

electrodeless gaseous current that flowed in the re-entrant tube shown in the photograph was

$$I_p = 2.84 \times 2.6 = 7.38 \text{ amperes.}$$

The magnitude of this value came as a surprise, especially since a current of only a few amperes was expected. The re-entrant tube warmed up quite appreciably throughout its length showing that considerable energy was being dissipated.

In this connection data were taken for pressure-current curves for six different gases. The procedure with each gas was to pump the system out to a very high vacuum and then wash it out successively with doses of the gas to be studied. After the purity of the gas was assured the system was pumped until a stage was reached at which the discharge would just begin (intermittently) to pass, whereupon the pump was shut off. Equilibrium in pressure throughout the system was soon reached, after which the coil was again energized and allowed to continue until the two ammeter readings became steady. The pressure was read before and after the current readings. The system was then exhausted to a new pressure and the readings repeated. Following this procedure data

(Continued on Page 20)

University Resurfaces Campus Roads

G. C. Miller '32

Thanks are due to L. L. Anderson of the university architect's office for providing the material for this report; and to E. E. Bauer for lending some of the illustrations used.
The Author.

THE purpose of this article is to acquaint the reader with the methods now being used in the construction or re-surfacing, as the case may be, of the south campus roads at the University of Illinois. In considering the various types of roads which might be used on the campus the Board of Trustees of the university was anxious to find one that would be dustless, as nearly noiseless as possible, and that fitted in well with the colors of the typical features of the campus.

The new road on Sixth street between Armory avenue and Gregory drive is the only permanent type constructed this fall. The other newly constructed roads, including Gregory drive from Sixth street to the broadwalk, from the broadwalk to Mathews, and from Fourth street to Sixth, the north-south road alongside the auditorium, and North Mall are semi-permanent types which will require re-surfacing from time to time. All the work is being done under contract by the Lehigh Stone Company of Kankakee, Illinois.

Macadam Base Used on Sixth

The completed road between Armory avenue and Gregory drive on Sixth street will be discussed first (see figure, type A). The base is waterbound macadam, 5 inches thick. Crushed rock of size ranging from 3 inches to 1 inch in diameter was used. This base was primed with an emulsion asphalt, applied under pressure by means of a distributor. About $\frac{1}{2}$ gallon of the emulsion

A view of the completed pavement on Sixth street, looking south from Armory avenue

per square yard of surface was used. On this a 2-inch layer of $\frac{1}{2}$-to $1\frac{1}{2}$-inch rocks covered with emulsion asphalt was added and rolled once with a 10-ton steam roller. Then a 1-inch layer of stone chips from $\frac{5}{8}$ to $\frac{1}{4}$-inch in size covered with the emulsion was applied, bladed to grade and finally rolled. The entire surface was then sealed with a coat of asphalt applied with the distributor and surface sprinkled with sand. When compacted the topping is about 2 inches thick. This street is 36 feet wide, back to back of curb.

This type of paving is known commercially as "Pre-Cote" from the name of the company which originated the machine used for emulsifying the asphalt and for coating the stone with the emulsion.

The emulsifying and mixing plant for the materials used on the campus roads is located on the Wabash railroad in Urbana. This location was established in order to facilitate the handling of the asphalt and the rock. The asphalt is shipped in tank cars. It is practically solid when received and is heated for 36 to 48 hours

Pre-coted stone being dumped on the base on the new Sixth street surface

with steam at about 125 pounds pressure in order to liquify it so it can be handled through the pumps which are steam-jacketed. The hot asphalt is mixed in an emulsifying chamber with hot soft water and a small quantity of emulsifying agent, usually a soap solution formed by combining red oil with caustic soda. It is essential that soft water be used. On this job a special softening tank is being used since the water supplied by the Champaign-Urbana plant is too hard.

The water, asphalt, and emulsifying agent are passed through meters so that an accurate check on quantities is maintained at all times. The aggregate, which in this case is limestone from quarries at Greencastle, Indiana, and Kankakee, Illinois, is taken from the railway cars and put into a large hopper from which it is passed into a tank partially filled with the asphalt emulsion. Buckets on an endless chain pass through this mixture, pick up the coated aggregate and dump it into trucks, which haul it to the prepared road-bed. Any excess asphalt drains from the mixture through holes in the buckets, falls into a trough, and finally reaches the mixing tank again.

Method Well Adapted to Conditions Here

The method used is especially advantageous in that the asphalt is emulsified on or near the site of the work; and the percentages of water and asphalt may be varied to suit the size and quality of the aggregate. The emulsion may be worked until it freezes. It will keep for about ninety days and in temperatures to freezing. The material handles very easily; it can be dumped, shovelled, and bladed as though it were wet gravel; and if it gets sticky when being rolled, the roller is sprinkled with a little water to correct this. The emulsified asphalt sticks to damp or wet stone and to a damp base. Cutback or hot mixed asphalts require a dry aggregate and a dry base. This means that all the rock, sand, etc. used with the latter-named asphalts must first be thoroughly dried in a drying plant.

The finished strip on Sixth street, which has been described above, cost $1.75 per square yard, as compared with $2.40 which would have been the cost for a concrete slab.

Temporary Surfaces on Other Campus Roads

The road from Sixth to the broadwalk on Gregory drive is of a temporary type, and a top of 1½ to 2 inches

A view of Burrill avenue, the south extension of the broadwalk. This surface is of a semi-permanent type. The building in the background is the commerce building.

will have to be added within the next 2 years. The cinder grade which until this year was on this strip was entirely too high. All of the cinders were excavated in order to finish the sub-grade. The sub-grade was thoroughly rolled. Then 6 inches of water-bound macadam was placed on it and rolled (see type B in figure). All interstices were filled with small stone and dust. On this surface a ¾-inch thickness, when compacted, of Pre-Coted chips were placed and thoroughly

The central mixing and emulsifying plant where the materials for all the campus roads were proportioned and mixed

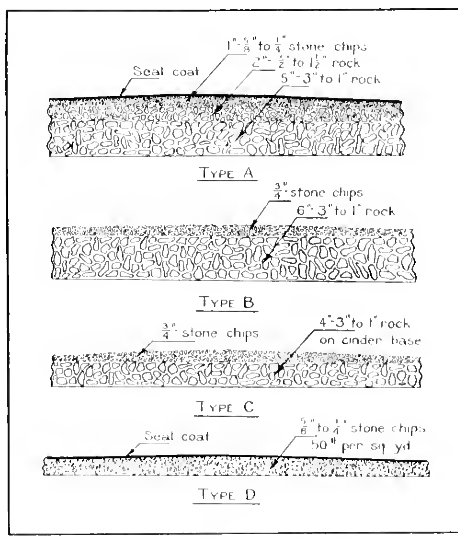
rolled. The cost of this type of surfacing was $1.10 per square yard.

On Gregory drive west of Sixth street the present cinder base was placed with the intention of adding a concrete slab later. The cinders were scarified, bladed, and rolled. On this surface 3 to 4 inches of 3-inch and smaller crushed rock was placed and rolled, filling all interstices (see figure, type C). Then a ¾-inch top was added as was done east of Sixth street. This road as it is now cost 70 cents per square yard, but it will need additional topping later on.

On Gregory between the broadwalk and Mathews and south of the architecture building the roads have been surfaced-treated as follows (see figure 1, type D):

The cinders were scarified, bladed, and rolled and the surface primed with 60-per cent emulsion asphalt. One-quarter to ⅝-inch stone chips were applied, 50 pounds to the square yard. This was sealed with approximately ¼ gallon per square yard of similar asphalt. The surface was then sprinkled with sand and rolled. This is a temporary treatment good for about 2 years. The cost, 22 cents per square yard, is about the same as for oiling for the same period.

The portion of the road south of the architecture building which lies between the broadwalk and the new agriculture building will be eliminated some time in the future. It would, therefore, be foolish to lay a permanent type of pavement on this strip. The street, known to some as North Mall, would under the above plans come to the broadwalk from the west, turn with a radius of 150 feet, and return to Fourth street. A similar layout would be provided on the east side of the quadrangle.



Cross sections of the different types of paving used.
Type A: The permanent type used on Sixth street.
Type B: Used on Gregory between the broadwalk and Sixth.
Type C: Used on Gregory west of Sixth.
Type D: Used on Gregory east of the broadwalk and on other south campus roads.

The roadway east of the auditorium is 5 inches of macadam topped with 2 inches of asphalt-coated stone chips.

The north campus roads will be improved as funds are available.

A View of the Railway Field

E. G. Young
Research Professor, Railway Mechanical Engineering

This article is the first of a series dealing with present conditions in the several branches of engineering, probable future developments in the fields, as nearly as they can be predicted by men who know the facts concerning the situation at present, and employment conditions. This article by Prof. Young points out the reasons for the pessimism which exists in the railway engineering field, the probable recourses which the railroads will have to take to overcome their present handicaps, and outlines the fields which are open to university graduates in railway engineering. The December issue of the Technograph will contain an article by Prof. Mitchell, associate in the mining engineering department, in which will be presented the problems being encountered in that field.—The Editor.

A REVIEW of the railway field shows that two conditions are responsible for the present unfavorable situation; namely, the general slackening of business conditions and competition in the transportation field.

Railway freight traffic attained its maximum in 1926 with 440 billion ton-miles of freight transportation. In spite of expanding business, this level was barely maintained through 1929; 1930 showed a drop of 12 per cent, and the current year shows a further decrease to a probable total of 300 billion. A trend curve based on the actual data indicates that with continued normal expansion in business activity, the railways might have anticipated 480 billion ton-miles as the measure of freight traffic for the current year, the actual results now expected being lower by 40 per cent. Current indices of business activity indicate that the level is 25 per cent below normal, and as railway traffic is so closely related to the general state of industry and commerce, 25 per cent of the loss of traffic may be properly charged to the depression, leaving a further loss of 17 per cent due to competition of other transportation agencies. This competition comes of course from highway and waterway traffic.

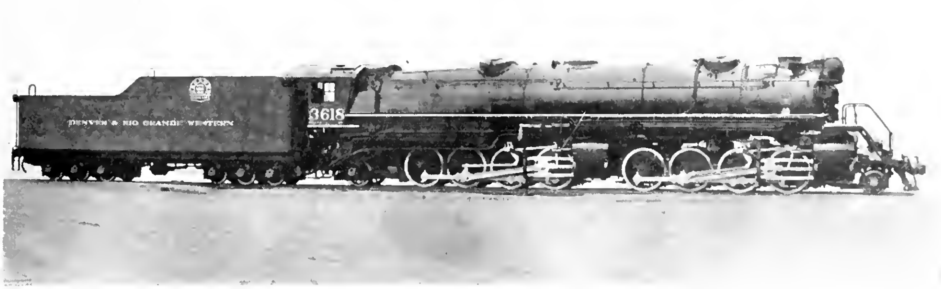
Compete Against Subsidized Agencies

In the case of the highway carrier, the railway is competing with a government-subsidized agency, since the use of the paved roads provided by the public are essential to the business, and no return in taxes or licenses adequate to the profit derived is made. The railway builds and maintains its own right-of-way at a cost of about one-sixth of its total receipts, and pays another six per cent of these receipts in taxes. Taxes and licenses paid by highway carriers loom large in the aggregate, but the contribution of the individual truck to the public funds is very small compared with the benefits the owner enjoys.

The case of the inland waterway is similar in many ways. Huge expenditures of public funds have gone into the improvement of rivers and the building of canals; the public desire for, and need of this form of transportation is best shown by the relatively small use which is made of it. Water rates where they are in direct competition with railways average half of the railway level, while the public contribution to building and maintaining the waterway is three times the return for the traffic; the shipper in other words paying about one-fourth of the cost of moving his goods, and the public (in taxes) the remainder.

Passenger Decrease Even Greater

In the case of passenger traffic the railways have fared much worse. Passenger business reached its peak in 1920 with a movement of 47 billion passenger-miles. For the known figures of 1930 the decrease from this peak is 37 per cent, and for the estimates of 1931, 57 per cent. The comparison becomes even more striking if the normal trend of traffic up to 1920 is considered as extending to the present time, and it becomes evident that in addition to the effect of the depressions the railways have lost half their traffic due to competition from the highway. What proportion of the traffic loss is the result of bus competition and what proportion has been lost to the private automobile can only be guessed at, but



Railways are looking for more economical designs in locomotives in order to cut down operating expenses. This locomotive is one of the late types, built for the Denver and Rio Grande Western by the American Locomotive Company. It is of the four cylinder simple class, twelve-wheeled tender type.

the latter is probably the larger portion of the loss. Private automobile traffic breaks all of the laws of economics, the true cost of operating a fairly good car under the most favorable conditions always exceeding the cost of railway travel unless two or more people use the automobile.

Against this condition the railways have but one possible recourse fare reduction. In the case of the bus, studies of bus traffic indicate that the predominant reason for bus travel is reduced price. Here, as in the case of the truck, an important reason for this reduction is found in the fact that the public furnishes the highway, and the motor carrier makes no return proportionate to the profit he reaps from it. This is not a case of supercession of one form of traffic by a better form; it is in the interest of the public to maintain passenger traffic on the railway at as high a standard of efficiency as possible, from the standpoints of technical efficiency, safety, and cost.

Note the opportunities which lie with the railway management of meeting the conditions:

In 1928 the average passenger train had seven cars, carried 56 passengers, received from the passengers $1.60 per mile, and from other sources 41 cents, or a total of $2.01. The separable costs of operating the train (those costs which would not have been incurred had the train not been run—coal, water, supplies, crew wages, repairs on a mileage basis, etc.) were $1.32; the full operating costs were $2.06 and the total costs $2.61. In order to make the traffic at least pay operating costs, either economies must be effected or the number of passengers increased. The capacity of the train would be at least 250 passengers; if each one paid one-half the 1928 average rate the return would be $3.50 per mile. Excursion trains are profitable, but no such drastic cut could be made a regular rate basis, as the traffic is probably not available; however, this average train would only have to carry 186 passengers (at half rate) in place of 250 to pay the total costs, and there seems to be a great opportunity to increase traffic by fare reductions.

Electrification Offers Possible Economies

In the matter of reducing costs there are also opportunities, but not comparable with the gains to be secured from increased traffic. Of the $1.32 separable costs which must be attacked, the bulk is made up of the following items:

Wages of crew	.35
Fuel for locomotive	.25
Maintenance of locomotive	.26
Oil, water, miscellaneous supplies	.10
Maintenance of cars	.23
Total, per mile	$1.19

Reducing the number of cars results in trifling savings. If even three of the five passenger cars could be cut off, the saving would be but 12 cents per mile.

Reducing the number of trains is effective only in part. Some of the remaining passengers will be lost due to decreased convenience of service. Only the cutting off of such trains as operate on returns below the actual separable costs is profitable in the long run. The largest single item is crew wages; there is no means of reducing this charge except by the substitution of the self-propelled car, which on a motor-and-trailer-train makes possible a reduction of two (sometimes three) men. This type of train effects other economies all along the line if the handling of sleeper traffic is not necessary, and such a train could carry profitably the present typical train-load. Here again, though, enters the question—will the same number of passengers travel with reduced conveniences? Probably not.

The item of fuel for the locomotive can be reduced somewhat by the use of the most modern steam power; perhaps by five or six cents. Gas-electric locomotives might do better but they are in too early a state of development to claim much. Electrification would help, reducing the fuel cost one-half, and perhaps the public approval might show in some increased return as well.

In 1929 and 1930, the percentage decrease in the number of passenger-miles was almost exactly equal to the percentage decrease in passenger-train-miles. The number of passengers per train remained constant at about 55, but during this period the return per passenger-mile fell five per cent. Meanwhile operating expenses fell 11 per cent. Consequently the comparison at the end of 1930 shows the receipts per train mile to be about $1.80, against operating costs of $1.82 (assuming the passenger-service shared equally in the reduction of operating costs, which is doubtful). Due to the sharp decrease in traffic, the 1931 returns will show an income at least 25 per cent below train operating cost, and no economies are in sight to narrow the margin of loss except those secured at a large capital expenditure.

Equable Taxation a Solution

It would appear to the student of present day transport condition that the answer to the railways' problem lies partly with themselves, but to a much larger extent with the public in effecting some change in conditions with regard to regulation and taxation, in order that the struggle for the privilege of meeting the public transportation needs shall be an equable one. Given an "even break," the railway industry will readjust itself, though this readjustment may be expensive and extensive.

In such an inevitable readjustment the engineer will play an important part, probably out of all proportion to his past role in railway service. There is already a definite policy on the part of some important railway lines to advance men from the technical departments to the higher operating positions, and this tendency may be expected to increase.

"Seniority" Handicaps University Graduates

The technically trained man in railway service has no "bed of roses." In many lines of work he might enter, he finds himself in competition with men of his own age who have been at work for four or eight years when he commences—and that four or eight years "seniority" appears for a long period to be of more value than the educational advantages he has enjoyed. In other lines the technical man enters a "special apprenticeship" or "student" course. Some of these courses have been managed with great skill and produced results beneficial to the railway and the student alike. At the end of four years of college work and a two-year apprenticeship, the student engineer is about on the same level as the man who has spent an equal time in the railway service. His future then lies with his own ability, the practices of the particular department in which he is working, and the seniority policy of the company. An unfortunate thing about many of the apprenticeship systems is the antagonistic feeling of the regular workman toward the student—a natural attitude, even though usually unjust. It is a condition that the student can often remedy by his own tact.

(Continued on Page 24)

The New Skating Rink — Problems Met by the Contractors

ANDREW KLESZEWSKI '32

The new skating rink, which was formally opened for use November 6, is another link in the chain of recreational facilities offered students by the university. Its use is to be for recreation only. While it is possible that a university hockey team may be organized later, it will not be allowed to monopolize the use of the rink, which is for all the students of the university. Readers are referred to the May, 1931 issue of the Technograph for a detailed description of the building.—THE EDITOR.

IN THIS article the author's purpose is to acquaint the reader with the problems met by the contractor in fulfilling the contracts connected with the construction of the new university skating rink. The general organization of the contractors and sub-contractors will be discussed first, then some general specifications to which the contractors were held, and last the details of some of the stages of construction of the rink.

In building the skating rink the direct supervision fell under the authority of Martin Carroll, a.e., '27, superintendent for Holabird and Root, architects. Directly responsible to him was Joseph Hughes, superintendent for the Nydele Building Construction Co., holders of the general contract.

In the general conditions of the contract, immediately upon its signing, the contractor had to insure its fulfillment by furnishing a surety company's bond for the full amount of the contract.

A view of the rink, taken from the balcony. Note the loud speakers in the far corner

Next the contractor had to obtain permits from the city of Champaign before he could begin work. This had to cover all branches of work, including the use of the city water.

CONTRACTOR RESPONSIBLE FOR WORKMEN'S SAFETY

The contractor had to effectually guard his own workmen, the workmen of other contractors on the job, and the public from liability to accident in consequence of his operations during the entire program of the work. He was held responsible for any and all injury that might have occurred through his neglect or failure to provide proper protection. He was also responsible for all damage caused to adjoining property in consequence of his neglect or failure to take the necessary precautions to prevent such damage. Fortunately there were no serious cases of damage to either persons or property on this job.

Immediately after the signing of the contract the contractor had to furnish three copies of building progress schedules which specified the time of completion for each of the subdivisions of the work. The actual time ran a

The completed skating rink, as seen from the armory

little over the specified time, since in the course of 157 days 35 were lost because of rain.

In specifying materials and workmanship the contractor was allowed to admit only the best. Materials had to be new in all cases unless otherwise particularly mentioned. All work had to be executed at such times as was best suited for the proper conduct of the entire work and had to be performed in a neat and skillful manner to the complete satisfaction of the architect's superintendent.

In winding up the high lights of the facts upon general conditions of the job it should be noted that the contractor had to remove all rubbish as fast as it accumulated, keep the building and premises clean during the progress of the work, and leave the premises broom-clean and in perfect condition as far as his work was concerned.

FILLED EARTH THOROUGHLY COMPACTED

The excavating was sub-let to an excavating contractor who did all the excavating down to the proper depth and dimensions required for the new building. This contractor had to provide all bracing and shoring of banks to prevent caving or disturbance of surrounding soil. The general contractor, however, had to make the proper disposition of all underground utilities encountered in the excavation by sending proper notices, making all necessary arrangements and performing all other services required in the care and maintenance of all public utilities, such as electric lights and telephone poles, electric cables, gas mains and water and sewer pipes.

All backfilling around walls and under floor slab had to be done with freshly excavated clay and sand as material approved by the architect, then rammed and puddled to a solid compact body so as to prevent any settlement. In this respect particular care had to be taken that the soil below the floor slab under the skating rink was thoroughly compacted and level. For this purpose the use of a steam roller was specified.

Rigid Tests Made on Cement

In concreting materials the cement had to be a Portland cement conforming to the current standard specifications and tests for Portland cement adopted by the American Society for Testing Materials. A complete set of tests was made for each 50 barrels of cement. The samples had to be taken at the place of manufacture or the warehouse where it was stored. Mixing of samples was not allowed.

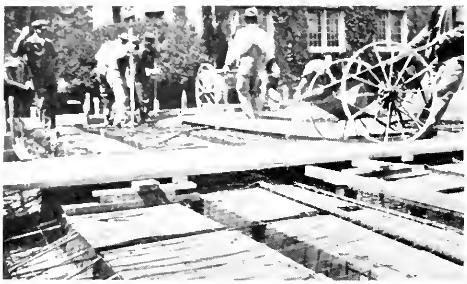


Figure 1: Forms for the floor slab of the rink, showing the reinforcement in place. In the background the concrete is being tamped thoroughly to insure a compact mass.

The following tests were performed on each sample of cement: Tension, fineness, percentage retained on a 200-mesh sieve, soundness after being in steam for 5 hours, initial set, final set, percentage of sulphuric anhydride, percentage of magnesia, and compression. The cylinders which were tested for compression had an average strength of 2,300 pounds per square inch after 28 days.

In the case of cement stored in warehouses, failure of any of the tests to meet the standard caused the rejection of the entire 50 barrels from which the sample was taken. When the sample was taken from carload lots, failure to meet specifications caused the rejection of the entire lot.

The sand used was of a grade known as torpedo sand. The coarse aggregate ranged in size from ½ inch to 1½ inches in diameter for plain concrete, ¼ inch to ¾ inch for reinforced concrete, and ¼ inch to ½ inch for concrete grouting and fireproofing. Quantities of material were measured by volume. The mix used was 1 sack of cement weighing 94 pounds and containing 1 cubic foot, 2 cubic feet of sand, and 4 cubic feet of coarse aggregate, with water not exceeding 7 gallons for each cubic foot of cement. The concrete was deposited quickly by means of buggy carriages, and no batch was allowed to be dumped later than 30 minutes after water had been added to the dry materials. As the concrete was poured it was carefully tamped and worked so that all reinforcement was thoroughly encased. Every care was taken to provide a smooth uniform surface after forms were removed (Fig. A).

Perfect Alignment of Steel

The steel frame of the building was designed to carry a wind pressure of 20 pounds per square foot in the vertical projection of the finished structure. The pitch of the rivets in the direction of the stress was not permitted to exceed 9 inches nor 16 times the thinnest outside plate connected and not more than 30 times that thickness at angles to the stress. The minimum distance from the center of any rivet to a rolled edge was 1½ times the diameter of the rivet. Drifting to enlarge holes and recupping and calking of rivets was not allowed.

In erecting the columns the column bases had to be set in place and blocked off the concrete with leveling screws at the corners to the exact elevation required, after which they were grouted in by the mason with concrete grout. Filler plates were set between ends of the girders and the columns wherever needed to maintain the columns accurately in a plumb position. Particular care had to be taken to have the work perfectly plumb and level before riveting. All members were connected temporarily with sufficient bolts to insure the safety of the structure until it was finally riveted and it was required that not less than 1/3 of the holes be bolted. Where holes were too small to admit a rivet the hole had to be reamed but not drifted or forced. All steel received two coats of DuPont DuLux metal paint.

In the construction of the arena or the rink floor, the slab was made independent of the rest of the building for reasons of contraction and expansion due to changes of immediate temperature. Eighteen inches of cinders were laid and well tamped by means of a steam roller above the tile drain. Upon these cinders a 6-inch concrete slab of 1:3:4 mix was laid connecting with the inside wall of the tunnel. Then a 2-inch layer of sand was laid on top of it to support the skating rink floor. The rink floor is 3½ inches thick, laid in 32 sections 6x125 feet in which are imbedded about 15 miles of 1¼-inch pipe. This pipe, through which the freezing brine flows, is coiled around and laid on 4½-inch centers. The mix of the concrete in this slab is of cement, sand and steel turnings running 10 pounds to the square foot. The coefficient of expansion due to the freezing mixture necessitated the design of this floor in 6-foot strips between which are ⅛-inch brass strips acting as expansion joints. The thin surface of concrete (1-⅛ inch) above the pipe will not hinder the freezing and will permit the use of the building for other purposes at other seasons of the year.

The two compressors in the engine room. Ammonia gas is compressed by these machines, then on expanding takes up heat from the brine pipes.

Map of the portion of the Mississippi below Cairo, showing the location of the principal scenes of flood-control construction and the possible channels through which water from the Mississippi may be diverted.

Mississippi River Flood Control

MAJOR GENERAL LYTLE BROWN
Chief of Engineers, U. S. Army

Outlined by Maj. Gen. Brown at the meeting of the Central Illinois section of the A. S. C. E., October 13, 1931, and written by William J. Bobisch '32.

FLOOD control of the Mississippi is a problem from the mouth of the Ohio river to the Gulf of Mexico, and has been a problem since the valley was originally settled over a century ago. In 1850, two of the ablest of the army engineers, Capt. A. A. Humphreys and Lieut. H. L. Abbot, were assigned to make a detailed study of flood problems on the Mississippi. They worked under handicaps which today would be almost unsurmountable, with no records of previous flow or floods, no weather bureaus, no stream gages, none of the refined equipment of today. Yet when they finished their studies in 1860, their conclusions as to the only practicable method of controlling floods on the Mississippi were almost exactly similar to the methods which are actually being used today.

The general concensus of opinion among engineers who have made a study of the problem is that a system of reservoirs, which is so often proposed, is impossible because of the cost. Levees, which can be built cheaply must be relied upon in the upper portion of the flood area. Below the mouth of the Arkansas river the tremendous watersheds of the Mississippi plus those of the Ohio and Red rivers, make it impossible to build a levee high enough to hold back the flood waters. Below this point the plan is to let the excess waters find their way to the sea by way of different routes. In brief, figuring on a maximum of 3,000,000 second-feet discharge on the Mississippi at the Red river, it is planned to divert half of this down the Atchafalaya basin to the Gulf. Of the remaining 1,500,000 second-feet, about 250,000 second-feet will be spilled into Lake Pontchartrain, near New Orleans, by way of the new Bonnet Carré spillway, now under construction. This leaves a remainder of about 1,250,000 second-feet to pass through the main channel at New Orleans, and it is known that the levees there are high enough to handle this water.

The present work on flood control is concerned with the saving of the main centers of population. Below is a brief summary of the methods being used to protect these areas:

CAIRO

The flood channel below Cairo is to be widened out by setting back the levees to make a channel five miles

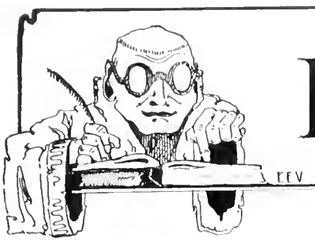
View from the top of the weirs at Bonnet Carre

wide immediately below the city and a channel of 12 miles further south. This will prevent the water from topping the levees at Cairo.

GREENVILLE

The levees through Greenville are being built three

(Continued on Page 23)



EDITORIAL

An Apology

In the October issue we stated in our editorial columns that credit should be given to last year's staff for establishing the Technograph as a monthly rather than a quarterly publication. It seems that we have given the credit to the wrong staff. The staff for the year 1929-30 worked out the details for the change and to them should go all the credit for taking the initiative.

We still insist, however, that last year's staff should be given credit, whether they want it or not, for actually establishing the Technograph on a monthly basis.

A Challenge

Illinois students received probably the greatest shock of their undergraduate days last month when they opened up the pages of the Daily Illini to read the stupendous news that the ancient, time-honored system of class attendance regulation, or "cut" regulation, to use the universal term, had been tossed overboard by the university, and that all regulation would hereafter rest in the hands of the instructors. According to the new ruling, the university itself would no longer try to keep a close check on the number of cuts taken by any student, nor would it issue excuses for absences. Instead the matter of attendance is to rest entirely between the instructor and the individual student. The teeth in the new ruling, however, lies in the provision that an instructor who thinks a student has been so irregular in his attendance of the class that it would not be worthwhile for the student to continue the course may cause said student to be dropped. Or if he is inclined to be a bit more kind-hearted, he may first arrange a conference between the student and the dean of the college, where a little detailed searching into the student's reasons for cutting will be held.

The first reaction to the new ruling was naturally one of jubilation. At last that eight-o'clock class could be cut! But a little saner thought on the subject and students began to realize that the new ruling did not mean that the university was going on record as approving cutting on a wholesale scale. Rather, the only important change was the transfer of authority from the dean's office to the individual instructor.

From the student's standpoint, the change means that he is going to have to be even more discreet about his cutting. Under the old system he at least knew exactly how many times he could turn up missing for each class without unduly jeopardizing his chances for passing the course. Now, however, there is no such definite understanding. It is going to be up to the student to ascertain in some manner, by direct or indirect questioning, just what each instructor's attitude is toward cutting his classes. If the instructor sees in the new ruling a chance to obtain perfect attendance, there is little the student can do except arrange to get to class. On the other hand, if the instructor is inclined to be lenient in his interpretation of the rule, the student has a little more leeway.

To the instructors this new ruling is just as much a challenge as to the students. Some of them are going to be broad-minded in their attitude on the matter. They will realize that many of the times that a student cuts he has a real reason for it. They will appreciate the fact that often it is much more of an advantage to a student to spend the class hour working on some definite problem which has to be in at a certain time, or studying for a quiz for another class, than to attend one particular session of a certain class. And they will perhaps look into themselves for a reason if they find that half the seats in their classrooms are usually empty when they give lectures. There is more than a remote possibility that there is some fault in the manner in which they present the subject. It may sound like heresy, but perhaps it isn't really worth the student's time to attend some of the classes where he always falls asleep anyway.

Other members of the faculty are going to seize upon the new era as a chance to secure perfect attendance. They will in great glee set down arbitrary rules that any one who cuts more than once, say, will be immediately dropped from the class. And they will probably hold narrow-mindedly to their regulation. We have a sneaking suspicion that it will not be long before this type is eliminated from the university.

Finally, we believe that the university has made a forward step and that results will justify the initiation of the new system. Both the student and the instructor are going to be given the opportunity to show how well they can fit into the spirit of the new era.

A New Slant?

"I have too much work to study tonight."

Probably that sentence in its present form is not often used by engineering students. But we wonder if they might not frequently have reason for giving utterance to some such statement. Perhaps its manner of statement requires a little explanation.

It has lately occurred to us that in several of our engineering courses there is so much actual laborious work assigned that we find ourselves so swamped that we have little time for what we call real study. We are often assigned to hand in for one class session a problem, the preparation of which may take five or six hours or more. We wonder if the training involved in working out some of these problems could not be gotten in less time, and still just as thoroughly.

To get down to brass tacks, one of the senior classes was recently assigned a problem which involved a detailed study of the stresses in a particular structure. Instead of calling for perhaps one representative study of the structure, the problem required the study of several sections of the structure, all alike in their methods, and differing only in the actual numbers which were involved. It seems to us that it might be possible to eliminate some of this. The proper study of this assigned problem took most of the students in the class about six hours.

One of our graduate students was recently heard to remark that the chief delight of being in the graduate school was that he now has time to do a little browsing around among the technical books and magazines in the libraries. During his undergraduate days he never had time to get all the lessons which were assigned, and the opportunity of doing a little research work of his own was never present because of lack of time. A little of the graduate atmosphere mixed into the undergraduate system might provide valuable opportunities for personal investigations on the part of students, and might allow time for a little diversified reading which is denied them now because of lack of time.

An Open Door Policy

Just why engineers must be kicked out of design rooms (not to mention the editor out of the Technograph office) at exactly ten o'clock every night is still a dark secret to us even after four years in this search for "truth and light." Architects are permitted to work all night long at the architecture building and furthermore are provided with a smoking room. Why Green street should be a time meridian is a mystery hidden deep in the musty shadows of engineering hall's unused basement.

Of course one may be met with the smug statement that "A good student can do all his design work in the periods regularly assigned." On looking around us, however, it is simply amazing to note the number of engineers who apparently must not be such good students if this is to be a criterion.

Liberalism is making itself felt in all the departments of the university. Engineers! Let's petition the powers that be for an open door policy for engineering hall.

—J. R. W.

Technograph Places in Awards

READERS of the Technograph will be interested in knowing that their magazine fared rather well in 1930-31 in the competition with other members of the group of engineering college magazines which form the Engineering College Magazines Associated. Of the awards which were announced at the convention of the association held last month at Penn State, the Technograph won five. The Iowa Engineer with five awards tied with the Technograph for the most places.

First places were awarded the Technograph for the best editorials for the year and for the best single editorial. Second place was won for the best cover series in the group. The other two places were first honorable mention for the best single editorial and second honorable mention for the best student articles for the year.

The editorial which won first place was "Our Attitude Towards Military Training," written by Don Johnstone, editor of the Technograph last year. It appeared in the December issue. The editorial winning first honorable mention was "Expert Testimony," also written by Johnstone, and appearing in the March issue.

Thank You

The new typewritten and framed titles for the pictures in engineering hall, which have recently been put in place, will make for a great deal more intelligent perusing of the pictures by engineers, and will provide them with much more pleasure when they look at these pictures. We have always been an admirer of the excellent views of engineering projects which are on display in the hall. The bridges, buildings, harbors, maps, and other constructions which are illustrated in the views are all well-chosen and excellently carried out, and have always been a valuable source of information and reference as well as pleasure. However with the exception of the few pictures which are labelled, there was formerly no way of knowing what the subject of any picture was, unless one happened to be familiar with it from other standpoints.

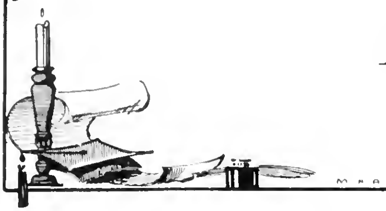
True, there was a numbering system, but it was insufficient. Each picture had a number, and there were in existence mimeographed sheets giving the titles corresponding to all the numbers. But the system was unsatisfactory because these sheets seldom were available at the time a particular picture was being examined.

The installation of the framed titles was a good move and deserves the appreciation of the students.

A New Feature

We wish to call attention to the article by Prof. Young on "A View of the Railway Field," which appears on another page of this issue. This article is in keeping with the Technograph's policy of offering each month a review of conditions in some one branch of engineering, with an attempt to explain the problems, possible developments, and employment possibilities in that field. The purpose of this series of articles is to provide readers with a perspective view of the several fields of engineering so that they may be guided to some extent in shaping the course of their studies both at the university and after leaving the scene of their formal education.

The December issue will contain a similar article by Prof. Mitchell, associate in the mining engineering school. Prof. Mitchell will explain conditions in the mining and metallurgical field.



ALUMNI NOTES

DR. SAMUEL W. STRATTON '84, former president of the Massachusetts Institute of Technology, died suddenly October 20, at his Back Bay home in Boston.

Dr. Stratton was born at Litchfield, Illinois. After his graduation from the university in 1884, he served as professor of physics and electrical engineering in the university until 1892, after which he held a professorship of physics at the University of Chicago. For 22 years he was director of the Bureau of Standards, Washington.

President Chase said in a tribute to Dr. Stratton:

"The death of Dr. Stratton leaves a blank in the files of our alumni body and in the life of the nation that will be hard to fill. His greatness was respected and known most by those whose interests are along engineering and educational lines. They are familiar with his accomplishments and honor him for the work he has achieved. I am exceedingly sorry to learn of his death."

LION GARDINER '09, and KENNETH M. TALBOT '09, contributed articles to the equipment engineering issue of *Engineering News-Record* for April 9. Mr. Gardiner who is president of the Lakewood Engineering company at Columbus, O., wrote on "How Equipment Builders Serve the Construction Industry." Talbot, who is director of research for the National Equipment corporation at Milwaukee, wrote on "Origin of New Designs and Improvements."

C. J. MITCHELL, c.e. '91, was chosen as the new secretary of his class at its last commencement conclave. Mr. Mitchell is in the canning business in Eureka. He was at various times after his graduation with the Illinois Central railroad and the Keystone Bridge company. For some years following he was connected with Fairbank, Morse & Co., at Chicago.

H. J. LITTELL, m.e. '31, is in the engineering department of the Littel Machine and Tool company, which is owned by his father.

J. WESLEY SMITH, m.e. '17, is conducting research work on aerial cameras and developing machines for the Philadelphia Air Transport company, Morristown, Pa.

E. F. BRAQUEA, m.e. '17, has left the National Broadcasting company to manage the radio department of Kenyon & Eckhart, advertising agency, New York City.

The death of WILLIS A. SLATER, c.e. '12, which came unexpectedly October 5 after a short illness, closed a brilliant career of noteworthy achievements in the field of engineering.

After graduation he spent some years in engineering work and later he became assistant in the Engineering Experiment Station, department of theoretical and applied mechanics, at the university. He received his M. S. in 1910, and his C. E. in 1912. In 1917, ranking as an assistant professor in theoretical and applied mechanics, he left the university to enter work and was engaged on research in reinforced concrete for the emergency fleet corporation. At the end of the war he became engineer physicist in the United States Bureau of Standards where he contributed much to knowledge of engineering materials.

In 1922-23, the university borrowed him from the Bureau of Standards to oversee the testing and inspection of concrete work in the construction of the stadium. In the spring of 1928 he went to Lehigh University as director of the Fritz engineering laboratory and research professor of engineering materials. This position he occupied at the time of his death. He was the author of a long list of bulletins and technical articles dealing with research in reinforced concrete. In 1922 he received the Wason medal of the American Concrete Institute.

One of his important investigations was conducted in 1925 when he was placed in charge of the construction and the tests of an experimental arch dam of unreinforced concrete, known as the Stevenson Creek dam, in the mountains of California. This investigation, entailing a large expenditure of money, was fostered by a committee of the Engineering Foundation which included some of America's most eminent civil engineers. Professor Slater was also a leading authority on cement and concrete and did much to increase the knowledge of the design and construction of concrete structures. Still another important contribution to the engineering world was his chairmanship during the last few years of a committee made up of representatives from five national engineering societies organized to formulate specifications for the design and construction of reinforced concrete structures.

MASON H. CAMPBELL, m.e. '17, is on leave from the University of Vermont this year, and is completing work for a Ph. D. at Wisconsin.

JOHN F. BRACKEN, e.e. '29, is employed in the engineering department of Commonwealth Edison, Chicago.

G. E. SORENSEN, m.e. '31, and W. F. RIDGEWAY, m.e. '31, are both employed by the Ingersoll Milling Machine company, Rockford, Ill. Sorensen is in the erecting department and Ridgeway is in the engineering department.

D. Joseph Brumley, c.e. '31, is a graduate student at the University of Illinois.

John R. Curtis, c.e. '31, is with the Illinois Division of Highways.

Lee H. Sentman, c.e. '31, is working for the Illinois State Highway Department at Aurora, Ill.

Montgomery B. Chase, c.e. '06, is chief construction engineer for the Port of New York Authority. He recently gave an illustrated lecture on "The Hudson River Bridge" before student members of the American Society of Civil Engineers.

V. W. Jaslin, m.e. '31, is in the tool designing department of the Troy Laundry Machine company, Moline, Ill.

E. M. Woerner, m.e. '31, is working for the Caterpillar Tractor company in the engineering department.

Fayette J. Flexer, c.e. '14, is third secretary at the American embassy, Havana, Cuba. Following his graduation Mr. Flexer followed the engineering profession in the far corners of the earth: Hawaii, Australia, Union of South Africa, and Mozambique. In 1916 he was appointed vice-consul at Port Elizabeth. In the following year he went to Cairo in the same capacity. Following his service in the war he was sent to Berlin, then to Mexico, and finally to Cuba.

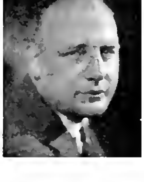
Albert W. Robinson, c.e. '16, is a sales engineer for the Oliver United Filters, Inc., and at present is specializing on the filtration of cement and the designing of filtration plants for cement plants.

Tom Brown, a.e. '17, who is sales engineer of the B. F. Reynolds Company, Detroit, was elected president of the Michigan Trade Golf Association, an organization of architects, contractors and engineers.

Charles Nelson, c.e. '31, and Stanley Perkins, c.e. '30, are both working for the Illinois state highway department.

Thomas A. Gillen, c.e. '29, is employed as a state engineer in LaSalle, Ill.

Harry F. Glair, m.e. '12, who was formerly manager of the Standard Oil Company's (Indiana) Whiting refinery has been promoted to the position of assistant general manager of manufacturing. Glair on graduation was with Curtis and Co., engineers, St. Louis, Missouri, for a short time, after which he started to work with Standard Oil. He has been with them continuously since that time. In 1915 he was promoted to assistant superintendent of the paraffin department and then in 1927 to the managership of the Whiting plant. While in school Glair was quite active on the south side of Green street. A partial list of his activities includes class baseball, business manager of the Mandolin and Glee clubs, Helmet and Ku Klux, junior cap committee and also senior memorial committee.



J. E. Dare, m.e. '31, is taking a course at the Central Station Institute in Chicago.

Elmer G. Krouse, e.e. '22, has left the engineering line and is now in the drug business. He is secretary-treasurer of the Walkohl Drug Co. of Belleville, Ill.

Edward J. Mehren, c.e. '06, is now full-time president of the Portland Cement Association. Formerly the presidents devoted only part of their time to the association job since all of them were presidents of various Portland cement manufacturing companies. The Portland Cement Association is an instrument through which the cement manufacturers of the company carry on jointly general educational work regarding the use of cement.

Mr. Mehren was born in Chicago and graduated from St. Ignatius College in 1889. He then came to Illinois where he studied engineering for three years. He was active in many campus activities: Sigma Nu, Tau Beta Pi, Sigma Xi, Delta Sigma Rho, and Philomathean. He was on the debating team, was class orator and vice-president.

Edward J. Mehren '06

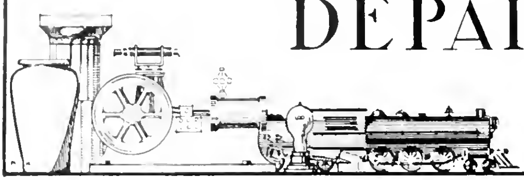
The year following his graduation he spent as transitman for the C. M. & Puget Sound railroad. Then on the recommendation of Prof. A. N. Talbot, he began his connection with the *Engineering News-Record* as associate editor in 1907. He rose to the editorship of this publication, which position he held for ten years. Then he became vice-president and editorial director of McGraw-Hill, which publishes a dozen or more engineering magazines and numerous engineering books. Some few months ago he devoted his time to the establishment of *The Business Week*, one of the latest McGraw-Hill publications.

Mr. Mehren has also been active in Illinois alumni work. He has appeared several times at the university, once as alumni day speaker. He has served as a member of the executive committee of the Alumni Association, as secretary of his class, and as a member of the editorial board of the *Illinois Alumni News*.

Frank A. Matteson, m.e. '31, is working for the Public Service company of Maywood, Illinois, as a gas engineer. He recently married Pauline Hurd '31.

C. M. Gardiner, m.e. '31, is taking a post-graduate course in engineering at the University of Illinois.

J. A. C. Callan, c.e. '07, is teaching at the Alabama Polytechnic Institute in the civil engineering department. He recently was elected president of the Alabama state section of the American Society of Civil Engineers.

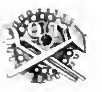


DEPARTMENTAL NOTES

Engineering Societies

Theta Tau, professional engineering fraternity, entertained guests at a smoker Wednesday, October 28.

Prof. J. J. Doland and Prof. Jamison Vawter gave short talks and Art Kowitz, c.e. '32, presented the history and purpose of Theta Tau. The following men were pledged to Theta Tau: J. R. Webb, c.e. '32, R. Young, c.e. '32, H. T. Stephenson, m.e. '32, H. D. Barber, c.e. '33, G. Bailey, g.e. '34, L. Arning, g.e. '33, G. W. Losee, m.e. '34, W. W. Potoker, m.e. '33, L. A. Pfaff, e.e. '33, J. Seymour, m.e. '33 and R. B. Hutton, e.e. '34.



Theta Tau will hold their annual national convention next spring at the University of Arkansas, Fayetteville, Arkansas.

Prof. H. M. Westergaard of the T. and A. M. department talked before the A. S. C. E. November 5 on "The Boulder Canyon Dam." His talk was illustrated with pictures of the dam.

A motion picture on aviation and several interesting talks were presented at the Illini Flying club smoker at the Kappa Delta Rho house November 4. Lieutenant Anderson from Chanute field talked before the group.

At a meeting of the Engineering Physics society October 21, plans were made to participate in the 1932 electrical show by entering an exhibit in the name of the society or by assisting some other groups in presenting an exhibit.

At a dinner meeting on November 3, Gargoyle's new class of pledges were submitted to an oral examination. They had previously completed a written test. These examinations are conducted by faculty members, and each pledge must qualify in them before he is initiated.

Because of the transfer of the department of architecture from the College of Engineering to the College of Fine and Applied Arts, Gargoyle is the only honorary society on the campus for which architects will be eligible two or three years hence.

Prof. H. F. Moore, who has just returned from an extensive tour of Europe, recently spoke to members of the A. S. M. E. on "Notes on British and Swiss Laboratories." R. R. Leonard, the midwest representative of the national organization of A. S. M. E., also spoke at the meeting October 4. A motion picture, "Electric Heat in Industry," was shown at the meeting of A. S. M. E. on October 14.

A motion picture on the life of Thomas A. Edison was presented at the regular meeting of the student branch of A. I. E. E. October 21. Plans for the 1932 electrical show were discussed.

Sigma Tau, honorary engineering fraternity, began its activities of the year with a dinner at the Theta Delta Chi house, October 15. Arrangements for the annual dance and plans for a smoker were discussed.

The smoker was held at the Triangle house October 22. Prof. C. A. Keener talked on "Something for Nothing," illustrated by sketches of perpetual motion devices which puzzled the engineers present.

The following men were pledged to Sigma Tau at a meeting November 5 at the Tau Upsilon Omega house: D. Humm, e.e. '32, B. Burgoon, e.e. '32, R. L. Dowell, e.e. '32, A. M. Daley, e.e. '32, W. E. Schultz, c.e. '32, M. O. Mathews, c.e. '32, W. M. Avery, c.e. '32, S. W. Benedict, c.e. '32, E. S. Turnipseed and W. C. Nelson, engineering physics '32, J. E. Somerville, a.e. '32, W. W. Vanderkolk, a.e. '32, W. M. Horowitz, a.e. '32, and A. W. Newither, m.e. '32.

Chi Epsilon, honorary civil engineering fraternity, entertained with a smoker at the Sigma Delta Rho house, October 29. Prof. F. W. Stubbs and Prof. T. C. Shedd gave short talks before the group and Prof. J. S. Crandell spoke on "The Evolution of Music."

After the program arrangements were made for the informal initiation which was held November 12.

The following men were pledged to Chi Epsilon: E. L. Wissmiller, c.e. '33, G. Righter, c.e. '33, J. Zaloudek, c.e. '33, W. Avery, c.e. '33, D. M. Baldwin, c.e. '33, and V. S. Kaufman, c.e. '33, R. Nelle, c.e. '32, George Chinn, c.e. '33.

Electrical Engineering

The Urbana section of the American Institute of Electrical Engineers has announced a prize essay competion open to all electrical engineering students who are student members of the American Institute of Electrical Engineers at the University of Illinois or Rose Polytechnic Institute. The first award for the best paper on any engineering subject will be a trip to the Great Lakes district convention in March. A second prize of ten dollars will be awarded at each school and also a third prize of five dollars.

Mining Engineering

Prof. C. M. Smith has returned from the southern Illinois coal fields where he spent several weeks studying coal mine ventilation conditions.

(Continued on Page 20)

Departmental Notes

(Continued from Page 18)

Prof. A. C. Callen, Prof. C. M. Smith, D. R. Mitchell and H. P. Nicholson of the mining department attended a meeting of the Illinois Mining Institute at Springfield on November 6.

Prof. C. W. Parmelee, head of the ceramics department, has brought from Europe several specimens of porcelain pottery and glassware. The specimens are to be exhibited in the ceramics museum.

Theoretical and Applied Mechanics

A new electric elevator has been placed on the large 3,000,000-pound Southwark Emery Testing machine in the main bay. The elevator was built by the Montgomery Elevator Co. of Moline Illinois, especially for this testing machine. The elevator, with a speed of 40 feet per minute, can be controlled from either the control case of the testing machine or from the platform of the elevator. The elevator has been placed on the testing machine to facilitate the work and also to reduce the danger of working on long compression or tension specimens. As the machine rises fifty feet above the concrete floor the danger from falls was very great.

Chemistry

Of interest to physicists is the fact that Dr. Gordon Hughes of the department of chemistry is at Alabama Polytechnic Institute in Auburn studying the apparatus used in the identification of elements 85 and 87, the two unknown elements, by the magneto-optic effect. He expects to reproduce the apparatus at the University of Illinois.

Ceramics

Dr. A. I. Andrews of the ceramics department lectured before the Chicago Enamel club at the October meeting held in Chicago.

Electrodeless Discharge

(Continued from Page 6)

for a number of curves were taken for each gas until the observers were able to reproduce the curves within the errors of observation.

The different gases studied and the corresponding pressure-current curves obtained are shown in Figs. 3, 4 and 5. Each gas has a maximum. It should be noted that

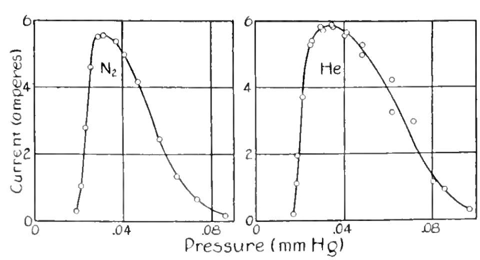


Figure 5: Currents in the electrodeless discharge in nitrogen and helium as a function of pressure. Exciting current 57 degrees

the magnitude of this maximum differs widely for the six different gases studied. Again, the curves show that the maxima do not necessarily appear at the same pressure for the different gases.

Maximum current, gas pressure at maximum and pressure range in the electrodeless glow discharge in various gases. Exciting current 57 amperes.

Gas	Maximum current	Corresponding Pressure	Pressure range of "bright glow"
Oxygen	9.9 amp.	0.060 mm Hg.	0.020-0.172
Hydrogen	2.4	0.052	0.036-0.090
Argon	8.3	4.042	0.020-0.60
Neon	8.4	0.190	0.040-1.00
Nitrogen	5.54	0.032	0.018-0.090
Helium	5.8	0.033	0.017-0.10

The table gives the value of the maximum current for each gas, the pressure at the maximum, and the approximate pressure range of the "bright glow" discharge. The values tabulated are only useful as a means of comparison. Oxygen yielded the largest current, and the optimum pressure in every instance was less than 0.2 mm. of mercury.

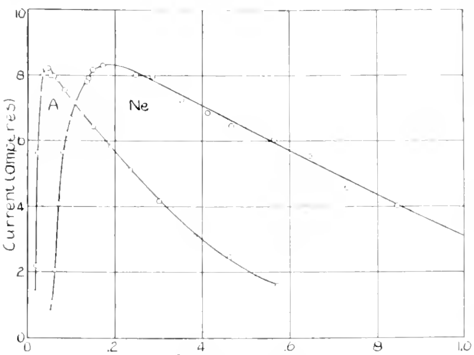


Figure 4: Currents in the electrodeless discharge in argon and neon as a function of the pressure. Exciting current 57 amperes. Note the change in pressure scale.

Additional interesting points observed were:

In order for the electrodeless discharge to form, the tube (or path) must be re-entrant, e. g., the discharge would not pass through the tube shown at B, Fig. 2.

The character of the discharge as the exhaustion proceeded presented an interesting sequence. It began gradually with a succession of flashes that went all the way round the discharge tube. These became more frequent and more luminous as the pressure decreased, finally filling the entire circuit with a brilliant glow, reached a maximum, then dropped rapidly to zero.

The discharge at no time overflowed into the expansion chamber.

When the upper ammeter was replaced by a 3 cm length of No. 30 nichrome wire it could readily be fused by the inductive effect of the gaseous current.

Summary

A method is described whereby the magnitude of the induced electrodeless gaseous current may be read directly by an ammeter.

Pressure-current curves were run for six different gases, and the chief characteristics set down in a table.

Additional interesting points are noted.

And did we tell you about the freshman studying forestry at a certain college who bought himself a log-log slide rule?

* * *

Until the perfection of the fool-proof airplane, the expression "Let's go out for a little spin" will not be used in polite society.

* * *

Once upon a time there was a civil engineering student who wouldn't study in highway engineering because Prof. Wiley said that low grades were most desirable.

* * *

Glancing at his watch, the engineer tightened his hand on the throttle. His jaw was set, and his eye was on the track ahead, for he had little time to lose. On, on, the mighty drivers rolled, the rods dipping and rising at a furious rate.

The bell was ringing as the engineer shut off the steam and the mighty machine came to rest.

"That will be all for today, men," said the instructor in charge of the locomotive testing lab.

* * *

Cheer Up!

You remember that Jonah was down in the mouth, but he came out all right.

—*Melbourne Technical School Magazine.*

* * *

Getting Hot

"What kind of a party was it?"

"Well, at about 1:30 the automatic fire sprinkler started to work."

—*Melbourne Technical School Magazine.*

* * *

"Dark and stormy night and the old engine was coming down the track whistling, puffing and flapping its ears—"

"Hold on, Pete; an engine doesn't have ears."

"Certainly it has, engineers." —*R. R. Magazine.*

* * *

He who courts and runs away,
Will live to court another day;
But he who weds and courts girls still,
May get in court against his will.

—*Melbourne Technical School Magazine.*

* * *

"Yeah, the war cost Sandy an arm. He couldn't bring himself to throw away a grenade."

—*Tennessee Mugwump.*

These New-Fangled Motions by the Football Referee and What They Mean

1. Military salute—Is whistling "*The Star Spangled Banner*" to himself.
2. Hands on hips—Is getting disgusted with the game.
3. Grasping of one wrist—Is teaching the crowd life saving.
4. Crossing of legs—Is a superstitious fellow.
5. Folded arms—Is a strong silent man.
6. Hand over mouth—Politely stifling a yawn.
7. Both arms extended above head—Thinks he hears that 7 a. m. radio broadcast. —*Colgate Banter.*

* * *

Jack: "I can't play billiards in the winter at all."

Tim: "How come?"

Jack: "Every time I see the three balls before me, they remind me of my overcoat."

—*Carolina Buccaneer.*

* * *

"Where do you sit at the games?"

"My seat is right on the fifty-yard line."

"Goodness, doesn't the whitewash ruin your trousers?" —*Ohio State Sun Dial.*

* * *

"Are you a union man?"

"Yes, and I work sixteen hours a day."

"I thought union men worked only eight hours a day."

"They do, but you see I belong to two unions."

—*Ohio State Sun Dial.*

* * *

A Scotchman was once run over by a beer wagon and for the first time in his life the drinks were on him.

—*Washington Dirge.*

* * *

Mr. Binks was busily engaged with a spade in the mud beside his car when a stranger hailed him.

"Stuck in the mud?" he asked.

"Oh, no!" replied Mr. Binks cheerily, "my engine died here and I'm digging a grave for it." —*Life.*

* * *

The G. E. D. department has already served notice that it expects others besides baseball fans to do their home plates. —*Railroad Sid.*

* * *

E. E.: "What makes you think my head is a cork?"

C. E.: "Because it's always at the neck of a bottle."

Mississippi Flood Control

(Continued from Page 13)

feet higher. Below the city, near the mouth of the Arkansas river, the levees are being built so that they will break in extreme floods, permitting the excess water to flow into the Boeuf basin, and thence out to the Gulf.

New Orleans

Present docks make the raising of levees here too expensive. This means that part of the water must be diverted from the river above the city. This is done, as noted above, by the Bonnet Carré spillway, diverting

Upstream view of wiers of Bonnet Carre spillway. About 250,000 second-feet is to flow over this spillway into Lake Pontchartrain at flood time.

water into Lake Pontchartrain where it does no harm, and from which it finds its way to the Gulf.

Levees must be strengthened all along the river. Side levees must be not less than 10 miles apart to be effective. To build these side levees, the United States must buy additional flowage rights. These side levees through the Boeuf basin will carry the extreme floods of about every 12 years. The enormous amount of money necessary to buy flowage rights through the Boeuf basin has forced the government temporarily to stay out of this basin. This question also comes up in connection with the Tennessee and Kentucky rivers. High levees cause the water to

Downstream view of the Bonnet Carre spillway, showing the baffles and articulated slabs

back up into these valleys. The suggestion has been made that the government should pay for the damages caused by these levees. The amount involved is huge, and no decision has yet been reached.

The rate of moving earth for levee construction is enormous. During the first year 15,000,000 cubic yards were moved, during the second year 42,000,000, and during the third year 90,000,000 cubic yards. This is three times the rate at which earth was moved in building the Panama Canal.

Borrow pits for the levees are on the river side of the levees, and the bottom must not be below grade line. If it becomes necessary to excavate below grade, the pit must be refilled. The method of moving the earth is by means of long beam drag-lines on caterpillar treads. The hydraulic process of moving earth is not satisfactory in this construction. It is suitable for sand, but on clay it washes out the fine particles, leaving only the coarse material.

As stated before, the high cost of work in the Boeuf basin has prohibited a solution of the problem there. The present plan is to take the money available and put it where it does the most good. The investment is being made in works, not land.

And then there was the dumb city feller who wanted to know if the farmers harvested the crops of their chickens. —*Railroad Sid.*

* * *

Which brings to mind the freshman in L. A. and S. who, after losing his fountain pen, hurried over to the foundry to see if it had been turned in.—*Railroad Sid.*

* * *

But have you heard of the freshman co-ed who spent forty-five minutes looking at the special clock in the physics building trying to find out what the temperature was. —*Railroad Sid.*

A View of the Railway Field

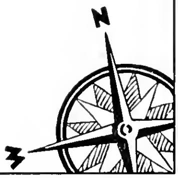
(Continued from Page 10)

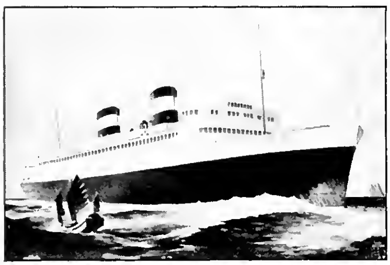
The graduating civil engineer goes into the engineering department of the railway and probably finds his way to becoming a part of the organization in charge of construction, maintenance, bridges, and buildings the easiest of the three major divisions. Illinois men have made notable records as chief engineers, bridge engineers, and engineers in charge of construction. The mechanical graduate entering the mechanical department must in general take a special apprenticeship, unless he secures work under the mechanical engineer or engineer of tests, where he begins as a draftsman or test assistant. An Illinois man holds the position of chief mechanical engineer on one of the largest railways of the United States. The electrical graduate finds a considerable number of "student engineer" positions open to him on electric lines, while on the electrified steam railway his position is similar to that of the mechanical graduate.

Opportunities in Manufacturing

For the electrical and mechanical men another railway field is open and usually more inviting than the railways themselves. This is the supply industry—the building of railway equipment. Here the seniority policy is not entirely absent but does not work against him quite so severely. He has a relatively better chance to advance on his ability to make good. It is not to be forgotten that in the supply industry the highest grade of railway engineering is carried on.

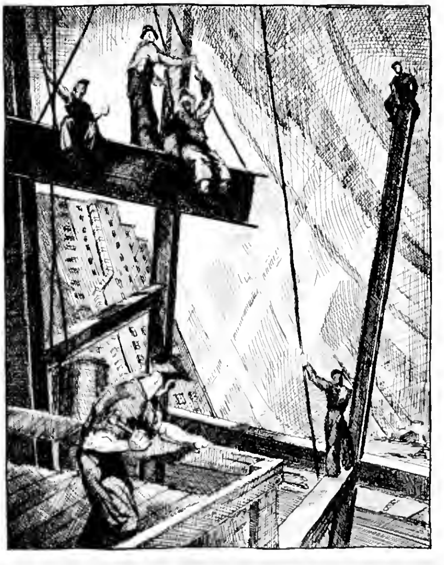
Typical engine room of a modern all-electric ship





THE TECHNOGRAPH

UNIVERSITY of ILLINOIS



DECEMBER 1931

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The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

Member of the Engineering College Magazines Associated

VOLUME XLVI URBANA, ILLINOIS DECEMBER, 1931 NUMBER 3

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The Risorgimento arch bridge in Rome, Italy, one of the world-famous bridges which Prof. Hardy Cross inspected last year

THE TECHNOGRAPH

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Bridges Here and There

HARDY CROSS
Professor of Structural Engineering, University of Illinois

A ROOM popular years ago in Chicago's Sherman House bore in Gaelic a mural description, "Here's to the bridge that carries us over." That's what a bridge is for, to carry the roadway over some obstruction; but it may do it in a great many ways. The bridge is a part of the roadway, and it is also a part of the landscape, and a part of the river or valley which it crosses. It must harmonize with its environment; it must meet the spirit of its associates. In a park it may be a jolly little bridge, and play, as a little suspension bridge over the lake seems to play in the public gardens of Boston, but it must be a very serious-minded bridge where it is to carry a railway over a gorge. If it lives in pine forests, the bridge will perhaps want to be of timber and feel that it fits into the neighborhood, but we connect rock gorges with cut-stone masonry or with concrete, and for huge spans we use the strength and grace of steel.

Paris, with all its fascination, center of art, ancient seat of learning, city of great vistas, of magnificent gardens, is also a city of beautiful bridges. Artist, architect, and engineer find fascination along and between the banks of the Seine. Pont Alexandre, Pont de la Concorde, Pont Royal, and all the bridges connecting the island with the banks fit gracefully and harmoniously into those magnificent vistas which stretch from Notre Dame to the Trocadero and from the Chamber of Deputies to the Madeleine. Pont de la Concorde, chef d'oeuvre of Perronet, architect to the king of France and first chief of engineers of the Department of Roads and Bridges, was being widened last year and I was able to examine the excellence of the workmanship throughout this fine structure. Perronet's notes are said to have contained plans worked out in detail for a masonry arch of a span length of 500 feet, a span which we often think of today as near the limit for reinforced concrete in spite of our fancied progress with theories of elasticity. This is about the span of the great arches recently constructed at Plougastel after designs by Freyssinet, and is more than one-half that of our Hell Gate bridge.

At Paris, as elsewhere in Europe, the accumulation of beautiful bridges has been through a process of long selection. The beautiful bridge is a bridge well designed; a bridge well designed is, in general, durable. As the years go by, it becomes part of the life and affections of the people, a part of a city, focus for civic development. It captivates the fancy of artists and poets, and so endears itself that it is permitted to survive with small change as the years pass. American books often convey the impression that Europe has more numerous examples of the quaint and the beautiful in bridge architecture than has our own country. In so far as Europe has been able to preserve the best of its ancient bridges, that is true, but their more recent bridge architecture is, I believe, not superior to our own. You may see this in the newer bridges over the Seine and the Marne in the zone devastated by war. At Chateau Thierry, for example, the modern bridge of reinforced concrete seems mediocre and harmonizes little with the ancient buildings along the river or with the mouldering castle on the heights; we feel a little sympathy for this new material forced into such ancient and distinguished company.

Europe has few bridges which we would call large; the bridge over the Elbe at Hamburg and the Forth bridge are among the few which would by their size alone attract attention in our technical press. To these we may add a few over the Rhine and perhaps over the Danube. The bridge at Hamburg, consisting of two sinusoids intersecting at the piers and entered through massive and rather purposeless gate towers at the banks, fascinates by its curiousness rather than by its beauty. Forth squats spraddle-legged in the Firth like an antidiluvian dinosaur, magnificent in size, but not distinguished in proportions. America is the home of the great bridge.

Bridges present one face to river travellers, another to travellers approaching by land, and a third to those who loiter by the parapets to fish or rest or dream. Much mighty fine art has gone into the study of approaches, of pier forms, of details of balustrade. Each bridge has its own environment; it may be merely an extension of the street and be dominated by neighboring buildings, as is the case of Ponte S. Trinita; or it may itself dominate the view as does Risorgimento.

I have included three foreign views, not because America does not furnish beautiful examples, but because those given are less familiar to American readers.

Every fine bridge has a personality of its own. The Lars Anderson bridge in Cambridge, Massachusetts, charms with its companionship with the river; the bridges of Venice are part of that glorious ensemble of renaissance architecture; the Eads bridge has grace and strength of line in keeping with the dignity of the Father of Waters; the Charles bridge over the Moldau at Prague fascinates with its Jew's Cross and other fine statuary; some play in the park, some majestically span great rivers, but the bridges that impress themselves on the imagination fit their environment. Ponte Vecchio is charming over the Arno, Ponte di Rialto is part of the

Grand Canal, but the Chicago river is another stream with another tempo.

Europe seems to have loved its rivers and its bridges more than we have learned to love ours. The embankments of the Seine, of the Thames, of the Tiber, the Alster Basin at Hamburg,—I think of quite as many lovely bridges at home as abroad, but abroad the river banks have been more fully developed to charm and rest those who pause to enjoy the hospitality of the bridges. We have appreciated the rivers in our own cities much less than we should have done and less than we will do in the future. Boston has done marvelously with her Charles River basin, Chicago is changing its river from a great sewer to a ribbon of restfulness, Pittsburgh is discovering the waterways whose junction made her a trading post, and Indianapolis has found that the White may be a thing of beauty as well as a flood maker.

This little essay may serve for some readers as introduction to a fascinating sideline of engineering. Nearly all of us are given to some hobby of collecting. Most undergraduates have a passion for collecting formulas and I find graduate students much given to collecting all sorts of variations of methods of analysis. Both varieties of birds-egging are likely to become vicious and for my civil engineer friends I recommend, as an outlet for postage stamp proclivities, an excursion in the field of bridge collecting. By photographs and descriptions, accumulation of historic associations and of artistic detail, one can build up a museum which is not only of interest as a hobby but also has value as a background for professional work. It is a real pleasure to turn from the exact mathematics of analysis or the details of connections to a more general view of the function of bridge structures. Look over the pictures in "A Book of Bridges" and "The Bridge," illustrated by the distinguished artist Frank Brangwyn, in our library; here you will see bridges, not as formulas, but as studies in light and shadow. Look over the fine collections of photo-

The bridge of S. Angelo, Rome

graphs by Charles R. Whitney and Wilbur J. Watson, and do not neglect the interesting collection of photographs of American bridges which Professor Shedd has put on the walls of engineering hall.

America today is developing excellent standards in bridge architecture. In the past we have been so busy building bridges that we have sometimes forgotten that they should be beautiful as well as useful. But where a bridge has been "right," that is, of materials which obviously fit into the community and of design which is structurally correct, our bridges have a dignity not to be surpassed in Europe. I think I have never received a greater thrill from the beauty of any bridge than from Walnut Lane arch when I first saw it from the bed of Wissachickon Creek.

A bridge must be structurally sound, correct in form, adequate in detail, of good materials properly used, but it should also fit into the picture and perform in a graceful and dignified way its function of carrying the roadway over from street to street or from hill to hill. Remember that the distinction between architect and engineer is quite recent and that in bridge architecture it is almost impossible to enforce it. One who would design a beautiful bridge must have correct conceptions of structural action; the artist must be something of an engineer, the engineer something of an artist and city-planner.

The S. Trinita bridge, Florence

Engineering Experiment Station

The Engineering Experiment Station published in July a bulletin by Prof. A. P. Kratz on humidification for residences. The bulletin states "The majority of people, normally clothed and at rest or under slight activity, require an effective temperature of 69.5° F. If relative humidity is only 20 per cent, which is representative of conditions in the average residence in zero weather, a dry bulb temperature of 71.5° F. is required.

"In the average house during zero weather, about 12 gallons of water must be evaporated every 24 hours to maintain a relative humidity of 40 per cent or about 6 gallons every 24 hours to maintain a relative humidity of 20 per cent."

Several types of water pans for warm air furnaces and radiator shields for steam or hot water systems were tested for rates of evaporation and it was found that for ordinary residences during zero weather none of the above methods proved adequate to maintain a 40 per cent relative humidity and that auxiliary evaporators were required.

Prof. E. B. Paine, Prof. H. A. Brown, and L. P. Morris of the electrical engineering department recently attended a meeting of the Chicago Utilities Research commission to discuss methods of testing high voltage cables.

Prof. E. B. Paine and Prof. A. R. Knight attended a committee meeting of the National Electric Light Association November 4, 5, and 6 at Lafayette, Indiana.

Preliminary Water Power Studies

Don Johnstone '31

The author of this article, who was editor of the Technograph last year, is at present employed at the Kansas City, Mo. office of the United States Engineer Department, and is engaged in making studies of the type he describes in the following pages, on several of the northern tributaries of the Missouri River. Civil engineering students who plan to take the course in water power would do well to file this copy of the Technograph for use in that course.—Editor's Note.

"AND the grass is always greener in the other fellow's yard!" So the steam engineer, looking into the field of the hydro designer, is likely to consider that few difficult problems enter into the construction of a water-power plant. "You have no intricate steam-lines to design," he says. "You have no heat insulation worries; your fuel comes to your station without need of transportation facilities or handling; it leaves without need of ash conveyors. Your big problem is to build a dam that will stand up."

Hence one purpose of this article is to take steam engineers and others for a stroll through the green pastures of the hydro designer, and give them a close-up view of the cockle-burrs and yellow patches not visible from the far side of the fence. The other purpose is to present a description of the construction and use of the principal tools of preliminary investigation in a form complete enough to guide a student of water power engineering in making a study of the power possibilities of a given site.

The assumption is made that the development site has been selected, that flow records exist for a period of several years at the site under investigation, and that a large-scale topographic map of the area is available.

The preliminary investigation is for the purpose of determining the amount of power developments at the site, the unit cost of such power, and the comparative economy of water power and power from some other source. It divides naturally into four steps:

1. Determination of prime rate.
2. Determination of the proper capacity of installation.
3. Determination of total average annual output.
4. Cost studies.

These will be discussed in the above order, and the preliminary investigation of a power site on one of the tributaries of the Yellowstone river will be used as an example.

1. Determination of Prime Rate

The prime power rate is that rate at which power is available the year around. Without any storage of water for use in dry seasons it is reduced to such rate as is available from the minimum stream flow. A development utilizing no storage is called "run-of-river," and is practicable only on large streams whose minimum flow is great (such as the Mississippi) or on smaller streams whose run-off is regulated to increase the minimum flow above its normal value (either naturally by lakes and springs or artificially by reservoirs of upstream developments). A large percentage of our important hydro developments would be impossible on a run-of-river basis. Particularly in the West, smaller streams are of such a flashy, variable character that more than half the total annual discharge may occur in two months of the year, while for say two more months the flow may be practically nil. The engineer's answer is storage. He creates a reservoir which holds part of the peak flows, and allows this water to discharge at a near-uniform rate during low-flow periods. The first step in determination of prime rate, then, is to determine what minimum flow can be maintained by storage.

From the flow records (records of mean monthly discharge are employed in the present study) a mass-flow diagram (Figure 1) is constructed. This diagram commences with the first month of flow record. Its abscissae represent time, and the ordinate to any point on the curve represents the total volume of water which has passed the damsite since the beginning of the record. It follows that the slope (y/x) of a line from any point on the curve to any other such point is the average rate of flow during that period (total quantity divided by time equals rate). Now in Figure 1, the year in which the least total flow occurred is seen to be 1919-20. This is

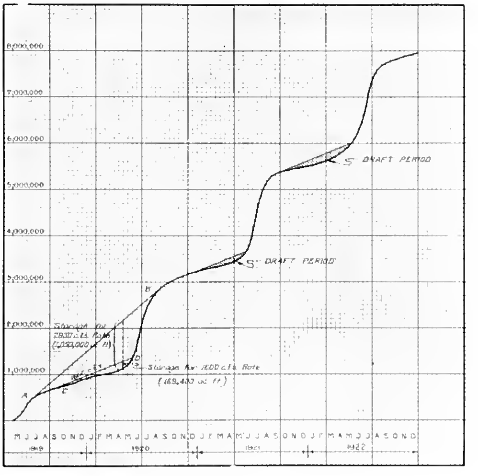


Figure 1 Mass-flow curve.

probably the critical year for study. The straight line drawn tangent to the curve at A and B represents a rate of 2930 cubic feet per second, the average flow of the stream during this period. On May 1, the accumulated discharge amounted to 1,100,000 acre-feet, and the required discharge up to that date for a uniform rate equal to the average rate was 2,150,000 acre-feet (the ordinate to the straight line at that date). As this is the point of maximum downward divergence of the actual flow line from the uniform flow line, the difference of the two ordinates, 1,050,000 acre feet, represents the maximum demand on storage to provide complete stream regulation.

The next step is to determine the available storage. This is done by planimetering the topographic map along successive contour lines, determining the area of the reservoir at these various elevations, and computing its volume by end-area method. The total reservoir capacity is plotted against height of dam to form a capacity curve (Figure 2). The lower limit of this curve is zero, and the upper limit is the maximum permissible height of dam, as determined by the physical features of the site or the location of towns, railroads, or other culture. In this particular case it is evident from inspection that there is not sufficient storage available in the reservoir to completely control the stream flow. Hence the height of dam is tentatively set at the maximum permissible, in order to provide as much regulation as possible.*

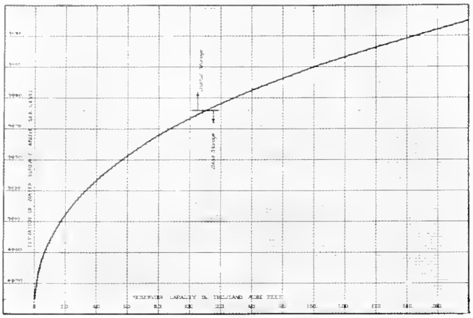


Figure 2: Capacity curve

It can be seen that all the water stored in a reservoir is not of equal value, since its worth for power depends upon its elevation. In other words, less power can be produced per unit flow when the reservoirs is partially drawn down than when it is full. Moreover, turbine efficiency falls off as the operating head reduces below normal, which further decreases the output. Hence there is an economical limit of reservoir drawdown, which experience has placed at (in general) about .3 the maximum head. Applying the rule to our present study we find available 169,400 acre-feet of useful storage.

Now we go to the mass curve and construct a tangent (C-D in Figure 1) whose maximum upward divergence from the natural mass curve is equal to this storage. The slope of this tangent is the uniform flow rate obtainable with the given storage, and is found to be 1600 second-feet. This operation should be performed for each low flow period on the mass-curve, as it may develop that in some years other than that of minimum total flow there will be a greater demand on storage than in that low-flow year. In the case under consideration the low-flow year caused the greatest demand on storage.

The prime rate can now be roughly determined by considering the uniform controlled flow to pass through an average head at a constant efficiency. Such a preliminary estimate usually assumes the average head to be the maximum head less one-third the maximum drawdown, or the head corresponding to 50% of the useful reservoir capacity (these two assumptions are usually very nearly the same). The overall efficiency is taken as 80% or 75%. It is often possible to say definitely at this point whether a project is worthy of further consideration, since the dam cost can be estimated accurately, and turbines, generators, and other equipment can be estimated at so much per h. p. to within a reasonable degree of accuracy. In this case the roughly determined prime rate is 1600 x 175 x .80 x .0848 = 19,000 kw.

The actual determination of prime rate is by trial and error and involves the use of a factor curve (Figure 3). The data for construction of the factor curve are given in Table 1 below. In the first column various heads of operation are listed. The normal head is taken to be the maximum head less one-third the maximum drawdown (in this case 194-19 or 175 feet). The second column shows the various heads as percentages of this normal head, and the third column gives the overall efficiency to be expected at these percentages of normal head. The data for this column are the product of a constant generator efficiency and the varying turbine efficiency as published by turbine manufacturers. The fourth column is the product of columns (1) and (3), and the last column is column (4) multiplied by .0848. The factor curve shows column (5) plotted against column (1). For any head within the range of operation, the corresponding factor multiplied by the flow in cubic feet per second gives the power in kilowatts.

TABLE 1

Head	Per Cent of Normal Head	Efficiency	H x E	Factor
(1)	(2)	(3)	(4)	(5)
194	111	79.4	154.1	13.09
185	105.5	79.8	147.8	12.53
175	100	80.0	140.0	11.89
160	91	79.3	127.0	10.78
140	80	77.5	108.6	9.21
130	74	76.1	99.0	8.40

Table 2 shows the reservoir operation for the prime rate of 15,000 kw. It is seen that for this rate the reservoir was drawn down to 110,800 acre-feet, which was set as the extreme low limit. In the determination of the prime power rate the estimated rate of 19,000 kw. was first assumed. This was found to demand more storage

*In cases where the reservoir offers more storage capacity than is necessary for complete control of stream flow, the determination of height of dam is by trial and error. Head, and consequently power output, increases with height of dam. So do the costs of dam, turbines, generators, and transformers. Hence the height will be set at that point at which the increment of income due to any further increase in height ceases to be a fair rate of return (say 15 per cent) on the increment of investment required for that increase. It is obvious that the possibility of finding a market for power may often limit the height of dam, but the above mentioned is still applicable, since after the market is satisfied the income from additional power output is zero and the solution is immediate.

TABLE 2—Calculations for Prime Power During Critical Period (September, 1919 to June, 1920)

Month	Natural Flow	Reservoir in Acre-Feet			Outflow		Factor	KW
		Storage	Draft	Volume	Acre Feet	C. F. S.		
Sept.	66,100	0	2,600	279,900	68,700	1153	12.99	15,000
Oct.	62,300	0	8,900	277,300	71,200	1158	12.95	do.
Nov.	57,900	0	12,100	268,400	70,000	1178	12.74	do.
Dec.	52,700	0	21,300	256,300	74,000	1203	12.46	do.
Jan.	47,600	0	29,600	235,000	77,200	1253	11.96	do.
Feb.	47,600	0	28,500	205,400	76,100	1322	11.32	do.
Mar.	56,800	0	30,600	176,900	87,400	1420	10.54	do.
Apr.	58,500	0	35,500	146,300	94,000	1578	9.50	do.
May	249,000	164,600	0	110,800	84,000	1372	10.92	do.
June	716,000	4,500	0	275,400	....	....	....	....
			...	279,900	....	....	....	....

than was available. A second trial, of 12,000 kw., indicated that the entire amount of useful storage would never be used. The third trial (15,000) was successful. The method is as follows: The reservoir is assumed full on September 1. Hence the head is 194 feet, and the corresponding factor is 13.09. During the month, however, the reservoir will be drawn down to supplement the actual discharge, which will cause the average factor over the monthly period to be something less than 13.09, say 13. Dividing 15,000 by this factor gives 1153 second-feet as the required flow, which converted to acre-feet is 68,700. The natural flow of the stream for the month of September amounted to 66,100 acre-feet, leaving a demand on storage of 2,600 acre-feet. The volume left in the reservoir is 277,300 acre-feet, and is recorded in the second line. The actual factor corresponding to the reservoir elevation on October 1 is determined, and averaged with 13.09 to see whether the proper original factor assumption was made. In this case it was. If the average had been far from the 13.00 assumed, a second trial would have been made. After a little practice it is seldom that a third trial is necessary.

The process outlined above is carried through the critical period.

2. Determination of the Proper Capacity of Installation

A prime rate of 15,000 kilowatts means that an average of 15,000 kw. shall be available at all times. The peak instantaneous demand may be twice this value. The ratio of average to peak demand is known as load factor. If we assume the load factor to be 50%, then the installation required to furnish 15,000 kw. prime power would

TABLE 3—Volume of storage required to be maintained in reservoir during draft periods to insure continuation of prime rate

Date	Volume, Acre Feet	Date	Volume, Acre-Feet
September 1	279,900	April 1	145,000
October 1	275,000	May 1	130,000
November 1	270,000	June 1	195,000
December 1	263,000	July 1	279,900
January 1	250,000	August 1	279,900
Februay 1	215,000	September 1	279,900
March 1	180.000		

be 30,000 kw. However, a turbine capable of putting out 15,000 kw. at the normal head would not be able to do so at the minimum head. The relation of power output to head is that power varies with the three-halves power of the head. Hence the necessary installation for a 15,000 kw. prime rate in this case is $30,000 \times 175^{3/2} / 136^{3/2}$.

It has been found that where a market exists for secondary power it is often economically possible to install turbines and generators to handle such quantity of water as is available 30 per cent of the time. If such is the case, a flow-duration curve is constructed. This curve shows the percentage of total time that any given flow is equalled or exceeded. The ordinate corresponding to 30% time is the quantity for which the turbines are then designed. A flow-duration curve for the project under consideration indicated that the 44,000-kw. installation was sufficient to handle this flow.

3. Determination of Total Average Annual Output

There are two limiting conditions which govern the output computation. One is the rule of reservoir operation during draft periods, and the other the "water usage curve."

The reservoir operation rule is almost obvious. The

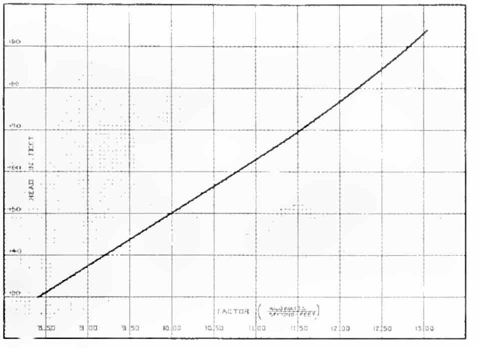


Figure 3: Factor curve

prime rate was determined for the critical period as discussed above and shown in Table 2. The results indicated that at the beginning of October the reservoir was drawn down to 277,300 acre-feet. Now since this was the worst period of record, and since it was possible to produce power at the prime rate throughout this entire period, it follows that in any year, on the first of October, the reservoir may safely be drawn down to 277,300 acre-feet, even though this produces power at greater than the prime rate, and that if in any year it is necessary to draw below that level on October 1 in order to produce prime power, then it is unsafe to attempt to produce *more* than prime until such time as the reservoir level exceeds the level for the same date in the critical period. The volume remaining in storage is plotted against time in Figure 4 (dotted line) and the solid line is drawn faring out irregularities and allowing some margin of safety. This solid line is the rule curve. Values for the various dates are taken from this curve and tabulated in Table 3.

The generalized rule may be stated thus: During the draft period (period during which the natural flow is being supplemented by discharge from the reservoir) power may be produced at greater than prime rate, provided that the reservoir at no time during the period is drawn down further than the amount of drawdown on the same date as indicated by the rule curve.

(Continued on Page 21)

TABLE 5—Power Study

Month 1928	Natural Flow Acre Feet	Reservoir in Acre Feet			Outflow		Factor	Power	
		Storage	Discharge	Volume	Acre Feet	C. F. S.		KW	Kw. Hr.
Jan.	77,600	0	35,000	250,000	112,600	1828	12.197	22,250	16,554,000
Feb.	70,200	0	35,000	215,000	105,200	1830	11.457	20,950	14,581,200
Mar.	83 600	0	35,000	180,000	118,600	1927	10.55	20,300	15,103,200
Apr.	101,000	0	15,000	145,000	116,000	1950	9.825	19,170	13,802,400
May	833,000	149,900	0	130,000	222,500	3617*	11.345	41,000	30,504,000
June	692,000	0	0	279,900	200,000	3360*	13.09	44,000	31,680,000

*Usable portion as indicated by water usage curve

Acoustical Correction of Rooms

F. R. Watson
Professor of Experimental Physics

The acoustical adjustment of rooms has been so perfected in recent years that satisfactory acoustics can now be prescribed with certainty of success—a development that is based directly on the brilliant, pioneer investigations of Professor Wallace Sabine.

Sound in a room starts from the source and proceeds rapidly outward as fast as a rifle bullet. On striking a wall of the room, it suffers some loss by transmission and absorption, depending on the nature of the wall, and then proceeds to the next wall for further transmission and absorption, and so on until it dies out. In a reverberant room, sound may be reflected 200 to 300 times before becoming inaudible, taking several seconds in the process.

The effect on the auditors is readily understood. In such a reverberant room, the successive words in a speech overlap and auditors are confused by the mixture. Figure 1, top, illustrates the state of affairs in which the curves A, B, C, D picture the loudness of four successive words as they die out. The overlapping sounds cannot easily be understood by auditors.

To correct this defect, it is necessary to increase the absorption, and this is brought about by applying suitable materials to the walls. The overdue prolongation of sound, or *reverberation* as it is called, is thus reduced. Figure 1, lower left, pictures the case of a corrected room where the walls have been treated with sound-absorbing materials. The overlap of sounds is now reduced and each word stands out more distinctly than before.

Figure 1, lower right, shows the beneficial effect of an audience, due to the absorptive action of the clothing worn.

The amount of sound-absorbing material needed to give correct acoustics in a room is calculated by means of Sabine's formula:

$$t = .05V/a$$

where t is the time taken for a standard sound to die out, V is the volume of the room in cubic feet and a is the absorption of all the surfaces exposed to the action of sound. For satisfactory results, the time should be reduced to 2 seconds or less,, depending on the size of the room, as shown in Figure 2, the smaller rooms having a shorter time.

The absorbing values of various materials have been determined experimentally. Plaster, wood and glass, which are the most common materials used in the construction of rooms, absorb only about 3 per cent of the sound falling on them, thus accounting for the reverberant effects in most rooms. Commercial materials have been developed with absorbing values ranging from 10 to 80 per cent. In making calculations, a material with 40 per cent absorption has a coefficient of 0.4, 60 per cent absorption has a coefficient of 0.6, etc.

Examples of Acoustic Correction

A number of rooms at the University of Illinois have been corrected in accordance with the theory outlined. The first case described is the auditorium in the new law building. This room has a volume of 44,000 cubic feet and has a seating capacity of 300. The absorption values before correction are shown in table 1.

The time of reverberation was thus:

$$t = .05 \times 44000 \div 869 = 2.54 \text{ seconds,}$$

which shows that the room was too reverberant, since a room of this volume should have an optimal time of 1.37 seconds. Accordingly, the absorption needed is calculated from the equation:

$$1.37 = .05 \times 44000 \div a$$

from which, $a = 1610$ units, so that it was necessary to add 741 units to the 869 for the empty room to give 1610 units, and thus get the correct time. Absorbing material was applied on the ceiling and satisfactory results followed.

Lincoln Hall Theater, University of Illinois, which has excellent acoustics

Lincoln Hall Theater

With the co-operation of Supervising Architect James M. White, an opportunity was afforded to incorporate some acoustical features in the design and construction of this auditorium, and to attempt to get ideal effects.

Ideal acoustics may be obtained by observing two conditions. First, the stage should be designed to favor the perfect generation of sound; that is, there should be reflecting walls near the performer that allow him to "hear himself." Second, the conditions should be adjusted for perfect listening conditions, and this is brought about by reducing the reflection of sound from surfaces about the auditors. This last requirement is evidenced by the excellent acoustics of outdoor theaters, which have practically no reflected sound.

Men's Gymnasium

This room presents a more difficult problem. The very large volume, 1,702,000 cubic feet, involves a long time of reverberation, with correspondingly large amounts

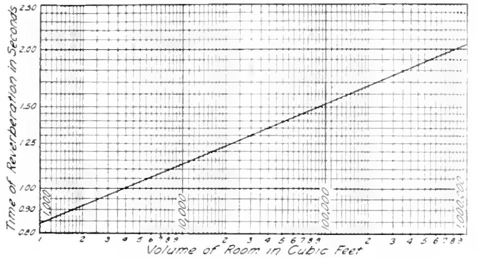


Figure 2: Optimal time of reverberation

of absorbing material. The roof construction gave some absorption, where the under surface (ceiling) was made of a fibre board, but it proved insufficient for good acoustics. The time of reverberation was 12 seconds, when it should be 2.15 seconds for the optimum.

The problem of correcting the room presented several complications. The ceiling, which was the most available surface for treatment, was already lined with the absorbing fibre, so that its value would be lost if covered with a more efficient material. The other surfaces in the room available for treatment were of limited area, thus necessitating the use of a product of very high absorbing value. Fortunately, several commercial products with high coefficients were available. The final complication was the expense involved. What was done was to install 8820 square feet of material on the two end walls, by which the time of reverberation was reduced to 6.3 seconds. This was not a complete correction, but the conditions were decidedly improved and various events could be carried on with fair satisfaction. The optimal reverberation is reached when an audience of 5730 people is present, due to the added absorption of the clothing.

Conclusion

The preceding discussion illustrates the degree of certainty with which the reverberation of rooms may be controlled. But it should not be concluded that the solutions are always easy. It is necessary to study also the shape of the room to ascertain any possible echoes. The absorbing material should be selected with an area and absorbing coefficient to minimize the effect of echoing walls. A larger and better choice of materials is now possible.

TABLE 1

Open windows	30 sq. ft. at	1.00		30 units
Plaster on tile walls	6000 sq. ft. at	.025		150 units
Plaster on lath	3000 sq. ft. at	.033	—	99 units
Wood floor	3000 sq. ft. at	.03	—	90 units
Seats 300	at	.15		45 units
Total absorption (empty room)				414 units
One-third audience		— 4.55	—	455 units
				869 units

Sound Proofing in Buildings

Another important problem in the acoustics of buildings is the sound proofing of rooms. A brief outline of the subject is as follows: Sound is transmitted from one room to another in three ways: first, by passing through the air passages in ventilator pipes or other openings; second, by setting the separating wall in vibration so as to create sound waves on the further side; and third, as an elastic wave motion in which the pressures and rarefactions of the sound waves are transmitted from particle to particle in the wall and then communicated to the air on the further side. Experience shows that the escape of sound is usually greatest through the ventilation ducts, and that, unless these vents are arranged in some special manner to hinder the transmission, it is a waste of effort to install sound-proof walls or floors or other special construction. Next in importance to the ventilation system, in the transmission of sound, is the vibration of walls. Sound pressures and rarefactions in one room set a wall in mechanical vibration, and the wall, in turn, sets up sound waves in the air on the further side. The important elements sought for in sound proofing are massive and rigid building structure; walls, floors and ceilings with all air passages closed as completely as possible; ventilator ducts equipped with sound absorbers; and disturbing machinery placed on suitably insulated platforms.

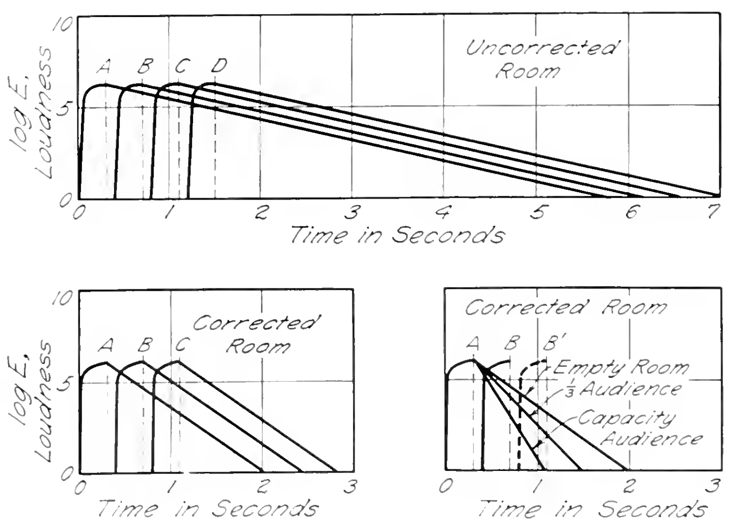


FIGURE 1:

Above: Overlap of four sounds in a reverberant room
Below, left: Reduced reverberation in a corrected room
Below, right: Absorbing effect of clothing worn by auditors

The Future of Mining Engineering

D. R. Mitchell
Assistant Professor of Mining Engineering

The following article is the second of a series of vocational articles dealing with conditions in the several fields of engineering endeavor. Prof. Mitchell gives a rather encouraging view of conditions in mining engineering, somewhat in contrast to that given by Prof. Young in the railway field, as printed in the November issue of the Technograph. The next issue, in February, will contain a paper by Prof. Ellery B. Paine, head of the electrical engineering department, telling of conditions in the field of electricity. —Editor's Note.

PRESIDENT and Mrs. Hoover, in the preface to their translation of Agricola's famous book, "Re De Metallica," which was written in Latin in 1556, state that mining engineering "is one of the least recognized of the world's professions." This is as true today as it was when written in 1912, and is probably due to the fact that much of the work of the mining engineer is at some distance from urban centers of population. A survey of the freshmen at one of the technical schools of the country revealed the fact that while they had definite ideas of the work of the civil, mechanical or electrical engineer, they had only the haziest conception of the work of the mining engineer.

The Work of the Mining Engineer

Many of the daily duties of the mining engineer could just as well be classed under some other kind of engineering. In the design of mining methods and at the face or in the stope, he has his own particular bailiwick, but from the time the mineral is broken loose his problems are those of loading, transportation and preparation, involving many types and applications of various kinds of mechanical and electrical equipment. Hoisting ventilation, drainage, lighting, blasting and geology present problems that involve the use of all kinds of engineering and scientific knowledge.

It is apparent that the educational training of the mining engineer should be broad, and it is true, actually and historically, that his training has always been the broadest of all the engineering professions. Certainly the mining engineer cannot be censured for being too specialized, as is frequently said of many technicians in other professions. It is not to be inferred that there is no specialization. The varied scope of mining activities offers many inviting fields for specialization, and it is likely that the future will see more rather than less.

Mines Hard Hit by Depression

The mining industry has been hard hit by the depression, as have all other basic industries. Coal, lead, zinc, silver, oil and many metallic and non-metallic minerals have dropped to record low prices. It is not the purpose of this discussion to present statistics showing the reason for all of this nor to forecast what the future will bring. Each individual mineral product would have to be taken up in detail in order to do this. It is sufficient to say that all industry is dependent on mining for its supply of raw materials. A revival in industry will mean a revival of mining activities. However, there is one bright spot on the horizon that deserves special mention.

Boom Days for the Gold Miner

There is a boom in gold mining that rivals in intensity and interest the boom days of industry in 1929 until the collapse of the stock market. Gold does not fluctuate in value. An ounce of gold is worth $20.67 wherever found. As commodity prices decrease gold becomes relatively more valuable and as a consequence of the great drop in commodity price levels including mining supplies, many gold mines can be worked now at a profit that could not be so worked when prices were high. The stocks of many leading gold mining companies have soared upward since 1929, registering gains as high as 300 to 400 per cent of 1929 prices. This offers a sharp contrast to the downward trend of the stock market during the last two years.

Gold Mining Aids Depression

There is not only increased activity and expansion at going mines, but a great number of new ones have been started, some of them in fields that have been lying dormant for years. New mines have been reported in Virginia, North Carolina, Georgia, Alabama, South Dakota, Alaska, Philippine Islands, practically all the Rocky Mountain states and in a great number of foreign countries of which Canada is probably the most important. Thousands of men have found employment. It is

TABLE I—Some Leading Gold Mines of the World
MINING AND TREATMENT COSTS

Mine	State or Country	Tons mined and treated per ounce of gold recovered	Average Grade of Ore	Costs per Ton of Ore	Costs per Ounce of Gold
Alaska Juneau	Alaska	23.8	$ 0.87	0.627	15.06
Mountain Copper	California	17.2	1.20	0.817	13.41
Howey	Ontario, Canada	5.0	4.17	2.50	13.68
Homestake	South Dakota	3.3	6.18	3.13	10.53
Dome	Ontario, Canada	3.1	6.60	3.60	10.59
Mysore	India	2.2	10.88	7.20	13.67
Modder Deep	Rand, South Africa	2.0	10.38	3.80	7.41
St. John del Rey	Brazil	1.9	12.42	9.20	15.39
Lake Shore	Ontario, Canada	1.5	13.10	5.16	8.14
Teck Hughes	Ontario, Canada	1.3	15.27	5.78	7.31
Balatock	Philippines	0.86	23.97	10.83	9.34
Ashanti	Gold Coast, Africa	0.85	24.18	9.65	8.29

not only the fact that mining jobs have been created but the benefits are more far-reaching than that. A mine uses large amounts of timber and rails, many pumps and locomotives, etc., during its life. This tends to help industry in general. For instance, a supply company operating in the Kalgoorlie gold fields of West Australia furnished 6,000,000 tons of firewood, several hundred thousand logs for underground timber and laid 1,475 miles of 42-inch railway during the last 27 years. Water for these same mines is pumped 350 miles through 30-inch pipe.

There are many prospects of merit, many abandoned mines with only the surface cream skimmed off that could be worked at a profit. Many of these mines were abandoned because of the inability of the early miners to cope with water, hoisting difficulties, or because of the refractory nature of the ore, and not for lack of ore.

American Engineers Lead the World

American engineers, including Canadians, have developed the art of mining in the past decade or two far

Senior mining engineering students on inspection trip to fluorspar mine, Hardin county, Illinois

beyond anything that has been accomplished by mining engineers from any other country. Copper ore is mined with a copper content as low as 0.6 per cent (12 pounds per ton). Table 1, compiled principally from data given in Engineering and Mining Journal, New York, and the Northern Miner, Toronto, Canada, gives comparative statistics of some of the world's leading gold mines. The low cost of mining and treating a ton of ore in North American mines with their high labor costs is in marked contrast to that obtained at mines in some other parts of the world. It must be kept in mind that such a comparison is not all-conclusive, for mines differ in the natural difficulties that have to be overcome such as geological conditions, presence of water and accessibility. Teck Hughes, working under adverse natural conditions shows a high cost per ton and yet because the ore has a high average grade ($15.27 per ton) holds the record for low cost per ounce of gold produced.

Similar records for low costs have been made by American engineers in all forms of metal, non-metallic and coal mining. This has created a demand for American engineers from all over the world. The Rhodesian copper properties which have received so much publicity in the financial sections of the daily press are all managed by American engineers, although their staffs are composed largely of English and Belgian engineers. Illinois graduates are found in all the chief mining centers of the world. Yet, opportunities exist at home as evidenced by the fact that at the University of Illinois approximately half of the graduates of the mining department have found employment within the state. Illinois with vast stores of coal and the non-metallic minerals is only exceeded in total value of mineral output by six other states.

Mining Technological Unemployment on the Decline

The problems of the engineer associated with those phases of the mining industry suffering from the depression have changed from those of production to those of utilization. A vast amount of research has been instituted in all forms of the mining industry for furthering the use of its products. This, coupled with the activity in gold mining has reduced unemployment of the mining engineer to a marked extent.

There is another factor that should be mentioned in discussing unemployment, which is, that the broad training of the mining engineer not only fits him particularly for administrative positions but enables him to transfer his activities from one phase of mining to another and even into other allied forms of endeavor.

The mining engineer has repeatedly demonstrated his adaptability to many and trying conditions as well as proved his ability to handle all types and kinds of jobs from building towns in the wilderness or constructing harbors to the more familiar task of going down to depths as great as a mile and a half into the earth's crust after nature's treasures. This ability of the mining engineer to readily adapt himself to trying conditions has stood him in good stead during this period of depression. Jobs are scarce but there is always something to mine, and for the lad of vision and courage the profession of mining engineering has much to offer.

The adaptability of the miner to various fields of endeavor has been rather humorously given by W. F. Boericke, mining engineer, New York City, as follows:

"Once There Was a Miner—"*

Once there was a hard-rock miner who had drilled his last hole on this earth and in due course rapped for admission at the Pearly Gates.

Saint Peter greeted him without enthusiasm. "We're not taking on any more miners," he stated. "The mines here are on short shifts, due to temporary depression in the gold pavement business, though conditions are fundamentally sound. But I can put you on with the halo makers—easy work and good wages."

"Nothing doing," said the hard-rock man. "My job is pushing steel and eating powder smoke, and I don't want to fool with no halos."

"How about signing up with the harpworkers?" said the Saint solicitously. "A nice clean job, with Saturdays off."

"Forget it," said Hard-Rock. "Don't you know that once a miner always a miner? I tried a dozen times to quit the business when I was on earth, but I always came back. They said copper was done for, so I mined jack. When zinc did a nosedive, I took a silver prospect. When they gave away silver with street car transfers, I tried gold. Don't you know, Saint, that you can't drive a good miner out of business? He's always going to mine something. Ain't you got anything open for me? Where's all my pals working?"

The good Saint hesitated. "To tell the truth," he admitted, "they're mining sulfur for the opposition party. There's a steady demand for it, and they're taking on all comers. But think of the working conditions. Now, if you want to consider driving a golden chariot—"

Hard-Rock shook his head. "Which way to these sulfur diggings?" he asked. "Maybe I could get a lease

(Continued on Page 24)

*Mining and Metallurgy, September 1931.

Merry Christmas!

The Technograph takes this opportunity of wishing its readers a very happy Christmas vacation. We hope that you all have your work in such shape that there will be no need for you even to carry a book home, and that the season can with a clear conscience be given over to hilarity. But we doubt if you do!

The Railway Problem

The economic difficulties which are being faced in the railway industry were quite forcibly brought out by Prof. E. G. Young in his article in last month's issue of the Technograph. As he stated the problem, the unfavorable condition in the railway field is due to two causes: first, the general depression in all industry, and second, competition in the field of transportation. The first condition will of course automatically be remedied, to some extent at least, when the upper side of the old familiar business cycle rolls around. But the loss in railway business due to competition may be quite another story. And it is this fact that is proving the chief worry of executives in the railway industry today.

The unfair thing about the strongest competition being offered the railways is that each of the three main competitors is to some extent government-subsidized.

Probably the largest onslaughts into the railway business are being made by the highways. Taxpayers have financed the construction of five trans-continental highways, in addition to the massive network of state and interstate roads. Here the voluminous truck and bus traffic has met with little opposition, and a comparatively free trade lane has been opened to suit growing needs. At the same time, railroads spend over $2,000,000 a day for the maintenance of their private rights-of-way.

The Mississippi waterway system will seriously affect the railroad traffic of the Mississippi valley, should the proposed plans of the federal government be thoroughly carried out. The question of water and rail competition is not, however, a new problem. Railways have fought federal waterways since the birth of the Erie canal.

The partial transfer of United States mails to the airlines decreased the railroad carryings by almost 4,000,000 pounds in the first half of 1930. Both federal and municipal governments have freely turned over large sums of money for the erection of landing fields, hangars, and for the improvement of air courses.

An important, yet little known, competitor of the railroad, is the pipeline. For hundreds of miles petroleum products may be transported in these lines with no great attention given the shipment between its entering and leaving the duct. What will be done with the 300,000 tank cars now in direct possession of the railroads if the pipe lines monopolize entirely the oil transportation?

The railroads are of course fully aware of their precarious position. And they realize that their hope lies in an equalization of competitive conditions by an equalization of taxation. They are not asking that they be subsidized. They do ask that their competitors, the waterways and highways, be taxed in a manner proportionate to the benefits they enjoy, thus putting all the transportation industries on an equal basis where true competition can have full sway. And it seems to us only fair that they be granted this by federal or state legislation or both. —B. B. J.

More New Slants

It has often been said that nobody reads editorials, so it doesn't matter what is said in them. But we have proved that statement to be absolutely false. Since the appearance of the November issue of the Technograph we have several times been groggy from the buffelings received at the hands of various faculty men who took personal offense from the editorial "A New Slant?". We spent one particularly unhappy hour trying to look unconcerned while blow after blow was rained on our defenseless head. And the funny thing is that the professor who took the most serious offense is the one who was farthest from our mind when we wrote the fatal editorial.

We still believe, however, that in several instances the work assigned in certain departments of the engineering school is far out of proportion with the returns, both in the actual educational advantages derived and in the credit hours received.

To quote actual cases, and probably bring more criticism on our head, we mention the mechanical engineering school. In two or three required courses so much work was assigned that a minimum of about three hours work five nights a week was required to make a passing grade. And in one of these courses, of 32 in a class one semester, one man made an "A," three made "B's," one made a "C," and the rest made "D's" or "E's." Now if that is a true measure of the intelligence of the Illinois engineers, they have been in the past vastly over-rated. We hasten to add, however, that according to reports conditions are much better this year, and mechanical engineers now have time to get several good nights' sleep each week.

There is a three-hour architectural course required in the city planning option in which so much work is assigned that instructors in other courses in the option are finding that their assignments are being grossly neglected. Instead of the nine-hours' total, three in class and six in study, which is the university requirement for a three-hour course, about twenty hours' work is necessary if the student is to keep up with this class. The instructor in this class is being unfair both to the students and to the other instructors whose work is being neglected because of his excessive assignments.

This is not meant as a general indictment of the engineering school. It is well agreed that most of the professors in the school are real gentlemen, with a sympathetic understanding of the problems met by the undergraduate. But there are a few who are so absorbed in their own particular field of specialization that they have lost the true perspective view of the purpose of the university educational scheme.

Maybe It's a Start

It has often been said the Illinois campus has become super-saturated with organizations and activities. It is true that one might easily gain that impression in considering the large number of campus societies, professional, social and honorary and the numerous fields of activity open to students. But on the other hand, if the percentage of students taking advantage of these opportunities were known, the impression would be quite different. Only a few students become interested and take active parts in campus activities, and the majority of these students are juniors or seniors.

Tau Beta Pi has taken the initiative in remedying this condition in the College of Engineering. Last month in co-operation with the sixteen other professional and honorary engineering organization, Tau Beta Pi entertained the engineering freshmen at Bradley hall, with an interesting and enjoyable program followed by refreshments and smokes.

The purpose of the meeting was to enable the freshmen in the engineering school to become acquainted with the various organizations and activities in the college and to stimulate their interest in these organizations at the very beginning of their college life in order that they may derive the most benefit from them.

Freshmen and sophomores, if you are not already a member of your departmental society, now is the time to enroll and enjoy the interesting, educational programs that most of these societies, through the co-operation of the faculty, business and professional men, and upper classmen are able to present to you. —B. B.

In the February Issue

The electrical show, to be presented next spring by the electrical engineering students, will be given prominence in the next issue of the Technograph, to appear in February. R. L. Dowell, manager of the show, and Bennett Burgoon, chairman of the Student Branch of the American Institute of Electrical Engineers, will co-operate in writing an article telling of the exhibits which are being prepared for the bi-annual event. Moreover, it is appropriate that the number in the vocational series which is to appear in this issue be devoted to a discussion of the field of electrical engineering. Prof. Ellery B. Paine, head of the electrics department, will continue the series which thus far has seen papers by Prof. E. G. Young of the railway engineering department and Prof. D. R. Mitchell of the mining department.

Correction

The November issue of the Technograph contained the statement that architecture students were permitted to work all night in the architecture building on design problems, and that furthermore they were provided with a smoking room. According to C. E. Palmer, assistant to the dean of the College of Fine and Applied Arts, there is no case on record where a student has been permitted to work later than midnight in the building, and smoking has never been allowed.

A New Decoration

Have you noticed the new section headings in this issue of the Technograph? How do you like them?

For several years, one of the main planks in the platforms of prospective editors of the Technograph has been the installation of a new set of headings for the alumni, editorial, departmental, and humor sections. And each year this matter was pushed into oblivion by more pressing matters, so that this year's staff faced the same criticism—out-of-date, inappropriate section headings. This year's art editor realized the crying need for a little dressing-up of the inside pages, and by an extra effort finished two of the drawings in time for use in this issue. The remaining drawings will be ready for the next issue.

On Acoustics

On another page of this issue the Technograph offers an article written by F. R. Watson, research professor in physics, in which are presented some of the fundamentals in the science of acoustics. Professor Watson's paper should open the way to readers to an entirely new and different field of engineering, one in which a great amount of fine work has been done recently, but in which much still remains to be done. While, as Dr. Watson states in his manuscript, the science of sound is exact to the point where solutions for acoustical problems can be found by application of formulas, a large part of the solution still rests on the use of judgment.

Dr. Watson's entry into the field of acoustics offers a rather obvious object lesson in the benefits of keeping one's eyes open. A number of years ago he was given the assignment of improving the acoustical conditions in the auditorium, which were not at the time satisfactory. He was not particularly interested in getting the job, but after devoting the time necessary to the study of the problem became so interested in the work that he is now one of the recognized authorities on the subject of acoustics, and is at present the editor of the Journal of the Acoustical Society of America.

Important!

We urgently recommend to the civil engineers that they read and digest the article by Don Johnstone on "Preliminary Water Power Studies," in this issue. It contains in clear, concise language a thorough summary of methods used in investigating sites for their water-power possibilities. We would also suggest that you file away this issue of the Technograph for reference in the course in water power which senior civils will take next semester.

ALUMNI NOTES

Mechanical engineers of the class of '95 will be shocked to learn of the death of ALBERT J. SAYERS on October 11 at his home, 7121 Eggleston avenue, Chicago, Ill.

Mr. Sayers was born in 1870 at Troy, Ohio. He entered the university in 1891. While attending the university he was a member of the Mechanical Engineers' Society. After graduation he was in business for a year in Champaign and then entered the service of the Illinois Central railroad for a year. In the year following this he was with the Sargent Steel company. The year 1898 saw him make his first connections with the Link-Belt company in whose employ he remained until his death.

ALBERT J. SAYERS '95

He began as engineer in charge of the physical testing laboratory and then was a draftsman. From 1899 to 1904 he was in charge of construction, and then entered the engineering sales department where he was in charge of the coal washery division. He held this position until the time of his death.

Mr. Sayers was a recognized authority throughout the country on the preparation of metallurgical and fuel coal. He was a member of the American Society of Mechanical Engineers and was the author of various technical articles.

JOHN PARKER '22, has been advanced to assistant professor of mechanical engineering at the University of California.

ROSCOE W. MORTON '23, is in the mechanical engineering department, Colorado School of Mines. Last summer he attended school at the University of Colorado.

DON JOHNSTONE, c.e. '31, DAN KETCHUM, c.e. '31, LESLIE DORR, c.e. '31, and LOGAN WOOLEY, a graduate of the University of Kansas, drove up to see the Chicago game last month. All of them are employed at the United States Engineer office, Kansas City, Mo.

ART NAUMAN, c.e. ex'32, is going to night school in Chicago and working part time. He expects to return to the university for the second semester.

NORMAN C. MAYER '26, works as engineer for the Public Service Company of Northern Illinois.

WAYNE E. LYNCH '26, is transportation engineer for General Electric Company. His home is at 305 Shenley drive, Erie, Pa.

F. K. SWEETMAN '31, has the position of sales engineer with the Trane Company, LaCrosse, Wis.

ENERSON F. SCHRAEDER '28, is employed as mechanical engineer for the Corn Products Company at Argo.

ROBERT DOHERTY, e.e. '09, is Professor Doherty, now, of the electrical engineering department, Sheffield Scientific School, Yale University. We wonder if the memories of his quiz days at Illinois softens his heart any when he gives a quiz.

LEO PELLER, m.e. '30, is with the Western Electric in the equipment engineering department, connected with the installation division.

LLOYD A. MCCORMICK, m.e. '30, is working at the Studebaker plant in South Bend.

ALBERT PELTZER, m.e. '30, has been doing experimental and developing work for the Merco Centrifugal Separator company.

GLENN CRAMER, m.e. '26, is head of the plant operating department of the American Manganese Steel company.

WILEY C. CHEN, m.e. '26, is working for the Central Government of China. He is working as an assistant engineer in designing a power plant for Hangchow City.

SHERRY JOHNS, m.e. '26, is head of the branch of the Gibralter Hoist company in Kuala Lumpur, Seangor.

DAVID A. DINSDALE, m.e. '26, is engaged as materials testing engineer with the Commonwealth Edison company.

LYNN H. CLARKSON, m.e. '26, is teaching machine design at the Carnegie Institute of Technology.

R. P. HONOLD, m.e. '31, is in the contracting business with his father in Sheboygan, Wis.

Harold G. Mason '26, is civil engineer with the Chicago, North Shore & Milwaukee, in Chicago.

Nap Boynton, e.e. '09, recently visited Chicago. Nap is an electrical engineer from Cleveland and now has responsibility for all sales west of Cleveland. Nap is one person who doesn't hide his light under a bushel basket. It's his business not to.

Members of the class of 1912 will be unhappily surprised to learn of the death of their senior class president, Charles J. Craigmile, c.e. His death occurred after an emergency operation for appendicitis. He and Mrs. Craigmile were returning to their home in Pompton Plains, N. J., after having been in Detroit during part of their vacation.

Mr. Craigmile was born December 27, 1890 at Gifford, Illinois. He attended Rantoul high school for his prep education. After graduating from the university, he held various engineering jobs, and enlisted soon after the United States entered the war. At the time of the armistice he was a captain on duty with the radio department of the army at Columbia University.

After the war he joined the New Jersey Water Suppy Commission which built the Raymond dam at Wanaqua, N. J., furnishing the water supply for the city of Newark and seven neighboring cities. He was senior engineer until the completion of the dam on September 1 of this year. He was returning to Newark to be a member of the city engineering department.

A. S. Epstein, c.e. '11, is a structural engineer in Chicago. Mr. Epstein attended the last homecoming reunion of his class recently. He was accompanied by his two sons and his wife.

A. C. Tosetti, c.e. '26, is employed by the state highway department. He dropped around to his class headquarters at Newman hall during the 1931 annual homecoming.

Paul Becker, m.e. '17, works for the Chance Vought Corp., manufacturers of aircraft. He lives at 57 Clearfield road, Wethersfield, Conn., a suburb of Hartford.

W. S. Freeburg, m.e. '17, is "steel-treating" for the Allen Bradley Co. of Milwaukee, Wis.

Charles M. Clark, m.e. '17, is pushing the sales of the Cincinnati Milling Co. He is living in Norwood, Ohio.

D. S. Cornell, m.e. '17, is also handling sales, besides service, for the Republic Flow Meters Co. of Western New York.

Edward C. Barkstrom, m.e. '17, has at last weakened and has married Miss Helen M. LeKander of West Chicago. They are living in Los Angeles where he is employed by the Stephens-Adamson Manufacturing Co.

R. H. Pedler, m.e. '17, says that he finally has decided that slipping a slide rule is better than slipping over sales. Therefore he is back in engineering with the Acme Steel Corporation.

Ed Barker, m.e. '17, has been advanced in rank in the U. S. Navy. He is now lieutenant commander of the U. S. S. Dobbin.

E. J. Herringer, c.e. '29, is at the Maywood sewage disposal plant of the Chicago sanitary district.

S. R. Jordan, e.e. '30 has been appointed an assistant instructor in the electrical engineering department.

Edward Barker, m.e. '17, has been advanced to the rank of lieutenant-commander of the U. S. S. Dobbin.

H. E. Shugars, m.e. '31, is in the engineering department of Barber Coleman company, Rockford, Ill.

C. L. Eddy, c.e. '00, has just been appointed head of the new department of engineering administration at the Case School of Applied Science in Cleveland. This new department is designed to give the students a better understand of the business world; will act as a transition between the four years of closely supervised data-content courses and the workaday problems in the field. Professor Eddy is also president of the athletic association and faculty adviser of student activities. He has been connected with the Case School since 1907, his first work there having been as assistant professor of railroad engineering.

C. L. Eddy '00

Eldon Cronquist, m.e. '31, is special representative of Paperboard Industries Association.

H. W. Elliott, c.e. '07, is head of the comparatively new Hiram Elliott Construction Co., engineers-constructors of Kansas City, Mo.

H. C. Haungs, c.e. '07, is serving his seventh year as recorder of the Mohammed temple and manager of the building in Peoria, Ill.

C. E. Hoff, c.e. '07, is vice-president of Colglazier & Hoff, inc., San Antonio, Texas.

C. James, c.e. '07, is in the engineering and construction, southern division, of the Allied Engineers, inc., Birmingham, Ala.

J. W. Schertz, c.e. '07, is in charge of the designing department of the Wescott Engineering company, consulting engineers.

T. H. Trams, c.e. '07, is teaching surveying at Marquette University, Milwaukee.

C. C. Williams, c.e. '07, is Dean of the College of Engineering, University of Iowa.

DEPARTMENTAL NOTES

Engineering Societies

Tau Beta Pi, honorary engineering fraternity, pledged sixteen men December 2, 1931 at the Wesley Foundation after they had fulfilled the requirements of the national office. The formal initiation will be held Wednesday, December 16 at Wesley Foundation followed by a banquet at the Inman hotel.

J. H. Rickerman was the only junior pledged. The following seniors were elected: J. B. Tiffany, Jr., W. J. Bobisch, S. U. Benscoter, A. F. Sears, C. K. Lynch, Ben Paller, J. G. Griffith, E. R. Sanner, A. W. Neureuther, G. I. H. Perry, F. C. Miller, R. L. Dowell, S. H. Pierce, J. M. Nash, and A. E. Grellinger.

The Railway club met at the Sigma Phi Delta house, Wednesday evening, November 18. A lecture, illustrated with a motion picture on the life and works of Thomas A. Edison comprised the program. Following the program refreshments were served.

Lib Panichi, president of the club, stated their goal of 100 per cent membership had almost been reached.

"Empires of Steel," a motion picture showing the fabrication and erection of the steel used in the construction of the Empire State building in New York City, on December 2 completed a series of programs presented by the Student Chapter of the American Society of Mechanical Engineers this semester. Among the outstanding meetings of the semester were a smoker on October 7 at which Prof. A. G. Willard spoke, a picture, "Electric Heat in Industry" on October 14, a talk by Prof. Moore on Swiss and British laboratories on November 4, and a talk by Prof. Savage of the geology department on the glacial periods in Illinois on November 18.

Prof. Savage's talk was illustrated by charts, diagrams and samples showing the effect of the four glacial periods on the present geological condition of Illinois.

Dean A. S. Langsdorf, dean of the College of Engineering at Washington University in St. Louis, spoke at the initiation banquet of Eta Kappa Nu, honorary electrical engineering fraternity, Thursday, December 17. The men initiated were J. C. Wheeler '33, A. M. Daily '33, W. W. Brooks '33, S. C. Miller '32, Carl Endres '32, T. W. Abbot '33, H. Bierta '33, P. S. Bickenbach '33, N. C. Fetter '32, C. Weber '33, Alan Bate '33, Bennett Burgoon '32, C. L. Teach '33, and G. H. Volle '32.

Dean Langsdorf also spoke before a meeting of the Student Branch of the American Institute of Electrical Engineers, Thursday afternoon, December 17, in the electrical engineering laboratory.

The talk on waterways by Major General T. Q. Ashburn, chairman and executive of the Inland Waterways Corporation, before the student chapter of the American Society of Civil Engineers, December 15, completed a program for the semester of four talks by prominent engineers of the country. On November 5, Prof. H. M. Westergaard of the department of theoretical and applied mechanics spoke on the Boulder canyon dam, on November 17, Albert Reichmann, assistant chief engineer for the American Bridge company spoke on structural steel, and on December 2, Dr. Carol Arnovici, city planner of the city of Los Angeles, spoke on "The Community Plan and the Sciences."

At a dinner meeting, held December 6 at the Inman hotel, Q. J. Crawford, Norman Nolling, R. K. Stephenson, and G. C. Primm were initiated in Phi Alpha Lambda, honorary general engineering fraternity.

On November 17, the seventeen honorary and professional engineering organizations combined their efforts to become better acquainted with freshmen engineers by entertaining the freshmen at Bradley hall.

Prof. A. C. Willard, head of the mechanical engineering department, was the speaker of the evening. A male quartet from the glee club and Eddie McGinnis, the well known accordionist provided the entertainment. After the program refreshments and smokes were served.

Pi Tau Sigma, honorary mechanical engineering fraternity at a recent meeting pledged G. Perry '32, B. G. Oberlink '32, G. W. Neureuthes '32, H. E. Renwick '32, D. A. Hastings '32, J. R. Vogel '32, E. N. Angell '33, R. E. Jones '33, and J. H. Rickermann '33.

Delegates to the national convention of Pi Tau Sigma will meet at Illinois for the next annual convention in the spring of 1933.

Mu San, municipal and sanitary engineering fraternity, informally initiated eight men Monday evening, November 23, at the Urbana sewage disposal plant. They were K. T. Barthelmess '33, M. A. Churchhill '33, R. H. Hansmeir '33, H. P. Lessler '33, M. T. Lynge '33, Scott Marriner '34, L. A. Pfoff '33, and T. R. Wire '33. The formal initiation banquet was held Sunday evening, December 6 at Sue's Inn. Prof. J. J. Doland acted as toastmaster. The new members were welcomed by President R. S. Nelle. Scott Marriner '34 responded. Mr. H. H. Black and H. L. White were made honorary members.

Ben Rine '32, was sent to the national convention of Scarab, honorary architecture fraternity, in Cincinnati, November 22-24.

The local temple of Scarab exhibited a collection of drawings, paintings and sketches at the national exhibit composed of contributions from all the temples.

Art Kowitz '32 was elected delegate to the national convention of Theta Tau at the meeting of the local chapter held Thursday, December 3 at the Pi Kappa Alpha house. J. S. King '32 was elected alternate. The convention is to be held during the last week of December at the University of Arkansas, Fayetteville, Arkansas. The date for the informal initiation of new members was tentatively set for December 16, with the formal initiation the first meeting after the Christmas holidays.

Chi Epsilon, honorary civil engineering fraternity, held its initiation banquet at the Inman hotel Sunday evening, November 22. Eight pledges were initiated and Dean M. S. Ketchum was made the first honorary member of the national organization. The national council chose Dean Ketchum from a list of eighteen of the most eminent civil engineers in the country as the first man to be awarded the national honorary membership.

Prof. Huntington as the speaker of the evening recounted the experiences and problems of John Smeaton, the first man to bear the title of civil engineer. Prof. Babbitt acted as toastmaster, and W. E. Bohn '32, president, gave a welcome to the new members, to which R. L. Nelle '32 responded.

The pledges initiated were W. M. Avery '33, D. M. Baldwin '33, G. W. Chinn '33, V. G. Kaufman '33, R. L. Nelle '32, G. B. Righter '33, I. L. Wissmiller '33, and James Zaloudek '33.

A motion picture tracing the construction and development of the U. S. S. Akron, the world's largest airship, was shown at a meeting of the Illini Flying club in the electrical engineering laboratory, November 19.

Beginning at the time the golden rivet was driven into the ship by Rear Admiral W. F. Moffett, the picture presented a detailed account of its construction, including the christening by Mrs. Herbert Hoover on August 8, and the first trial flights in September.

Plans for a tri-school meeting of student branches of the American Institute of Electrical Engineers, to be held April 2 have been announced by B. Burgoon, chairman of the Illinois student branch. Purdue and Rose Polytechnic Institute will be the guests of the local branch. C. E. Skinner, national president of the American Institute of Electrical Engineers, has been asked to speak at the meeting. A business meeting, banquet, entertainment and the electrical show will comprise the program for the annual get-together of the three branches.

Electrical Engineering

Prof. C. T. Knipp of the physics department spoke before a joint meeting of the Urbana section and the student branch of the American Institute of Electrical Engineers, November 17, in the physics lecture room. His subject was, "The Contributions of Physical Sciences to Human Welfare." The talk was followed by a number of experiments illustrating principles in electrical discharges, such as cathode rays in a discharge tube, electrodeless discharges, and afterglow in nitrogen.

R. L. Dowell '32 was selected general manager of the 1932 electrical show at a meeting of electrical engineers, November 11. Other officers selected by the nominating committee and approved at the meeting were Lib Panichi '32, business manager, C. F. Rogier '32, chief engineer, D. L. Pettit '32, treasurer, B. Burgoon '32, programs, R. R. Wood '32, stunts and exhibits, P. S. Bickenbach '33, assistant business manager, R. V. Lahr '32, electrician and B. M. Carothers '32, construction.

Stunts and exhibits for the show are already being planned. The Westinghouse mechanical robot, which has attracted considerable attention throughout the country will be among the many exhibits at the show. A miniature, automatically controlled, electric railway to be presented by the Railway club is another of the exhibits already planned to thrill spectators next spring.

Civil Engineering

Dean Charles Derleth, Jr., of the University of California College of Engineering spoke before a group of senior civil engineers, November 19. He told of the proposed Golden Gate bridge at San Francisco, in which he is interested.

Dean Derleth was the guest of Dean Milo S. Ketchum during his visit here. Both deans formerly held the position of professor of civil engineering at the University of Colorado. They met again this year at a meeting of the Land Grant College association in Chicago, several weeks ago.

Prof. Hardy Cross spent part of his sabbatical leave in England last year to get at first hand the views of English engineers on methods of design and construction, particularly of concrete and masonry structures. Prof. Cross feels that his year abroad has enabled him to get a much broader view of his work in conducting his graduate courses and this he finds especially valuable in view of the fact that many of his graduate students come from foreign countries.

Chemistry

Moses Gomberg, professor of organic chemistry at the University of Michigan, and president of the American Chemical Society, was the principal speaker at the meeting of the A. C. S., held on the evening of November 9. He spoke to an audience of 200 chemists on "A Survey of the Chemistry of the Free Radical," and assisted his lecture with slides showing the actual reactions in obtaining the free radical. Prof. Gomberg summarized the history of organic chemistry and showed the changing conception of the free radical from the time of its supposed isolation to the present date.

Physics

A meeting of the Physics Colloquium was held November 12. The first lecture was presented by H. G. Fuller whose subject was "The Enhancement of Iodine Absorption by Admixture of Oxygen." Slides were used to illustrate the changing spectrum of iodine when oxygen was admitted to the iodine vapor. Mr. Fuller intimated that other research would be attempted to discover the results of oxygen absorption by the other halogens.

The second talk was made by R. F. Nusbaum, on "Magnetic Rotation Spectra and Heats of Rotation of K_2 and Na_2." Mr. Nusbaum showed by a series of graphs and spectrum photographs, just how the heats of rotation were obtained for lithium, potassium, and sodium.

On Thursday, November 19 "The Beryllium Molecule" was the subject discussed by W. H. Furry; and C. D. Hause spoke on "The Spectrum of Potassium Hydride."

Technograph Passes Forty-Sixth Birthday

Matt Wilson '34

PROBABLY few people realize that the Technograph, by virtue of having been founded in 1885, is one of the oldest publications on the University of Illinois campus. It was first called *Selected Papers of the Civil Engineers' Club*, and was the official publication of that organization for the first few years of its existence. A note in the first volume tells the purpose of the magazine.

"The Civil Engineers' club of the University of Illinois is essentially an undergraduate society, most of the papers being prepared by students. Not the least important of the results to the members have been the stimulation of independent thought, a development of the ability to hunt up one's own information, and of cultivation of the power to express ideas clearly, concisely, and forcibly.

"This publication is made to place in permanent form some of the papers read at meetings, and also to extend the influence of the society. The intention is to publish a similar volume annually. The committee regrets that the number of illustrations and length of many of the papers precludes their publication, and also that the valuable discussions of the papers have not been preserved."

From a financial standpoint the advertisements in the first issue paid for all expenses, cuts, and left a balance of twenty dollars, which was invested by W. R. Roberts and Lincoln Bush in a bulletin board as a surprise on Prof. Ira O. Baker and Prof. A. N. Talbot.

The first volume contained a number of good papers. Among them were "Hulton's Formula for Normal Wind Pressure," and "Hints to Students on the Education of an Engineer," the latter by Prof. Baker. Prof. Baker stressed the importance of a well-rounded education to an engineer, in addition to his technical training.

The first volume was published by the following committee, aided by the members of the club: Prof. A. N. Talbot, chairman, now professor emeritus of the university; the late Prof. I. O. Baker; William Barclay '87; L. Bush '88; and E. I. Cantine '87. The club was organized in 1883.

The first few volumes of the magazine sold for thirty cents each, and were about the size of a composition book.

The Civil Engineers' club continued to publish *Selected Papers of the Civil Engineers' Club* for four years. During this time the Mechanical Engineering club was organized, and in the spring of 1891 the magazine was published under its present name, *The Technograph*, with the two organizations co-operating in publishing it. Soon after this the Architecture club was organized and joined forces with the first two clubs to put out the magazine. At about this time they increased the price to fifty cents.

The second issue published under the name *Technograph* was of unusual interest because of the illustrations contained in it. Pictures were shown of the present University Hall, with the title, "The College of Engineering." Other pictures showed the machine shop, drawing room, collection of civil engineering instruments, the electrical laboratory, and the heads of the departments.

The eighth volume, published in 1893, contained an architect's drawing of engineering hall, for which the state legislature had just appropriated $160,000. The trustees of the university had asked graduates of the architecture school to compete in the design for the building, and first prize was awarded to G. W. Bullard of Tacoma, Washington, who became architect of the building.

It was not until 1895 that the *Technograph* had an independent staff. It was about this time that *Technograph* articles were favorably noticed by indices of engineering literature. Several articles were reprinted in other engineering magazines, among which Prof. Talbot's railway spiral, now a classic, was probably best known.

In 1896 the *Technograph* became an entirely scientific publication. The following year, however, marked another big change. Each engineering department was given a separate section of its own, for both notes and news. The Association of Engineering Societies was formed, and had charge of the magazine.

The next ten years passed with very few changes in the makeup of the *Technograph*. The magazine contained both articles of purely local interest and articles of engineering value. Successive editors began to bemoan the lack of interest of students in the paper, so a competition between societies for representation on the staff was arranged, and met with some success.

About 1908 general business conditions, similar perhaps to those prevailing today, began to make themselves felt in the *Technograph*, and the financial situation became very precarious. A change of some sort was necessary, and it was thought that the problem might be met by making the magazine a quarterly. However little success was met with, as the first year in which it was supposed to be quarterly only one issue appeared, the next year three, and it was not until 1911-12 that four complete issues were distributed. Throughout this entire period financial problems handicapped the staffs. In 1911 a complete reorganization of the editorial policy allowed the use of articles of more general interest, and broadened every department. The advisory board was also enlarged.

World conditions during the period of the war had their effect on the *Technograph*, and in 1918 publication was suspended. After the return of normal conditions, the magazine was completely reorganized under the direction of G. L. N. Meyers '21. The size was changed from the booklet size to its present dimensions, and the custom of using a different picture on each cover was adopted. In March, 1923 another big step forward was taken when the magazine became affiliated with Engineering College Magazines Associated, an organization which has since grown to include magazines from twenty-three of the foremost engineering colleges in the country. The purpose of this association is to raise the standards of the member magazines. This is accomplished by the adoption of uniform standards of practice, and by co-operation in both business and editorial problems.

The decade 1920-1930 saw few radical changes in the paper, but a gradual improvement in all departments. Feature articles tended to be of more local interest, as well as of engineering value, and departmental pages were enlarged.

In 1930 another big change was made when the *Technograph* became a monthly publication. During the year 1930-1931 student articles were featured, and more space was given to honorary and professional organizations on the campus. An informally conducted "Know Illinois" campaign was conducted throughout the year, with such features as the engineering library and the

Engineering Experiment Station being introduced. A new cover was designed, with a series of pen sketches of ancient engineering masterpieces appearing on successive covers.

Few radical changes have been made this year. The cover was altered only slightly, to include the words "University of Illinois." Modern engineering triumphs are being used as the subject for the cover series. Financial problems are being encountered this year, and have forced the elimination of several improvements that were suggested. The standard of the magazine has been kept up to par, however, as evidenced by the fact that the first two issues of this year were rated as "A" issues by the chairman of the association.

An attempt is being made this year to dress up the inside of the magazine. Readers may notice that this issue is printed on an enamelled paper, a better-appearing and more pleasing paper. New section headings are being designed, and two of them, for the editorial and departmental sections, are included in this issue. The remaining drawings will be ready in time for use in the next issue, in February. In the departmental columns, in addition to the new headings, cuts of the pins and keys of several of the professional organizations have been made, and are used with the notes pertaining to the organizations.

Freshman Lectures

That the lectures primarily for freshmen, given in the auditorium every Wednesday morning are a pronounced success has been evinced by the unaminous applause directed at each speaker as he concludes his talk.

Dean Jordan, who presides over the meetings, has shown in his choice of the lecturers who have thus far appeared that his motive is not to bias students in favor of any particular branch of engineering, but to acquaint them with the components of engineering with which they are not familiar.

The discussions are not technical or involved, and may be understood by all. Interest is stimulated and held by the use of lantern slides and by practical exhibitions.

On October 14, Prof. R. K. Hursch of the ceramic engineering school explained the changes through which clay formerly passed before it reached our tables and mantels in a finished condition, and then contrasted the modern methods.

"Oriental Crafts and Technologies" was the subject of Prof. E. G. Young's commentary on October 21.

Prof. Young, of the railway research engineering department, drew his material from his impressions as a railway engineer in China. With the aid of charts he explained China's geological peculiarities, and pointed out the localities where primitive customs still prevail. The greater part of China's population, he said, was centered in the southwest, and as compared with United States' most densely occupied section, New York, the ratio of persons per square mile was two to one.

Preliminary Water Power Studies

(Continued from Page 9)

The second limitation in the computation of total power output is the ability of the turbines to accommodate flow. The installation in this particular problem is for 44,000 kw. at 175-foot head. The factor at normal head is 11.89, which divided into 44,000 kw. gives 3700 second-feet as the flow required. Hence at normal head any flow in excess of 3700 second-feet must be wasted or

(Continued on Page 23)

"See that cop over there? He pulled in the Yale crew."

"Yeah? What had they been doing?"

—*Washington Dirge.*

* * *

A traffic cop at a busy corner saw an old lady beckon to him one afternoon. He held up a dozen autos, a truck and two taxis to get to her side.

"What is it, lady?" he asked rather impatiently.

The old lady smiled and put her hand on his arm. "Officer," she said in a soft voice, "I just wanted to tell you that your number is the number of my favorite hymn." —*Carolina Buccaneer.*

* * *

She: "How do freshmen keep those dinky little caps on?"

He: "Vacuum pressure." —*Texas Longhorn.*

* * *

"You say you go to a school for chorus girls? Why, what do they teach you?"

"Rhythm and writhin'." —*Temple Owl.*

* * *

Some people take courses in ancient history and others prefer to see the releases of Pathe news at the local theater. —*Amherst Lord Jeff.*

* * *

Artist: "May I paint you in the nude?"

Model: "Gracious, no! I expect you to wear something!" —*Rice Owl.*

* * *

First Cannibal: "What's the matter with me, doc? I feel mighty sick."

Cannibal Doc.: "What'd you have for dinner?"

F. C.: "A gangster."

C. D.: "Lead poisoning!" —*Missouri Showme.*

* * *

First Farmer: "Do you think rain water is really good to put on your hair?"

Second Farmer: "Well, if it's good enough for my fodder, it's good enough for me." —*College Humor.*

* * *

REAL BONER

Papers, magazines and even books are filled with a lot of so-called schoolroom boners, but here is a bona fide one. In answer to the question, "What is pasteurized milk?" a young school girl of Cumberland Gap, Tenn., answered: "Pasteurized milk is milk that has been heated to take the taste of the pasture out of it."

—*Pathfinder.*

The absent-minded professor was busy in study.

"Have you seen this?" said his wife, entering. "There's a report in the paper of your death."

"Is that so?" returned the professor without looking up. "We must remember to send a wreath."

—*Montreal Star.*

* * *

"Look here, waiter, I just found a collar button in my soup."

"Oh, thank you sir. I have been looking all over for it." —*Pathfinder.*

* * *

Once upon a time there was an ultra-conservative who wouldn't take either chemistry or math because they had so many radicals.

* * *

Jones: "Before Brown got married he said he would tame his wife's mother or die in the attempt."

Smith: "And how did he come out?"

Jones: "In a black, silk lined box with silver handles." —*Pathfinder.*

* * *

BOILING IT DOWN

"Johnson . . . er . . . I think I'll run out for golf this afternoon. And I wish you'd take care of our daily Wall street letter. You know our style, Jones. Everything boiled down. Terse. To the point. Nothing but the absolute essentials. Ah . . . I hardly know just what to feature today . . . Er. . . .What do you think the market will do next?"

"I haven't the slightest idea, sir."

"Fine! . . . Great! . . . But remember to be brief, Johnson. See if you can't say that in three thousand words." —*Judge.*

* * *

Tom: "Was it a big wedding?"

Tim: "Yes. I got in line twice to kiss the bride and nobody noticed it." —*Pennsylvania Punch Bowl.*

* * *

Men will wear brown this winter, says a stylist.

They will if they did last winter. —*Life.*

* * *

If you think of an original joke, won't you please send it in? You will notice that we do not want any copied jokes. We have a pretty efficient copying department of our own.

* * *

And then there was the man at the football game who was arrested for trying to stir up labor trouble because he yelled "Get organized" at the losing team.

Preliminary Water Power Studies

(Continued from Page 21)

stored. For all heads above normal, the turbines can still produce 44,000 kw., but the quantity of water necessary for this production decreases with increase in head, until at the maximum head of 194 feet only 3360 second-feet is required, and flows in excess of this quantity are rejected. Below normal head the limiting factor is the water-capacity of the turbine, which varies with the one-half power of the head (the turbine being considered as

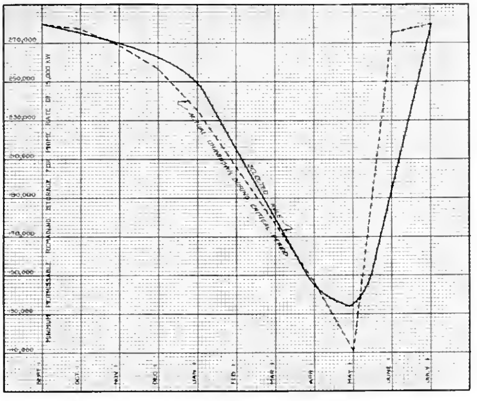


Figure 4: Rule curve

an orifice, for which $Q = CA\ (2GH)^{1/2}$). These limiting flows are shown in Table 4 below, and graphically in Figure 5.

This final power study is best tabulated as shown in Table 5. The portion of the table shown includes a draft period (January through April) during which the output was controlled by the rule curve, and a spill period

TABLE 4—Data for Water-Usage Curve

Factor	Head	$(Head)^{1/2}$	C. F. S	Power
13.09	194	....	3360	44,000
12.80	190	....	3440	44,000
12.20	180	....	3605	44,000
11.89	175	13.23	3700	44,000
.....	170	13.04	3645	.. ..
....	160	12.65	3535	.. ..
. . .	150	12.25	3420	
. . .	140	11.83	3308	
.....	130	11.40	3185	

(May and June) during which flows in excess of those shown to be usable by the water usage curve were wasted.

After this tabulation is completed for the entire period of record, the kilowatt-hours of output for the entire period are totalled. The kilowatt-hours of prime are computed by multiplying the hours in the period by the prime rate, and this amount is subtracted from the total output to determine the number of kilowatt-hours of secondary and off-peak power. Both quantities are then reduced to the basis of a year.

The total average annual output for the plant under consideration was thus determined to be 240,437,600 kilowatt-hours, of which 131,400,000 were primary and 109,037,600 secondary.

4. Cost Studies

The turbine costs are estimated at so much per horsepower, the generators, transformers, and switching, at so much per kilowatt. The power house substructure can be estimated by the cubic yard, and the superstructure either by volume or, more accurately, by actually designing and taking off quantities. Penstocks, valves, and so forth, are estimated by weight. The cost of transmission to the power market must be included. The total cost in the present case amounted to $8,240,000.

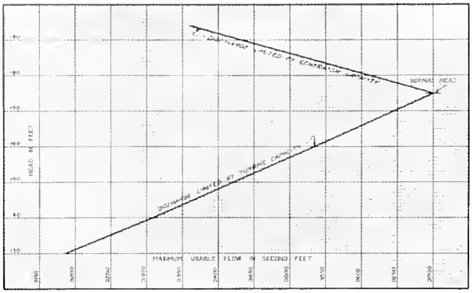


Figure 5: Water usage diagram

The cost of hydro power is now computed as follows: Annual fixed charges (including taxes, depreciation, interest on investment, and so forth) are taken at 10 per cent of the capital cost ($824,000). To this are added operating expenses, estimated at $2.00 per kw. per annum ($88,000). From the total of these two items ($912,000) is subtracted the value of the secondary power. If we assume that this value is 1 mill per kw.-hr., the annual income from this source is $109,000. The net annual charges are $803,000, and the cost per kw.-hr. is $803,000 divided by 131,400,000, or 6.1 mills.

The second step in the cost study is the cost estimate of power from a hypothetical steam plant located at the market. It is made on the same cost basis as the hydro estimate, and every effort must be made to keep the two studies comparable in every respect. It is beyond the scope of this article to discuss this phase of the problem. Suffice it to say that in this case the cost of fuel-generated power was found to be 8.2 mills per kilowatt hour, which left a balance of 2.1 mills in favor of the hydro development, a margin sufficient to indicate that the site was worthy of a detailed investigation.

The Future of Mining Engineering

(Continued from Page 13)

on some ground after I got acquainted. Bet there's gold in some of them hills."

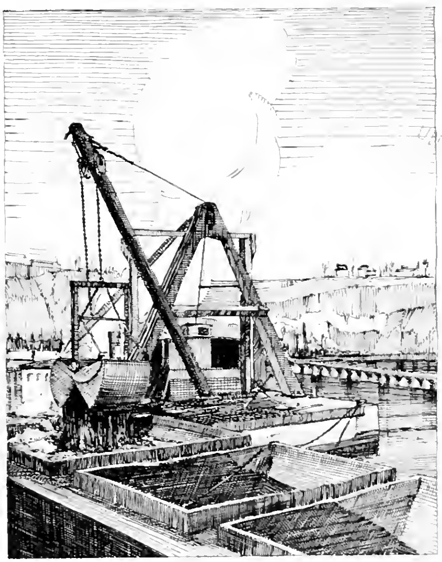
"It's a wide-open camp, there below," protested Saint Peter. "Twenty-four-hour shifts, no water, fire hazards, and poor accommodations. Do you realize all that?"

"Well," said Hard-Rock, cutting a huge plug of astral Battle Axe, "a miner is so used to Hell anyhow that it won't be any novelty to him. An' Hell or no Hell, Saint, I got to keep on mining, and I'm going to. I tell you, that country below may be worth prospecting. Right down? Thanks, Saint—give us two bells."**

**"Two Bells" is the signal used the world over for lowering the mine cage down the shaft.

THE TECHNOGRAPH

UNIVERSITY of ILLINOIS



FEBRUARY 1932

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

The TECHNOGRAPH

UNIVERSITY OF ILLINOIS

Member of the Engineering College Magazines Associated

VOLUME XLVI — URBANA, ILLINOIS, FEBRUARY, 1932 — NUMBER 4

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One Hundred Years' Development in Hydraulic Power in Missouri.

Above: An old mill, built more than one hundred years ago, on Indian Creek, near Kansas City.

Below: The finished dam on the Osage River, near Bagnell.

THE TECHNOGRAPH

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

VOLUME XLVI | FEBRUARY, 1932 | NUMBER 4

Electrical Engineers Will Present Biennial Show Next Month

B. BURGOON, E.E. '32

The author, who is assisting in the preparation of the show this year, is also chairman of the Student Branch of the A. I. E. E. He reviews below the origin and development of the show which has become recognized as the outstanding university electrical exhibit, some of the most popular exhibits of past shows, and a few of the features that will be presented at the 1932 show.—EDITOR'S NOTE.

IN THE spring of 1907 subscriptions were solicited for the Robert Fulton memorial fund of New York City. Someone in the department of electrical engineering conceived the idea of arranging an electrical exhibit, charging a small admission fee, and giving the proceeds to this fund. So, twenty-five years ago this spring, the first electrical show was presented.

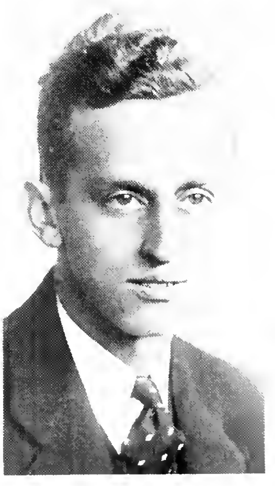
It was a small show, and little expense was incurred. However, it was well advertised and the curiosity of the university community was aroused. The attendance was considerably larger than had been expected, and the students managing the show were able to contribute $289 to the Fulton fund.

The experience of planning and executing this show proved to be so interesting that the students repeated the performance in the spring of 1908. This time the exhibit was more elaborate, but the expenses were greater and the net profit was less. The proceeds were used to purchase chairs, a rug, and a table for the electrical society reading room.

The show involved an enormous amount of work on the part of the students, but they believed the undertaking was worth the effort so they decided to make the show a biennial event and present it the week following the Easter recess to prevent interference with class work.

By 1915 the show had grown to such proportions that it had outgrown the electrical laboratory and permission was granted to use the gym annex, which previous to that year had been the armory. The 1915 show greatly exceeded all previous efforts both in number of exhibits and in attendance. The expenses, however, increased more rapidly than the receipts and the fund of $100 which had resulted from preceding shows as a guarantee fund was not increased.

In 1917 there was a slight deficit in the finances of the show on account of the World war, but the Electrical Engineering society was able to restore the $100 fund.



R. L. DOWELL '32

Because of conditions arising from the war, plans for a show in 1919 were abandoned. But in 1920 the few students left who had participated in the 1917 show were eager to present another show. The financial risk involved was large on account of increased costs of materials, freight, etc., but with slightly increased admission and excellent management on the part of the students involved the show was a success. Due to its financial success the guarantee fund was substantially increased.

As a result of the increased profits of the 1920 and the 1922 shows, due to the reputation the past shows had established and also to the growth of the student body, the electrical engineers were able to establish a sufficient guarantee fund for future shows and also to provide $1,000 in a student loan fund for electrical engineers.

Since the 1922 show this loan has been increased by the profits of biennial shows until at present there is $2,972 in the fund and $1,000 on reserve to finance the next show.

By 1924 the Illinois electrical show had gained national recognition and many large electrical manufacturing and utility companies were anxious to exhibit their products during the show. While some of these exhibits were merely displays of electrical apparatus others were among the most interesting stunts of the show. An automatic dial telephone system, the electric telegraph clock system, a miniature power transmission line, a model hydro-electric plant,, and many other entertaining and educational features were presented as commercial exhibits.

With the rapid development of radio and the vacuum tube field, including television and the photo electric cell, and other recent developments in electrical engineering, the shows of 1926, 1928, and 1930 were able to present many unusual and spectacular features including a demonstration of radio broadcasting and receiving, power amplification, television experiments, the singing arc, and several unique stunts employing the photo electric cell.

Among the outstanding features of the 1930 show was

(Continued on Page 20)

Reinforced Concrete Arch Studies Being Made by Engineering Experiment Station

MATT WILSON '34

Since this article was written, in January, tests were completed on the preliminary single-span arch. The single span was tested to try out the apparatus to be used in the multiple-span types. Data are not yet available on the results of the tests, but later issues of the Technograph will contain the information as soon as it becomes available. The multiple-arch structures will be built and tested as soon as possible, but it is estimated that the entire program will require about three years.
—EDITOR'S NOTE.

THE program started this year in the materials testing laboratory by Prof. W. M. Wilson is the investigation of single-span reinforced concrete arches. Up to to the present time, work has been done in building the spans and making the apparatus with which the spans are to be tested. The single-span is being tested to try out on a simple structure the apparatus that is being built for use in testing the more complicated three-span structure. The results of the elastic properties of the single-span are to be used as the basis of comparison in studying the elastic properties of a three-span arch series on high slender piers.

The behavior of the multiple-span differs from that of the single--span arch in that the bases of the intermediate piers are fixed. The elastic deformation of a pier permits its top to move and therefore moves the ends of the arch rib as the bridge is loaded. This movement of the ends effects the stress in the rib due to the load.

Five multiple-span structures are to be built and tested. The first will consist of ribs without decks, a structure that can be analyzed algebraically, taking into consideration the elastic deformation of the piers. Each of the other four structures will consist of a rib with deck similar to the open spandrel arch bridges frequently used for highways. Each of these latter structures will have a different deck, the decks differing from each other in the number and location of expansion joints and in the height of the deck above the crown of the arch rib.

Each specimen is to consist of three 27-foot span arches supported on abutments and piers 20 feet high, so the structure will be approximately 100 feet long and 35 feet high. The arches will be broken by loading with concrete blocks of known weight, ranging from 25 pounds to 500 pounds, distributed in the same manner as loads are assumed to be distributed in the design of an arch for a highway bridge.

The tests are being made to determine the strength of the arches and the elastic deformation caused by the load, particularly the movement at the tops of the piers due to the stress in the piers.

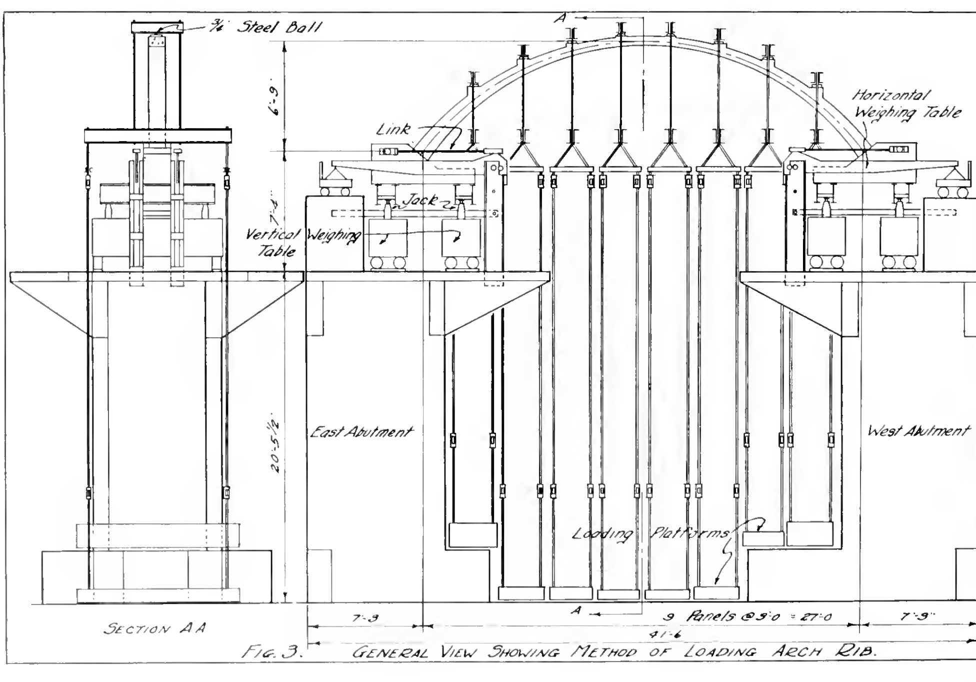


FIG. 3. GENERAL VIEW SHOWING METHOD OF LOADING ARCH RIB.

The single arch was poured October 17, 1931 and was allowed to cure in an entirely closed form until October 27. The arch was allowed to cure without addition of moisture until the test was made.

The concrete was designed to have a strength of 2,200 pounds per square inch in 28 days. A 1:3:3 mixture having a 1.2 water-cement ratio by volume was used and the quantities for the batch were determined by weight. In determining the weights, allowance was made for the moisture content of the aggregate.

The loads, which are gravity loads, are applied to the rib at right loading shelves located as shown in the plan. The load has been considered as made up of two parts, dead load and live load.

In selecting the magnitude and distribution of the load, the specimen has been considered as a model, built to a scale of 1 to 5, of an arch having nine panels 15 feet long and having a span of 135 feet and a rise of 33 feet 9 inches. The dead load is not the weight of the specimen, but the load that produces stresses in proportion with the dead load stresses in a 135-foot arch. The dead load panel loads are so proportioned as to keep the dead load thrustline within the kern of the arch over its entire length. A single-centered circular arch was selected so as to simplify mechanical operations and to insure greater accuracy in the shape of the arch. Since the arch is single-centered, the dead load panel loads near the ends are somewhat greater relative to the intermediate loads than is usual in actual arch construction.

The selection of the live load has been governed by the Standard Specifications for Highway Bridges and Incidental Structures prepared by the American Association of State Highway Officials. The specifications provide that the live load be made up of two parts, a distributed load expressed in pounds per linear foot of roadway, and a single concentrated load on one panel. The distributed live load may cover any portion of the length of the roadway but the concentrated live load is applied at only one panel point, and is in addition to the panel load due to the distributed live load.

The live load will be placed to produce a maximum compression at the extrados on a section at the springing, the point where failure is to occur in the test to determine the load-carrying capacity of the rib. This point of failure has been selected because the analysis indicates that, for the experimental multiple-span structure having a deck without intermediate expansion joints, the section having the least load-carrying capacity is the section at the springing. The live load that will be used consists of a distributed live load of 900 pounds per panel point on any panel and an additional concentration of 2,800 pounds on one panel point.

It is impossible to reduce the load on a 135-foot arch having 15-foot panels to the equivalent load of a 5 to 1 model having a equal number of 3-foot panels, by applying a single load-reduction factor. The selection of the live load has been influenced by the following considerations:

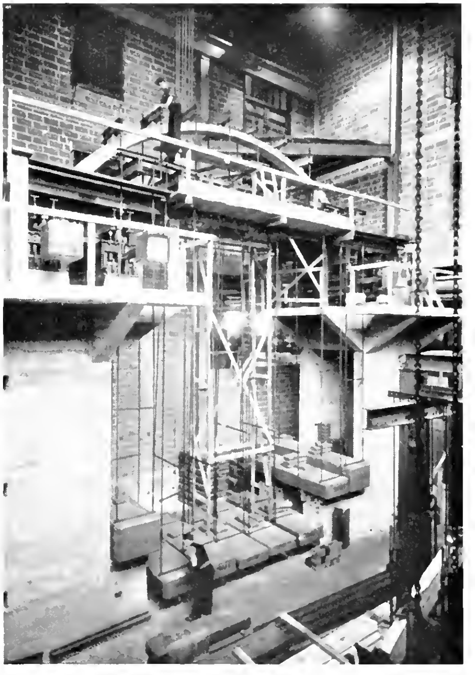
The ratio, *D.L. L.L.* should be within the limits that might reasonably be encountered in the design of a highway arch bridge having a span of 135 feet. The average dead-load panel load for a 135-foot bridge having 15-foot panels, to give the same *D. L.-L. L.* ration with an H-20 loading, and a single lane of traffic, would be 67,700 pounds, a value that is not abnormal.

The ratio, *Distributed L.L. Concentrated L. L.* should be within the limits encountered in practice. Considering the experimental arch to represent a 135-foot arch having 15-foot panels has made this ratio the same as it would be in an actual structure having 15-foot panels. The dead-load unit stress should be approximately half of the allowable unit stress for concrete in compression in an arch.

There are a number of functions which are required of the apparatus: It must:

1. Produce a vertical load of known magnitude at each of the eight load points;

2. Determine the position and magnitude of the vertical component of the reaction of each of the abutments;



A view of the single-span arch which was tested last month in the materials testing laboratory, showing the method of applying the loads to the arch rib.

3. Determine the position and magnitude of the horizontal component of the reaction of each of the abutments;

4. Determine for each abutment that it has not rotated or that it has been rotated by a predetermined amount;

5. Determine that the length of the span has not changed or that it has been changed a predetermined amount;

6. Determine that the relative elevation of the two abutments has not changed or that it has been changed a predetermined amount;

7. Determine the vertical movement of the rib at each load point;

8. Determine the position of the thrust line throughout the length of the rib.

The vertical loads are produced by concrete blocks carried on reinforced concrete loading platforms as shown in the illustrations. Each loading platform is carried by four vertical rods attached to a cross beam resting on a loading shelf on the rib. The contact between the cross beam and the loading shelf is a tool steel block at the

(Continued on Page 17)

The First Skyscraper

W. F. Barnes, Jr. '34

USUALLY the razing of a building marks its doom and relegates it to oblivion. The wrecking of the Home Insurance building in Chicago, however, had the effect of definitely establishing the fact that it deserves the honor of being the first of the "skyscrapers." Observation of the structural details of the Home Insurance building during wrecking operations establishes its claims beyond any doubt.

Of what value is such a claim and why is it important to have fixed the real point of beginning of "skycraper" or skeleton construction? It has been stated, and we believe it to be true, that the greatest contribution of America to architecture is the skyscraper. It therefore appears to be of historical interest to fix the structure and the date which mark the beginning of the era of this type of construction. The value of skyscrapers built in the United States since 1884 runs into billions of dollars. Their value in the economic development of the country is inestimable.

The Home Insurance building almost demolished, showing the skeleton framework used

"Skycraper" Defined

In order to establish the claim for the Home Insurance building we shall first define what is meant by a "skycraper," next discuss the claims of other buildings for the honor of being the first, and finally, by a brief description of the construction as revealed during the wrecking operation, show that the Home Insurance building is entitled to the credit.

Webster's dictionary describes skeleton construction as, "A method of constructing buildings in which the chief members are steel, the wall being supported at the floor levels by the steel frame itself."

The Encyclopaedia Brittanica says that in skeleton construction "steel takes up all the stresses to which a building is subjected; compression, tension and shear."

The Chicago building ordinance states, "The term skeleton construction shall apply to all buildings wherein all external and internal loads and strains are transmitted from the top of the building to the foundation by a skeleton framework of metal." There are many other descriptions from various sources but the purport of all of them is that in skeleton construction there is a frame or skeleton of structural materials which supports all interior and exterior loads.

To substantiate the claim of any building or person to the honor of being the originator of skeleton construction, priority must first of all be proved. Investigation shows that although there are a number of buildings in which an iron frame has been used there are only three whose claims seem in any way justified.

Buffington's Patents Never Used

The claims we will discuss in detail are those of the Home Insurance building, Chicago, Illinois (demolished), William Le Barron Jenny, architect; the Tacoma building, Chicago, Illinois (demolished), Holabird and Roche, architects; and the letters patent of Leroy S. Buffington.

Considering these in reverse order, Mr. Buffington, an architect of Minneapolis, well known in his profession, in reading an essay by Viollet le duc, was struck by a statement of the great Frenchman that with an iron frame buildings could be built to an unlimited height. Based on this idea he secured, May 22, 1888, letters patent covering an iron frame for tall buildings. This iron frame was essentially different from any that was used subsequently. The columns, for example, were solidly composed of iron slabs staggered and bolted together, a design impossible of practical application. In 1884, Buffington designed a sixteen-story building with a frame of cast iron columns and iron beams in which the curtain walls were supported at each floor by the iron beams. This building was never built, at least with this form of construction. In 1885 he made a perspective design for a 28-story skeleton building which he called a "cloud-scraper." Although Buffington never built a skeleton building, he attempted through the courts to collect royalties on various others that had been built as infringements of his patents. In every instance he lost his suit, although the owners of the Rand Tower, Minneapolis, built in 1928, voluntarily paid him one-eighth of one per cent of the cost of the steel work.

Self-Supporting Walls in Tacoma Building

The Tacoma building, demolished in 1928, stood at the northeast corner of LaSalle and Madison streets, Chicago. It was built from plans of Holabird and Roche. The building was started on May 1, 1887 and finished April 1, 1888. In the case of the Tacoma building, the claim has usually been made that it was the first skyscraper ever erected in which skeleton construction was used throughout, or that it was the first "complete" example of skeleton construction. Holabird and Root, successors, in a published letter say: "The construction is cast iron supporting columns, cast iron spandrel lintels, wrought iron girders and beams, hollow tile arches and spread foundations made of concrete, re-inforced with railroad rails."* Frietag, in *Architectural Engineering*, refers to the Tacoma building as "probably the first complete type of skeleton construction." George E. Pistor,

*Obituary of L. S. Buffington by R. C. McLean, *Western Architect*, March, 1931.

treasurer of the American Institute of Steel Construction, states: "The Tacoma building . . . was supported entirely by a metal frame and the walls did not more than curtain off the elements." The story of "Architecture in America" captions a picture of the Tacoma building thus: "The first complete steel skeleton building ever erected."

The wrecking of the Tacoma building showed, however, that the north lot line wall and east walls were of solid brick. The court walls as well were of self-supporting masonry. There were in addition two solid masonry transverse dividing walls that ran from the basement to the roof. These divided the building into three sections. There were five interior columns on each floor, two in the east section, three in the center and none in the north. The lot line walls, court wall, alleyways and interior bearing walls thus absorbed, roughly, 75 per cent of the floor load, so there was only a small portion supported exclusively by the iron construction.

The Home Insurance building, Chicago, as it appeared before razing operations were started

Home Insurance Building Originally Ten Stories

The Home Insurance building was designed in the early part of 1884. The building permit was issued in March, 1884. Ground was broken May 1, 1884 and the first tenants moved in in the fall of 1885.

The Home Insurance building, as it was built in 1884-5, consisted of 10 stories. To these, two additional stories were added in 1890-91. These extra floors were of different design but of similar construction, using the same column centers or framing.

The original building, therefore, as constructed was in the main a rectangle 138 feet on LaSalle street and 98 feet on Adams street, with an ell on the northeast corner, 50 feet north by 26 feet west. The super-structure was supported by foundations consisting of isolated footings of the spreading type, built of dimension stone, under each pier center on the street fronts and under each column center under the party walls. The first two stories on the street fronts were of solid rock faced granite backed with tile. Above the granite on the street front, the facades of the building were of red pressed brick unvitrified, with continuous stone sill and lintel courses confining spandrels of brick or terra cotta.

The party walls on the north and on the east side were of solid masonry, composed of common brick and continuing from the foundation to the roof. On the two street fronts, there were cast iron columns beginning at the level of the third story window sills. All floor loads throughout were carried on these and the interior columns, of which there are 99 on each floor, extending from the foundation to the roof. There were no masonry interior walls.

The columns and their connections may be described briefly as follows: Typical columns in the fifth story were 10 inches by 14 inches and in the ninth story 8 inches by 12 inches. These columns supported heavy cast iron lintels the full thickness of the wall on integral cast iron brackets. Three-quarters of an inch above the lintels and extending from column to column were two wrought iron 12-inch I-beams supported on cast seats. These beams were further secured to the columns by one-inch diameter wrought iron clamps 9¾ inches long, screwed into the column and turned down and let into the flanges of the beams. The function of these beams was dual; as bracing and ties for the columns and as support for the masonry spandrels and cast iron mullions.

Home Insurance Claim Proved in Wrecking

As the columns are in sections, each a story in height, they were flanged at top and bottom and fastened to each other on a sheet lead bearing with one-inch bolts through the flanges. Extending from each exterior column to the nearest and opposite interior column were 12-inch wrought iron girders supported on cast brackets and also secured as described by wrought iron clamp. The interior columns were round, 9 inches in diameter on the ninth story and increasing on the lower stories. They had square top and bottom flanges and were bolted together through their flanges with ¾-inch bolts. The girders connecting the interior columns were composed of two 12-inch wrought iron beams supported on cast iron brackets and separators and clamped as described.

There can be no possible question that the metal frame described above was a perfectly rigid and stable metal cage. Under the definition of skeleton construction, however, it would be necessary to prove that this rigid metal cage supported all the loads of floor and wall. Here again, there can be no question of floor loads for which there is no support other than columns.

During the wrecking of the building the opportunity was furnished of determining whether or not the exterior masonry piers were completely supported by the enclosed iron columns and the contiguous iron frames. Two typical piers were stripped or girdled. In each case the masonry was entirely removed for a space of two feet, completely exposing the columns. The stripping was left undisturbed and unshored until the building was wrecked to that point, a matter of one day. No cracking of the piers or other failure of the masonry was apparent during the interval. This indicates that regardless of Major Jenny's intention in the matter, and of the opinions of various commentators on the building, the piers were in fact supported by the structural skeleton.

Conceding then that wherever the metal skeleton is present it did in fact support all loads, we have then to weigh its importance and position in the evolution of the skyscraper. We believe that the claim of LeRoy S. Buffington as the inventor and the father of the sky-

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Waterways — Their Part in a Coordinated Transportation System

Major General T. Q. Ashburn
Chairman and Executive, Inland Waterways Corporation

This article is made up of excerpts from a speech delivered by General Ashburn at the Harvard business school, December 5, 1931, and on December 15 at the University of Illinois before a meeting of the Student Branch of the American Society of Civil Engineers.—Editor's Note.

I HAVE assumed that the readers are familiar with the general principles of water transportation and with the general physical developments of the transportation net work of the United States, and will deal only with the broad policies of inland transportation as it is related to railway and motor transport as a part of our general transportation system.

The declaration of the policy of Congress, you will note in the Transportation Act, "It is hereby declared to be the policy of Congress to promote, encourage, and develop water transportation, service, and facilities in connection with the commerce of the United States, and to foster and preserve in full vigor both rail and water transportation." This act refers only to the development of rail and water transportation, and does not mention motor transportation or air transportation, and yet these two systems have become of great importance; and in any co-ordinated, developed system of transportation, have a very vital bearing. It is quite useless for opponents of such development and co-ordination to attempt to confine transportation problems to rail and water; because, it is at once evident to the most casual observer, that this declaration of policy by the Congress was made at a time when truck and air transportation were negligible, and did not enter into the picture which Congress was trying to paint. Since such competitive conditions have become important to both rail and water carriers, it is a condition we must meet, not a theory. In approaching a solution of this condition we must consider that the transportation problem confronting the United States is one of *national transportation* rather than the problem of any particular *transportation agency*.

Mr. Ezra J. Brainard, chairman of the Interstate Commerce Commission, in a recent speech, using quite similar phraseology to that frequently employed by me, said:

> "It is not a question of whether any particular form of transportation shall prevail or be given advantage.
>
> "Ruthless economic law will eventually determine that, no matter what artificial impediments may be interposed to interfere with natural progress temporarily.
>
> "The public interest lies in determining the most economic and efficient transportation services by whatever facilities are best adapted for that purpose. The readjustment of transportation facilities should be made with the least possible economic waste.
>
> "Railroads should be permitted to discontinue unprofitable service which can be more economically replaced by motor or other forms of transportation.
>
> "Each of the several transportation agencies should be utilized to the extent and in the place where it is most economically productive. This can only come through experimentation, study and vision."

The Inland Waterways Corporation is entirely in accord with these views; in fact, we have maintained this position consistently since the inception of our corporation.

Every new country passes through four stages of transportation: Transportation by water, by paths and

A typical Mississippi river tow, tied to the banks at Memphis

roads, by rail, and finally the stage of co-ordination and co-operation—the stage through which the United States is now passing.

Each of these stages follows as naturally as day follows night, each performs its functions satisfactorily considering the conditions involved, each in the order named inevitably leads to the other; and as a better and cheaper and more satisfactory form appears, the less satisfactory and the more expensive form fights constantly to prevent the people of the United States from enjoying such transportation, and always on the ground that the existing forms of transportation fill all our needs, and competition will destroy the revenue of existing forms.

This does not seem to me to be a sound argument, but rather a denial of the rights of the people to have what Mr. Brainard asserts they are entitled, the most economic and efficient transportation service by whatever facilities are best adapted for that purpose.

I do not think any one will attempt to controvert the statement that a manufacturer locates where he can manufacture and distribute his products most satisfactorily. No more can one deny that a primary consideration of such location is the problem of gathering his raw material and distributing his finished products cheaply. If we examine the location of our great manufacturing cities, we find them where rail and water meet, and where trucks have entered into the picture of recent years.

If the costs of collecting his raw material or distributing his finished product gets out of line for a particular locality, the manufacturer moves where the costs are in line, and that is to the coast, the lakes, the gulfs, or our interior navigable streams where there exist means of transfer from barge to car and vice versa.

Due to the vast extent of our territory a large portion of what is roughly referred to as the Mississippi valley (which includes the Ohio and Missouri valleys as well) is located so far in the interior, or away from our sea, gulf, or lake ports, that it suffers a natural handicap in marketing its products abroad, be they agricultural or manufactured. "The price of export grain is fixed in Liverpool, and the price the farmer gets for his grain is the Liverpool price, less the cost of handling it, and the middleman's profit." Nowhere has this been more clearly brought out than in the hearing before the Interstate Commerce Commission by Colonel George Lambert, of St. Paul, Minnesota, re the application of the railroads for a horizontal increase of 15 per cent in their rates. Doubtless the commission recognized this fact, for they allowed no increase on export grain.

As pointed out by this representative, a very curious situation exists in this respect. He quotes me, as above indicated, and says, quoting his authority, "that a bushel of wheat, carried from the farm in Montana on its way to Liverpool pays 32.2 cents to the railroads for a haul of 1,394 miles, while the inland water and ocean lines, privately-owned and operated, carry the same bushel a distance of 4,041 miles to its destination at a cost of 9.52 cents, including all transfer and terminal charges. The revenue accruing to the railroads participating in this movement is, therefore, 7.69 mills per ton mile, and the revenue to the water line is 0.78 mills per ton mile, or approximately one-tenth of the rail cost. The material savings due to the low cost of water transportation have enabled the railroads to handle this tonnage in spite of their higher rates. In other words, without the aid of this cheap water transportation, the farm products of the Midwest and Northwest could not move in foreign commerce and rail tonnage and revenue would be correspondingly reduced."

I have no doubt that if investigations were to be made covering the territory of the Mississippi valley, many similar situations will be found to exist.

As a people we have reached the sound economic conclusion that the country as a whole is prosperous only when its component parts are prosperous; and when a condition arises wherein one section is penalized for the benefit of another, it is the business of the nation to correct that condition.

Such a condition can reasonably be stated to exist between the Appalachians and the Rockies; but fortunately an all-wise Creator has endowed that section with abundant rivers and streams, and man has supplemented this system by canals, highways, and pipe lines, so that there is potentially the solution of the problem of restoring an economic parity in our hands.

As our civilization pushed its way westward from the Atlantic north from the gulf, our interior streams were utilized to their best advantage, and it is interesting to note that our large inland cities of today sprung from trading ports located at strategical points on our rivers. Kansas City, for example, is located where it is because the Missouri river at that point changes from a nearly southward flow to an easterly flow. In the westward push the river was utilized as far as practicable, and when no longer an artery to carry our pioneers directly west, they left it, built a trading post, and Kansas City became what it is today.

No one can doubt that the present prosperity and growth of Houston came from connecting it with the sea by a canal; nor can one doubt that it will continue to prosper and thrive.

Canals are the life feeders for Port Arthur, Beaumont, Lake Charles, and other Texas communities.

Now there is a real relationship existing between urban and rural communities; and a distinct place in the sun for interior waterways.

The industrial development brought about by water transportation naturally has a very close relationship with agriculture by creating large industrial centers and greater population as a consuming market near the agricultural producing areas. This brings about a better

Incline and cradle, upper terminal at Memphis

distribution of population throughout the United States and a greater national economy by bringing the consuming and producing markets closer together. Intensive agriculture results which mutually benefits both the industrial city and the farming regions.

Let us examine for a moment the cycle of events following the loss to a comparatively small city of its largest manufacturing plant. Primarily, it may be observed that so long as this manufactory can get its raw materials cheaply and distribute its finished products economically it will maintain its location, but let these costs get out of line and it moves. Assume that this condition of unbalanced costs is brought about through some transportation costs. Scarcely anything else could bring it about except lack of market for the produced article. See the inevitable trend of events.

The manufactory, located in this small city, pays a fair share of the total taxes, as do its employees; and usually liberally contributes to charity, religion, and civic improvements. Suddenly it moves—its taxes ceases, its employees are thrown out of work, increasing the difficult problem of unemployment.

These workers have bought from the retailer, who in turn has bought from the wholesaler, and these products have come in by some form of transportation; which loses it. All of these employees and their families have purchased the products of agriculture of their environment. The loss of this source of revenue to the farmer forces him to produce less, or to market his products some other place, involving a transportation cost, and therefore he receives less for his produce. His purchasing power is decreased, reflecting itself again in loss of sales of the retailer, a reduction of his funds, a vicious cycle, all tend-

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From Lightning Rod to Television

ELLERY B. PAINE
Head of the Department of Electrical Engineering

IT IS a commonplace remark that electricity is still in its infancy. However, if we call the beginning of the electrical age that time when the first important application of electrical knowledge was made, the electrical era has now existed two centuries. Therefore if a discriminating person refers to the present time as the infancy of electricity he must have in mind a span of years for full life something like the reputed nine hundred and sixty-nine of Methuselah rather than the proverbial three scores and ten years for ordinary man.

The electrical industry is unique in that more than in any other industry its beginning was the result of scientific study and experimentation. The marvelous development of the electrical industry is due to the fact that research methods have been so freely used to solve the many problems which arose when practical applications were made of the basic principles. The results achieved have been so spectacular that the methods which have been found successful in the electrical field are now used in many other lines of work.

When we study the development of electrical engineering, noting the geniuses who made the fundamental discoveries and considering the guiding principles which these geniuses formulated, we find that the electrical era is readily divided into equal periods of thirty-five years or into periods each nearly equal to what is usually called a generation. Each of these periods is marked by a guiding principle or discovery of basic importance leading to wide practical applications.

The accompanying table outlines the development of the electrical age, showing the names of the leading geniuses, the guiding principles and discoveries and important applications for each of the periods. The reader will doubtless think of other names which might be included in the list. It is true that there are many who are not included who have made valuable contributions to the development of the use of electricity. Those listed are the ones whose contributions were of a fundamental or basic character.

At the head of the list stands Franklin, that many-sided genius whose ideas and influence were felt in so many other fields. The names of several other Americans will be noted in the list, especially Edison, the only man whose name has been listed in more than one period.

The great electrical discovery of the first period under consideration was the identity of lightning and electricity. This according to our definition marks the beginning of electrical engineering and the lightning rod was the earliest useful application of electrical knowledge. The second period saw the birth of electrio-chemistry as the

OUTLINE OF DEVELOPMENT OF ELECTRICAL ENGINEERING

Period	Leading Geniuses	Guiding Principles and Discoveries	Applications
1750-1785	Franklin	Identity of lightning and electricity BIRTH OF ELECTRICAL ENGINEERING	Lightning rod
1785-1820	Volta Davy	Identity of chemical affinity and electricity BIRTH OF ELECTROCHEMISTRY	Primary battery Electric arc
1820-1855	Oersted Ampere Ohm Weber Faraday Henry Morse	Unification of electricity and magnetism BIRTH OF ELECTRODYNAMICS	Electromagnets Wire telegraphy Direct current generators Direct current motors Direct current induction coils
1855-1890	Maxwell Kelvin Hertz Bell Tesla Edison	Identity of light and electricity Variable currents in conductors and dielectrics Electric Waves BIRTH OF RADIO MECHANICS	Alternating current generators Alternating current motors Transformers Cable telegraphy Incandescent lamp Power transmission Wire telephony
1890-1925	Thompson, J. J. Roentgen Millikan Edison Richardson Curie Marconi Fleming	Electron as carrier of electricity Reaction between electron and radiation BIRTH OF ELECTRONICS a. X-rays b. Thermionics c. Photoelectricity d. Piezoelectricity	Radio telegraph X ray tubes Vacuum tubes as illuminants Rectifying tubes Amplifying tubes Oscillator tubes Photoelectric cells Radio telephone Sound pictures Telephotography Television
1925-1960	Einstein Rutherford DeBroglie Schrodinger ? ?	Identity of matter, energy and radiation Unification of electricity and gravitation Dynamics of the universe New thermodynamics New lectrodynamics BIRTH OF PROTONICS a. Solution of the riddle of magnetism b. Transmutation of matter c. Conversion of matter into energy	? ? Perfection of television Transmission of telegraph messages and pictures to homes A thousand-fold multiplication of broadcasting channels through use of ultra short waves. Sound picture transmission from Central Sounds Record Library for home, school and theatre Extension of automatic control of manufacturing processes supervised by televison from a distance Electric power transmission by d. c. using inverters Discovery of new magnetic and dielectric materials which will reduce machines and appliances Electric power directly from sun rays Tapping of interatomic energy

result of the discovery that chemical affinity is an electrical force. The primary battery as a source of electric current and the electric arc as a source of light and of high temperature were practical application of electrical knowledge obtained during this period. The third period saw the birth of electro-dynamics through the unification of electricity and magnetism, and the discovery by Faraday and also by Henry of the principle of electro-magnetic induction. The applications of electricity for power and for communication are based on the principle of electro-magnetic induction. The identity of light and electricity was established during the fourth period. This led to the birth of radio mechanics and, after nearly a half century, to the applications of electricity in radio communication so familiar to all of the present day. The chief electrical discovery of the fifth period was the electron as a carrier of electricity. This led to the birth of electronics and the wide application of vacuum tubes for X-rays, and for many other purposes. The present or sixth period, which, according to this analysis began in 1925, has not yet progressed sufficiently in time for a very complete survey. But already we have in this period a new principle of enormous importance; namely, the identity of matter, energy and radiation. This, with the unification of electricity and gravitation and the new electro-dynamics and the new thermodynamics which will follow will lead to the birth of what we venture to call Protonics and to new applications which, from our present point of view, are no less than miraculous.

Perhaps the most important discoveries in the electrical field since the beginning of the electrical era as measured by the magnitude of practical applications which have been made, were those of Faraday regarding electro-magnetic induction. This work was done during the third of the periods shown. A commemoration exhibition and celebration was held in London last September to mark the one hundredth anniversary of Faraday's epoch-making experiments. Statisticians have attempted to compute the total wealth which has been created as the result of Faraday's work. The conclusion reached is that in a material way society has been changed more through the application of this principle than by any other idea which has come from man's mind.

Oersted had already shown that moving electricity gives a magnetic effect and Faraday believed that a reciprocal relation must hold between a magnetic field and an electrical effect. But it was several years before Faraday found just what the reciprocal relation was. In the meanwhile Henry, an American, was working with the same end in view. Henry also was successful and it may be that he discovered the principle of electro-magnetic induction at an earlier date than did Faraday. Faraday however published his results before Henry considered his experiments had been carried to the point which justified publication and so to Faraday the chief credit must be given.

During the fourth period under discussion Maxwell carried out one of the most remarkable mathematical investigations in history based on the discoveries of Oersted and Faraday. Maxwell came to the conclusion that light is an electro-magnetic phenomenon. He worked out the laws of electric radiation many years before anyone had experimental evidence that electric waves did as a matter of fact exist. Neither Maxwell nor any one else of his generation could possibly have dreamed that within a half century the world would have available the marvelous systems of radio communication which have been established during the last decade. Yet Maxwell's equations still are the basis of calculations of the radio engineer of today.

For a full half century Edison has been an outstanding figure in the electrical field. In the past his fame has perhaps been based more on his development of the incandescent lamp than on any other of his many achievements. It may be, however, that in the future his greatest contribution will be considered a discovery which he made in seeking the cause of a certain type of incandescent lamp failure which attracted his attention soon after he began the manufacture of incandescent lamps on a large scale. This phenomenon was called "The Edison Effect" and its remedy in incandescent lamps was readily provided. Neither Edison nor any other scientist at the time appreciated the marvelous possibilities of applications in the use of electricity which this phenomenon provided by opening the new field of thermionics. During the fifth of our periods the electron of J. J. Thompson led to a clearer understanding of the Edison effect and from it came the vacuum tubes which made possible the great improvements in our communication systems during the last fifteen years. Vacuum tubes are also finding wide application in electric power systems and their use has led to great changes in methods for conversion and control of electrical energy.

The photoelectric cell which came during the fifth period of our time classification has already led to many significant new applications of electricity. Sound pictures leading to the recent complete reorganization of the motion picture industry is an illustration of one practical application of the photoelectric cell. The transmission of pictures by wire is another well known recent development which the photoelectric cell has made possible. The photoelectric cell is also now used for the control of many automatic devices in industry. This cell makes possible television and we now have in operation a considerable number of television broadcasting stations. Television reception is possible at present over distances of many hundreds of miles but improvements in quality of pictures is necessary before television will be greatly used.

The useful applications of electricity have increased in a cumulative manner and the advance made during the last decade has been most remarkable, especially in the field of communication. This accelerated rate of growth may be explained by the ever increasing number of persons who work in the field of electrical engineering applying the basic or fundamental principles and also by the ever increasing number of basic or fundamental principles which are available for use. At present there is much less time lag than formerly between the announcement of a new principle and the utilization of the principle in practical applications. This is due to more prompt and complete dissemination of knowledge through scientific societies and publications and to greatly improved development and research laboratories.

The prospects of further advance in the use of electricity are bright indeed. The most rapid progress just at present is in the use of vacuum tube devices. It is impossible accurately to predict the developments in the electrical field which will take place during the next generation. However, there is every prospect that the recent discoveries regarding matter and electricity will lead the way to many new and important applications.

It may be possible to break matter into its ultimate constituents and make the energy liberated available for practical purposes. Thus, in the not distant future we may learn how to tap interatomic sources of energy and also how to get energy direct from the sun rays. Nature still holds many gifts of untold value to humanity. The future reviewer must, as we, count the lightning rod as the first practical application of electrical engineering, but he certainly will not count television as the last.

That Dispute Is Settled!

For a good many years there has been a dispute as to which building was the first skyscraper, that is, the first building which embodied skeleton construction throughout. The two chief claimants to the honor were the Home Insurance building and the Tacoma building, both built in Chicago between 1880 and 1890. With the razing of both these buildings within the last few years, an opportunity was offered to settle the dispute once and for all. It was found that both used skeleton construction in part, but that both in a few instances resorted to the old wall-bearing principles, but that the Home Insurance building by virtue of being three years older, had the better claim to the title, "The first skyscraper." An article on another page of this issue gives an account of the razing of the Home Insurance building.

On Engineering Training

Graduating engineers this year are going to be confronted with the familiar problem, "Shall I accept a job in a field other than engineering, if no job in engineering is available, or shall I hold out until I can locate something in my chosen profession?" Many of us, if we do find it necessary to take a job in some field apparently far removed from engineering, are going to have the feeling that we have wasted four years of time and money, and that our entire university career has been in vain.

A few years ago the Daily Illini contained an advertisement that read something as follows: "Wanted. A young man with some training in secretarial work. Answer with complete personal history, stating degrees. Engineering preferred." The advertiser was a well-known public utility company in the north part of the state. The attention of one of the more promising students was called to this ad by a member of the faculty, and the student got the job. He has since then had several advances in salary, and today is about ready to step into an executive position with real responsibility.

Here was a case where a cold-hearted corporation, realizing that the training given in engineering fitted men for responsibility in any field, deliberately chose an engineer for a job which was apparently a perfect opening for a commerce school graduate. We do not mean to belittle the commerce school, but we do mean to point out that engineering training is not narrow. A man who has the mental ability and training necessary to solve satisfactorily the problems that are encountered in the engineering profession has a tremendous head-start on graduates of other schools in almost any field. After all a man's success is dependent very little on the definite facts that he has accumulated during his university career, but is dependent a great deal on his training to gather together the facts pertaining to a particular problem, study them intelligently, and arrive at a logical conclusion. And the engineering training offered at Illinois is well suited to the acquiring of such an ability by students who occasionally make an effort to get a perspective view of the material that is being offered them.

Good Work

Members of the A. S. C. E. are to be commended for their action last month in suppressing the entrance of politics into their organization. The local chapter owes its position as the leading student branch in the country to the fact that its officers have always have been elected on their merits as indicated by past services, and that they have given perfect co-operation to the faculty men, who, after all, are to a large degree responsible for the high rank of the Illinois chapter. The issue was not personal. The very foundation on which the A. S. C. E. rests was at stake, and the members acted wisely when they decided to leave politics and its attendant evils to the leisurely gentlemen from the south campus, who have time for such pursuits.

In Next Month's Technograph

Richard W. Schmidt '22, assistant engineer for the sewer division of the city of St. Louis, Missouri, has prepared for the March Technograph a manuscript telling of the River Des Peres drainage project in St. Louis. The River Des Peres is a small stream which winds through both a part of the industrial section of St. Louis and through some of the finest residential and park districts. Frequent flood conditions, added to the fact that industrial and domestic wastes were being dumped into the river, made it imperative to improve the river. The project is a good practical example of the engineering method of collecting all available data, analyzing it, and determining from it the most economical structures that can be built.

R. H. Ford, assistant chief engineer of the Rock Island, who addressed the local chapter of the A. S. C. E. in January, is preparing a paper dealing with the condition of the railways. Several students who heard his speech last month have requested that the Technograph make the text available to them in written form.

Professor Espy of the mechanical engineering department will continue the vocational series with an article dealing with conditions as he sees them in his field of engineering. Joe Brumley '31, a graduate student, will explain the opportunities that are offered in the Illinois graduate school.

The Electrical Engineering Show

Immediately following the Easter vacation, which is not so long distant now, will come the big event in the life of the electrical engineering department—its biennial show.

The Illinois show has become the largest of its kind in the United States. Starting in a small way twenty-five years ago, the exposition gradually grew until at the last three or four shows exhibits have been attracted from all sections of the country, showing all the latest developments in the electrical field.

This year's show is to be presented under tremendous difficulties, with economic conditions as they are. It is to be hoped that the engineering student body, not only electricals, but civils, mechanicals, ceramics, and the rest, will give their full support to this activity which is thoroughly worth-while. An engineer owes it to himself to keep abreast of new developments not only in his special branch of his profession, but in all related branches, and the electrical engineering show offers a rich opportunity for a quick acquaintance with the recent discoveries in electricity and their applications.

Let's Broaden Out, Engineers!

One does not have even to leave the seat of higher learning to find out that most people have a rather distorted idea of the sort of person an engineer is. The popular conception of the engineer is that he is a wild-haired, unkempt sort of rough-neck, dressed in filthy corduroys or boots and breeches, with a slide rule in one hand and a handbook in the other, solving by means of these two mysterious tools all the problems that may come his way; that when he strays off the reservation allotted to his kind he walks around in a sort of haze, with no particular idea of what things are all about; and that when such names as Beethoven, Michael Angelo, or H. L. Mencken, or subjects connected with music, art, or the English language, are brought up, the poor engineer hurries back into his sanctuary of x's and y's and bending moments. This attitude towards the engineer can be sensed very readily at any university. There is quite a noticeable feeling on the part of the supposed liberal arts students that the engineer is a crude fellow with none but practical thoughts.

And it is quite possible that this sort of judgment of the engineer has been deserved to some extent. There have always been so many actual facts and fundamental theories that had to be learned that the average engineer has not had time at college to devote any thought to anything other than the actual material at hand. And when he left the scene of his higher education, he found himself in such keen competition with other men of equal ability that he spent all his spare time in further study of his profession. Furthermore, the position of the engineer in the professional and business world was such that it was probably sufficient that he know engineering and little else.

This situation can perhaps be attributed to the fact that the engineer in the past has been an engineer in the very narrowest sense of the word. He was, as stated above, a trained manipulator of slide-rules and formulas, with of course the understanding necessary to their proper use. He had few contacts with any parts of the construction of a particular project other than the actual engineering portion. Naturally he had no real necessity for taking up the study of any of the cultural pursuits, and since other matters were pressing on him, the former were neglected.

However, in the last few years, the status of the engineer has been undergoing a change. More and more of the work incidental to an engineering project is being given to him to solve. He is more directly concerned than before with the promotion of projects. He is called upon to make detailed studies of their feasibility. He is being asked to handle the financial end of the work. In brief, he is being consulted on every phase of the building of a piece of construction, from its conception to its completion.

The direct result of this enlargement of the field of engineering has been that the engineer has been coming into contact with other business men who do not possess his technical training. He is finding that he has to mix with them socially, and that occasionally a purely engineering education is not sufficient for his conversational needs. A general knowledge of cultural subjects is necessary for him in order that he keep up appearances.

Moreover, he is finding that he needs to have an intimate knowledge of the English language, both for purposes of speaking and writing. He is often in direct competition with men trained in speaking or writing, and it is no doubt true that many a capable engineer has been bested by a confident lawyer in competition for a contract that was to be let by a city council.

A thorough knowledge of economics and finance is becoming necessary. Psychology is becoming more important to the engineer as he leans more to the administrative side of his work.

Most of the arguments advanced so far have been concerned with the necessity for having some knowledge of cultural subjects in order to advance in the profession. However, there remains the fact that the development of a hobby of some sort plays a large part in the rounding out of a man's life, and the injection of happiness into it. The systematic gathering of training and knowledge of something not connected with his work is known to be extremely valuable to any man whose work is largely mental, and something in the line of music or books fills this requirement for the engineer.

The universities of this country are beginning to appreciate the necessity for training engineers in some matters other than technical. Almost every year they make more room for the insertion of non-technical electives into the engineer's schedule. And it is time for the engineer to realize that while his profession is a noble one, its requirements are widening, and that even with its widening it does not contain all the choice experiences of life. And that the best opportunities for meeting these increasing requirements are going to be found at the university.

Tau Beta Pi Essay.

ALUMNI NOTES

WESLEY D. (BUS) WILSON, c.e. '22, is now a supervising engineer in district one of the Illinois State Highway department with headquarters in the Courier-News building in Elgin. Bus and his wife, Dorothy Hollinger Wilson, class of '25, have one son, Richard, 2 years old.

ELWOOD B. (WOODIE) COLE, m.e. '17, has certainly risen since he waved goodby to Chambana. He is now the secretary of the newly created Illinois Aeronautic Commission, which regulates flying in the state. In addition to zooming through the blue in his new Stinson four-passenger cabin monoplane, his work covers the licensing

ELWOOD B. COLE '17

of all airports, beacons and flying schools as well as the regulation of flying. Cole was a member of the naval aviation unit during the World War, stationed at Great Lakes in 1917, and at Key West, Florida in 1918. His headquarters are now in Peoria.

KENNETH TALBOT, c.e. '09, attended the recent annual meeting of the Road Builders' Association held January 10 to 15 in Detroit. He accompanied Prof. H. F. Moore of the T. and A. M. department and Prof. J. S. Crandell of the department of civil engineering. Talbot is now with the National Equipment company with headquarters in Milwaukee.

The department of civil engineering recently received the gift of a Gurley transit from C. S. ELLS, formerly a member of the class of '83. Mr. Ells is now living in Heyworth, Illinois.

C. E. FORD, e.e. '31, is now with the Western Electric company in Chicago.

Members of the class of '79 will regret to hear of the death of WILLIAM ARTHUR BALCOM who was a member of their class for three years. He died October 15 in Denver.

Mr. Balcom had retired about a year ago as civil engineer for the Denver and Rio Grande Western Railroad after a service of 43 years.

EVERETT S. LEE, e.e. '13, was recently appointed chief engineer of the laboratory of the General Electric company at Schenectady, N. Y.

Lee succeeds L. T. Robinson, who died recently. Robinson's electrical engineering research work made him well known and the position tendered to Lee is therefore regarded as a high honor.

A. C. BRAUCHER, ex-'84, one of the five Braucher brothers who have attended the university, died November 24 at the old family home in Lincoln, Illinois.

Mr. Braucher was born November 28, 1859, in Logan county. He attended the Lincoln high school, and while a student in the school of civil engineering was a member of the band and of the Civil Engineering club.

He died from heart attack while working on the plat of a survey he was making for a large estate. He had been a drainage engineer for many years although previously he had been in mining engineering in Colorado and New Mexico, had run a machine shop, and was the inventor of a feed water heater, and a smoke-consuming devise.

ALBERT G. MANNS, '85, who graduated in chemistry, died November 16 in a hospital at Oconomowoc, Wisconsin, from injuries he received when struck by an automobile.

For the last 23 years he has been an industrial chemist. He was graduated from the School of Pharmacy of the University in Chicago in 1881. He then enrolled in chemistry at the University of Illinois and was graduated in 1885. He studied for several years at the University of Berlin and in 1888 received his Ph. D. there. From 1890 to 1893 he was professor of analytical chemistry and director of the chemical laboratory in the School of Pharmacy of the University of Illinois. He established the first chemical laboratory of Armour and Company, packers. His last position was as chief chemist for A. Trostel and Sons Company of Milwaukee.

FRED FOERSTERLING, e.e. '11, was drowned November 24 while duck hunting near Shreveport, Louisiana, when the boat in which he and his companions were riding capsized. While a student Foersterling was a member of Eta Kappa Nu, Onyx club and the E. E. Society. He was employed as sales manager for Kelvinator in Detroit at the time of his unfortunate death.

FREDERIC T. MAVIS, c.e. '22, is associate engineer in the Institute of Hydraulics Research and associate professor of mechanics, University of Iowa. He is also associate editor of "Architects' and Builders' Handbook" published by Wiley.

Harry Rubey, c.e. '05, is head of the department of civil engineering, University of Missouri. Harry prepares articles, occasionally, for technical journals and papers.

Fred G. Straub, ch.e. '20, is still doing special research work in chemical engineering. Last year he completed a six-year research which resulted in saving the power plant industry millions of dollars by discovering a treatment to prevent embrittlement in steam boilers.

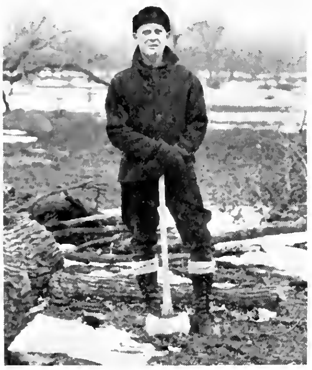
T. C. Epps, a.e. '23, has just completed 16 school projects in Springfield, Missouri, as construction superintendent for William B. Ittner, Inc., architects and engineers of St. Louis. He is now constructing an $800,000 high school in Pottsville, Illinois.

Emmons DeBarard, c.e. '31, is employed by Black and Veatch, consulting engineers, with offices in Kansas City. Deb lives with Dan Ketchum, c.e. '31, who is employed at the government engineers' office in Kansas City.

Don Johnstone, c.e. '31, recently made a trip to Cheyenne, Wyoming, in connection with his work with the U. S. Engineer office, Kansas City.

Denton H. Peoples, c.e. '31, is working as a detailer for the Missouri Valley Bridge and Iron Works in Leavenworth, Kansas.

William Lipscomb, c.e. '29, is a civil engineer with the Gulf Coast Lines of the Missouri Pacific Railroad. Bill says, "Louisiana, swamps, bayous, pretty French girls, Huey P. Long, lovely country."



Art Mann ex'14

Art Mann, '14, whose picture appears above used to be a lumber jack in the far north and although he is now in the more prosaic business of furniture manufacturing at Kankakee, Illinois, he still looks longingly back on the days he spent in the north woods. He can talk about them so convincingly that he is in great demand as a speaker at luncheon clubs. While a student in architecture from 1910 to 1914 he was captain of the gym team. At present he is the superintendent of the Kroehler Manufacturing Company, one of the largest manufacturers of furniture in the country.

Although William C. Rowden took civil engineering with the class of 1910 he prefers to follow farming as his occupation at Canton.

Prof. Ira W. Fiske, e. (?), formerly of the department of electrical engineering, and now a senior member of the firm of Fiske and Roberts, consulting engineers, has prepared a report for the New Jersey state commission on the merging of the railroads of southern New Jersey. The merging of these roads will eliminate a great number of grade crossings, improve suburban train service, and effect prospective saving of nearly $1,500,000.

H. A. Webber '97

H. A. Webber, arch '97, has accepted the position of secretary of his class, although he has been confined to his bed for several years with heart trouble. Mr. Webber retired from his profession which he has followed since his graduation. He was superintendent of construction on public buildings, U. S. Treasury Department for a great many years.

William Miller, c.e. '10, as a civil engineer for the sanitary district of Chicago, is the builder of the Crawford and Harlem avenue bridges.

Concrete Arch Studies

(Continued from Page 7)

center of the beam which bears upon a ¾-inch steel ball inserted in a steel plate embedded on the top of the loading shelf. The reinforced concrete loading platforms together with the suspension rods and beams constitute the design dead load. The design live load is obtained by putting upon each platform enough of the various concrete blocks to make the predetermined live load.

The suspension rods will be connected by means of laterals so as to form a tower stiff enough to carry the weight of the cross beams. To relieve the arch of all super-imposed load, the turnbuckles in the suspension rods will be turned so as to extend the rods, raising the cross beams so as to break the contact with the loading shelves. Zero-load readings will be taken with the loading platforms in this position. The dead load will be applied to the arch by turning the turnbuckles, thereby shortening the suspension and transferring the loads to the arch rib. In this process the various turnbuckles will be turned

(Continued on Page 23)

DEPARTMENTAL NOTES

Engineering Societies

Mu San, municipal and sanitary engineering fraternity, elected W. R. Fickett '32 president of the organization at a meeting held Thursday evening, January 14, at the Phi Mu Delta house. Prof. C. F. Hottes, head of the department of botany, spoke on "Redwood trees of California." The other officers elected are: R. S. Brown '32, vice-president; L. C. Pickett '32, secretary; and C. U. Kring '32, historian.

H. K. Madison '32 was elected president of Chi Epsilon, honorary civil engineering fraternity, at a meeting held Tuesday, January 19, in the Green Tea Pot restaurant. W. J. Bobisch '32 was elected vice-president; I. L. Wismiller '33, secretary; and Ben Paller '32, treasurer. In a talk, "United States Light House Service," Scott Dillon '32 told of his experiences in the engineering department of the Light House Service. I. L. Wissmiller '32 presented a paper on "The Development of Trigonometry."

An interesting program was presented at the regular meeting of the student branch of The American Institute of Electrical Engineers Wednesday, January 6. Papers were presented by students in the department for the prize offered by the Urbana section. R. D. Varma discussed the electrification of railroads in India. He gave an account of the latest and modern developments in that country. D. L. Pettit gave an outline of television theory and discussed problems confronting television engineers. B. Figlowski presented the subject of temperature measurement in electrical machinery. M. Deerhake gave an account of vacuum tube devices and their industrial appdications. Mr. Deerhake's paper was judged the best by the committee composed of members of the electrical engineering department.

On January 5 Robert H. Ford, assistant chief engineer for the Chicago, Rock Island and Pacific railroad, spoke before the student chapter of the American Society of Civil Engineers. His address was the second in a series of three dealing with modern transportation methods. He discussed the various phases of railway transportation and also the conflict between the railroads and waterways. The third speaker of this series not yet announced, will talk on motor transportation.

Franklin Thomas, vice-chairman of the Metropolitan Water district of Southern California, talked on the "Colorado River Aqueduct" at a meeting of the student chapter on January 12. This aqueduct is a supply line from a point below the Hoover dam to the cities in the region around Los Angeles.

Mr. Thomas is professor of civil engineering at the California Institute of Technology and is also a director of the American Society of Civil Engineers.

Officers for this semester were elected at this meeting. C. W. Ennis was elected president; J. R. Schuyler, vice-president; E. A. Greenlee, vice-president; M. H. Goedjen, secretary; and W. R. Fickett was re-elected treasurer.

Officers were elected for the coming semester at a meeting Friday, January 8. W. H. Bohn '32 was elected president; A. C. Hottes '32, vice-president; B. Paller '32, treasurer; J. H. Rickermann '33, recording secretary; and W. P. Jones '32, cataloguer and master of initiation. Several open meetings are planned for next semester, and it is hoped that some interesting and well known engineers will speak.

Sigma Tau, honorary engineering fraternity, held their annual dance at the Theta Upsilon Omega house January 8, 1932. Zackie Moore and his band from Decatur played, and a very enjoyable evening was had by everyone present. A regular dinner-meeting was held Wednesday, January 13 at the Alpha Kappa Lambda house.

Theta Tau, professional engineering fraternity, elected officers for the second semester at a meeting held at the Phi Kappa house, Thursday, January 21. A. C. Kowitz '32 was elected president; J. B. Tiffany '32, vice-president; S. Dillon '32, secretary; J. C. Wheeler '33, treasurer; and E. E. Stephens '33, corresponding secretary. The officers elected discussed plans for the second semester. Art Kowitz presented a report of the national Theta Tau convention held at the University of Arkansas during the Christmas vacation.

Pi Tau Sigma, honorary mechanical engineering fraternity, elected officers for the second semester at a meeting held Thursday, January 20, in the mechanical engineering laboratory. K. F. Eklund '32 was elected president; J. H. Rickermann '33, vice-president; R. E. Jones '33, corresponding secretary; A. C. Hottes '32, recording secretary; and W. E. Bohn '32, treasurer. No definite plans were made for activities during the second semester.

Architecture

Prof. James M. White, supervising architect for the university, and Prof. Loring H. Provine, head of the department of architecture, spent four busy days attending President Hoover's convention on home building and home ownership held in Washington, D. C., December 2-5. The purpose of the convention was to find ways and means for honest wage earners to earn their own homes. The scope of the discussions included methods of financing, methods of construction, suggestions for heating, plumbing, and other mechanical features and interior decorating. There were treated such questions as tenement housing in large cities, negro housing, and the sociological aspect of delinquency in large cities.

Exhibitions of student work from Lake Forrest were on display at the architectural building in December. Each year the university chooses from among the students two architects and two landscape architects to study at Lake Forrest during the summer.

Mechanical Engineering

Professor A. C. Willard attended the President's conference on home building and ownership, held in Washington, D. C., from December 2-5. Professor Willard is chairman of the subcommittee on heating, ventilation and air conditioning.

Professor A. C. Willard, Professor A. P. Kratz and Mr. S. Konzo also attended the annual convention of the National Warm Air Association held in Washington, D. C., December 2-4. Professor Willard presented a paper on future research on warm air heating at the University of Illinois. Prof. Kratz and Mr. Konzo discussed the results of investigations on warm air heating made at the University of Illinois.

Prof. H. R. Thomas and Prof. N. H. Roy have been in Gary, Indiana, inspecting the rolling of steel rails to be used in the investigation of transverse fissures in rails. Prof. Thomas will, in the near future, be in Birmingham, Alabama, and Pueblo, Colorado, inspecting the rolling of rails made in those cities for the rail investigation.

Prof. N. H. Roy has been investigating the bending of car axles during the past year. This investigation was carried on in conjunction with the Rapid Transit company of Chicago. The bending in the axles was measured by the changes in gage length between the flanges of the wheels. This was recorded on a continuous sheet by an automatic testing and recording device. To get a record it was only necessary to run the test car over the piece of track on which the test was desired. From the test results it was possible to pick out points along the track, such as frogs and switches, which caused excessive bending of the axles as well as to determine the bending stresses developed in the axles.

Theoretical and Applied Mechanics

Prof. M. L. Enger, head of the department, and A. N. Talbot, professor emeritus, attended the annual meeting of the American Society of Civil Engineers. The meeting was held in New York from January 17 to January 22.

Prof. Enger also attended a meeting of the sectional committee on cast iron pipe which was held in New York following the meeting of the A. S. C. E. Prof. Enger made a report to the committee on the results of tests made on cast iron pipe and fittings in the materials testing laboratory at the University of Illinois.

V. P. Jensen who was formerly in the T. and A. M. department at the University of Illinois is at present an instructor in theoretical and applied mechanics at Iowa State College at Ames, Iowa. Prof. H. J. Gilkey, who is head of the T. and A. M. department at Iowa State, was formerly in the same department at the University of Illinois.

Electrical Engineering

Prof. E. B. Paine and Prof. H. A. Brown, of the department of electrical engineering, conferred with patent attorneys in Chicago on January 15 concerning research on high voltage cables.

Waterways

(Continued from Page 11)

ing toward a general demoralization of prosperity. Multiply this case by thousands, and imagine what inequitable transportation costs have done to our great interior. Now if we can reverse this process, instead of driving our interior manufacturers to large cities where transportation is already saturated, thus increasing that saturation, but can offer through cheap inland water transportation opportunities for their location in our interior, we have greatly advanced towards the solution of the problem of not only restoring economic parity, but of bringing about a better distribution of population and distribution of wealth, and have offered to the people of the United States a better chance to earn a living wage through the sweat of their brow, or the genius of their brain, and have given aid to all forms of transportation through our ability to produce and our ability to buy.

I think we might predicate any further remarks along this line by the not-to-be-denied premise that the people of the United States, having been taxed in some form or another for the benefit of rail, water, motor and air transportation, are entitled to the best transportation possible at the cheapest possible rate. This promise inevitably leads to a discussion of what *is* the cheapest form of transportation, and on that subject there is as wide a divergence of opinion as there was between Germany and the allies. A natural corollary of this is whether the harm done to one system of transportation through the utilization of another, counter-balances the good done to a certain section.

As students of business administration you are doubtless interested in the relative costs of transportation by rail, water, and motor. The lowest operating expenses I have ever seen quoted by the railroads are 8.8 mills per ton mile, and they average, I assume, around one cent per ton mile.

Taking into consideration all charges our opponents may want us to assume, even a tax exemption based on railroad taxes and not on waterways, we arrive at a cost which is not there, but might be there, of 5.5 mills per ton mile for water transportation, as against the 10.04 mills per ton mile our opponents claim, and of the one cent per ton mile average railroad operating cost.

Those figures are furnished, not as counter propaganda against the opponents of waterway development, but as evidence which can be verified by any honest student. And it may be remarked that the waterways are carrying only a fraction of their capacity, and on incomplete rivers. It is self-evident that with increasing tonnage, increased navigational facilities, all of these costs will be reduced.

I am frank to say that I do not know much of the relative merits of truck and rail competition.

As I visualize the future, however, I see a vast co-ordinated system of rail, water, motor transportation, each fulfilling the function for which it is best suited, offering, through such co-ordinated effort, a cheaper and a better system of transportation, the costs of which bear a reasonable relation to the cost of service performed; which will consequently result in a reasonable return to the agency performing the service.

The First Skyscraper

(Continued from Page 9)

scraper should be dismissed for the reason that he never erected a building embodying his patent (issued after the erection of the Home Insurance building), that his infringement suits were decided in court against him, and that he, himself, stated that his idea of an iron skeleton was suggested by the writings of Viollet le duc, in which case Violett le duc would have as good or better claim than Buffington.

Tacoma Building Architecturally Pleasing

The other claim for first honors is that of the Tacoma building. The claim usually takes the form of the first "complete" skeleton skyscraper in which the metal skeleton was "completely" developed. This building was built three years after the Home Insurance building. The Tacoma building introduced many important improvements over the construction of the Home Insurance building and that it marked an advance in the science of skyscraper design, there can be no doubt. The most important of these improvements was a continuation of the skeleton on the street fronts from grade to roof line. The next of importance was a direct support of the masonry piers by cast iron angle brackets, a feature, as stated, lacking in the Home Insurance building except in the corner columns on the street fronts. The use of terra cotta for lintels, etc., in order to lighten the load was a further improvement. In the aesthetic appreciation of the problem, the expression of its construction by its architecture, it was far ahead of its time. In fact it is a question if it has ever been excelled even to this day in this consideration. Nevertheless, the Tacoma building still made use of cast iron for columns and all shapes other than the beams and girders, which were of wrought iron.

It also had solid masonry lot line walls, court and alley walls which could have been made skeleton construction and in our opinion showed a retrograde step in the introduction of the transverse masonry walls which assumed a very large portion of the floor loads; whereas the interior of the Home Insurance building was entirely free from self supporting masonry. The use of solid masonry party walls were obligatory under the Chicago building laws in 1885 and 1887 so it is manifestly unjust to condemn their presence in the Home Insurance building. The Tacoma building, however, was not so bound when it elected to use lot line instead of party walls. Probably the first of all complete skeleton skyscrapers in Chicago was not built until 1899 when the Manhattan building, Jenny and Mundie, architects, was constructed, all the enclosing walls being made of skeleton construction.

As in the case of every great invention skeleton construction in its completeness was not nor could it have been discovered by any one man nor expressed in any one building. The early buildings are for this reason all more or less transitional and experimental. Each learned from the experience of the preceding and added its contribution in the development of the idea. It is, however, entirely possible from a consideration of the evidence to appraise the relative importance of each in terms of its originality and its influence on the work which followed. Acting on this conviction, we have no hesitation in stating that the Home Insurance building was the first high building to utilize as the basic principle of its design the method known as skeleton construction, and that there is convincing evidence that Major Jenny is solving the particular problems of light and loads appearing in this building, discovered the true application of skeleton construction to the building of high structures, and invented and here utilized for the first time its special forms.

Electrical Engineering Show

(Continued from Page 5)

the television exhibit. In keeping with the policy of the show it represented the latest development in radio transmission of images. Part of the apparatus used was loaned by a Chicago television manufacturing company and had been exhibited before huge crowds at shows in Chicago and New York City.

The set-up consisted of a transmitting booth from which the images of the artists were converted into electrical impulses by means of a scanning disc, photo electric cell, and a transmitter. The image was received on two television receiving sets, one giving a small picture and the other projecting the image on a screen about 18 or 20 inches square. The observers were able to view the transmitted image and the artist at the same instant.

Another feature attraction at this show was an application of the photo electric cell invented by Dr. Kunz of the physics department. Sound was transmitted through a 100-foot tunnel by a beam of light. The beam was modulated at the transmitting end by a mechanical shutter operated from the amplified signal of a phonograph pickup or an ordinary broadcast microphone. At the receiving end a photo electric cell reacted to the varied intensity of light from the source and produced electrical impulses which were converted back into a sound by a radio amplifier.

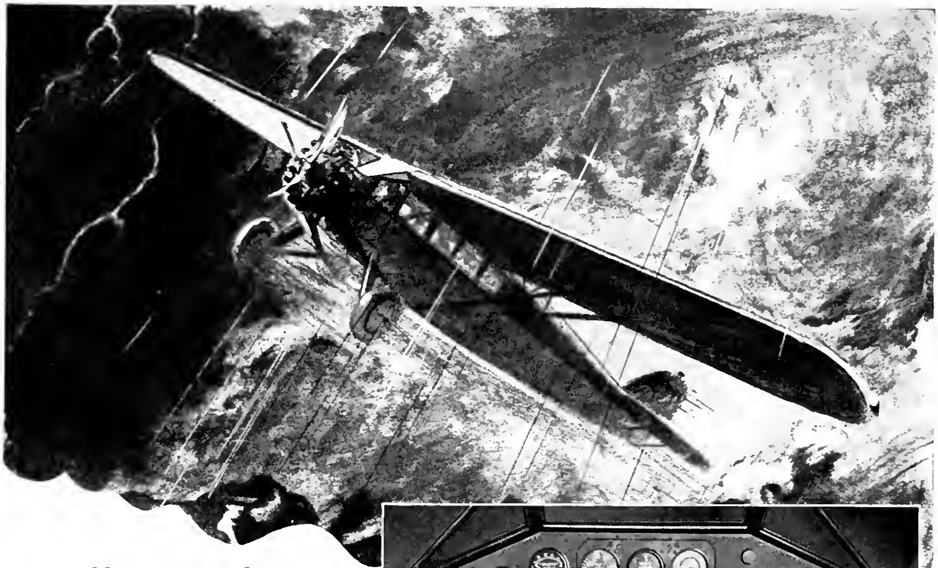
A demonstration of talking pictures attracted considerable attention at the 1930 show. A standard projection machine was equipped with each of the two means of producing sound pictures, the synchronous disc and the sound band on the film using the photo electric cell. This modern equipment contrasted with the first known exhibit of talking pictures presented before the 1922 electrical show when Professor Tykociner demonstrated the results of his research with talking movies at that time.

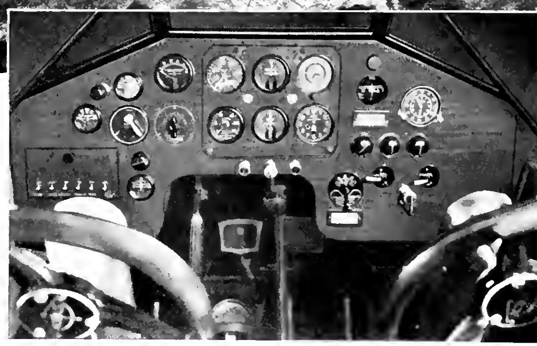
There were many other exhibits at this last show which will be vividly recalled by those who attended. There was the miniature electric railway operated by 150 relays from a central control board, the locomotive operated by simply speaking into a microphone provided for the purpose, the electrodeless discharge which Dr. C. T. Knipp of the physics department has developed for the 1933 world's fair in Chicago, the thermin box, the singing and talking arc, the bucking bronco, a motor which continues to reverse direction, the everflowing wine bottle, the talking skull, the traveling electric sign, and many other features too numerous to mention.

Plans for an electrical show this spring were begun early last fall with the selection of R. L. Dowell as manager of the thirteenth biennial show. With this forboding number and the cries of financial depression everywhere, he and his staff have begun the tremendous task of presenting a show which after 25 years of existence has become the greatest student electrical exhibit in the country.

The stunts and exhibits which have been so popular in previous shows will be presented again this year and in addition many new student stunts are being arranged. Television equipment far superior to that used in the last show will be used to demonstrate the marvels of transmitting images. Other novel applications of vacuum tubes, the outstanding development in the electrical field at present, will be the features of the 1932 show.

The exhibition will be staged the week-end following the spring recess, March 31, April 1 and 2 in the electrical engineering laboratory and the gym annex.





"EYES" THAT GUIDE AIRCRAFT

SPEED with safety and dependability is the essence of airplane service. To-day's ship is safer in fog and darkness. Its "eyes" are in its instruments, and the equipment of a new monoplane recently purchased by General Electric is unique in that the instrument panel is almost completely electrified.

The ship is equipped with many electric devices: automatic steering, radio apparatus for communication and contact with directional radio range beacons, and a sonic altimeter to give accurate indication of height above the ground, regardless of visibility. The 300-horsepower engine is equipped with a G-E supercharger.

Other General Electric apparatus on the ship includes an electric engine-temperature indicator and a selector switch, a magneto compass, a card compass, a drift indicator, a turn indicator, a tachometer, an oil-temperature indicator, an oil-pressure indicator, a voltammeter, control pulleys, landing lights, and an oil immersion heater.

These developments in air transportation were largely the accomplishments of college-trained engineers who received preliminary experience in the Company's Testing Department. Hundreds of college graduates join the ranks through this department, which trains them for electrical leadership on land, on sea, and in the air.

95-925DH

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

On the new brakeman's first run there was a very steep grade. The engineer always had trouble getting up this grade, but this time he came nearer sticking than ever before. Eventually he did make it to the top. Looking out of his cab he saw the new brakeman and shouted with a sigh of relief, "We sure had a hard time getting up, didn't we?"

"We sure did," assented the brakeman, "and if I hadn't put on the brakes we'd have slipped back sure."

* * *

Commerce Stude: "Due to the press of scholastic activities this week I'm finding it rather difficult to get in my usual amount of recreation."

C. E.: "Hell, man, what I'm trying to get is sleep."

* * *

Intimate Glimpse of Most Any Senior in C. E. 10a Last Month

*

"This is certainly a nice plant," exclaimed the M. E. as he left the Frigidaire factory.

* * *

"This is a concrete example of a bone head," chortled the doctor as he held up the cement cast of a skull.

* * *

Prof. Crandell: "What makes the tower of Pisa lean?"

Bud Wingfield: "It was built during a famine."

Dumb Aggy

And then there was the Aggy who thought the rhumba was a kind of geometrical figure.

* * *

Only Fifteen Minutes a Day

If all backward engineering students are like some we have met, the following list of facts should prove helpful:

Two and two are four.

The name of the institution which you are attending is the University of Illinois.

The automobile is here to stay.

A horse is a kind of animal.

The current calendar year is numbered 1932.

A boy's best friend is his mother.

Interested persons can secure further information of this type by applying at the Technograph office.

* * *

They have football games at Sing Sing, musical comedies at Auburn prison, and college courses at Minnesota State penitentiary. Apparently an attempt is being made to draw the better class of people. —*Life.*

* * *

He made a run around the end,
Was tackled from the rear,
The right guard sat upon his neck,
The fullback on his ear.
The center sat upon his back,
The ends upon his chest,
The quarter and a halfback then
Sat down on him to rest,
The left guard sat upon his head,
Two tackles on his face,
The coroner was then called in
To sit upon his case. —*Beanpot.*

* * *

"What," asks a sob writer, "will be colder this winter than a home without a fire?"

How about Gandhi in a rumble seat? —*Life.*

* * *

Doctor: "This is a very sad case, very sad indeed. I much regret to tell you that your wife's mind is gone—completely gone."

Mr. Peck: "I'm not at all surprised, doctor. She's been giving me a piece of it every day for fifteen years." —*New Haven Register.*

* * *

Texas reports the largest pumpkin, weight 127 pounds. The man who wanted to throw an egg at an electric fan would enjoy rolling this pumpkin off New York City's Empire State building. —*Life.*

Concrete Arch Studies

(Continued from Page 17)

successively a small amount, thereby bringing the load on all loading shelves simultaneously.

Each abutment is supported on two weighing tables, as shown in the plans, and is transmitted from the abutment to the weighing table by means of jacks. The contact between the abutment and the jacks is through knife-edges embedded in the abutment. This fixes accurately the point of application of the vertical force that is weighed by each weighing table. The horizontal thrust is transmitted to the horizontal weighing table by means of the link shown in the figure. The contact between the link and the abutment is by means of a knife-edge embedded in the abutment, thus fixing accurately the line of action of the horizontal component. This link will be maintained in a horizontal position throughout the test. A sensitive level bubble will be attached to each abutment and adjusted so as to be in mid-position before the arch is loaded.

In the test with fixed abutments, if the abutment rotates due to the application of a load or other cause, the abutment will be rotated back to its original position as indicated by the bubble, by manipulating the jacks on the vertical weighing tables. In the test with predetermined rotation, readings will be taken with a portable level bar before the arch is loaded. After the arch has been loaded, readings will again be taken to determine the magnitude of the rotation produced by the application of the loads.

The length of the span of the arch will be controlled by means of a ½-inch steel rod rigidly connected to one abutment at one end and carrying an Ames dial at the other end, which is in contact with a prepared point embedded in the other abutment.

In the case of a test in which the abutments are fixed, the span will be brought back to the original value after the application of a load, by turning the link connecting the abutment with the horizontal weighing table. In the case of a test in which the span of the arch changes, the link will be manipulated so as to produce the predetermined change in the span as indicated by the Ames dial.

The vertical deflection of points on the arch rib will be determined by means of hook gages attached to rods embedded in the rib at points directly under the loading shelf. A pipe will extend from one abutment to the other and will have fittings so arranged and so located that a vertical glass tube about 1½-inch in diameter and 6 inches high will come directly beneath each load point. The gage, consisting of a hook attached to an inside micrometer caliper and constructed so that it can be readily attached and detached to each of the vertical rods, will be used to measure the distance from the end of the rod to the surface of the water inside of the glass tube. Because all of the glass tubes are connected to the pipe extending from abutment to abutment, the water surface will be at the same level throughout. Noting the change in level of each point on the arch with respect to the springing of the arch gives the deflection of the rib at the various points. The apparatus will also be used to determine changes in level of one abutment relative to the other.

The deformation of the concrete at the intrados and the extrados will be obtained from readings of an 8-inch

Berry strain gage taken on steel plugs embedded in the concrete, two gage lines being provided on the intrados and two on the extrados at sections midway between each pair of adjacent load points.

The following tests will be made on the single-span rib in the order that they are listed:

1. Determination of abutment reactions and position of thrust line of dead load.

2. Determination of the influence diagrams for abutment reactions by applying a unit load successively at the various load points and weighing the resulting abutment reactions.

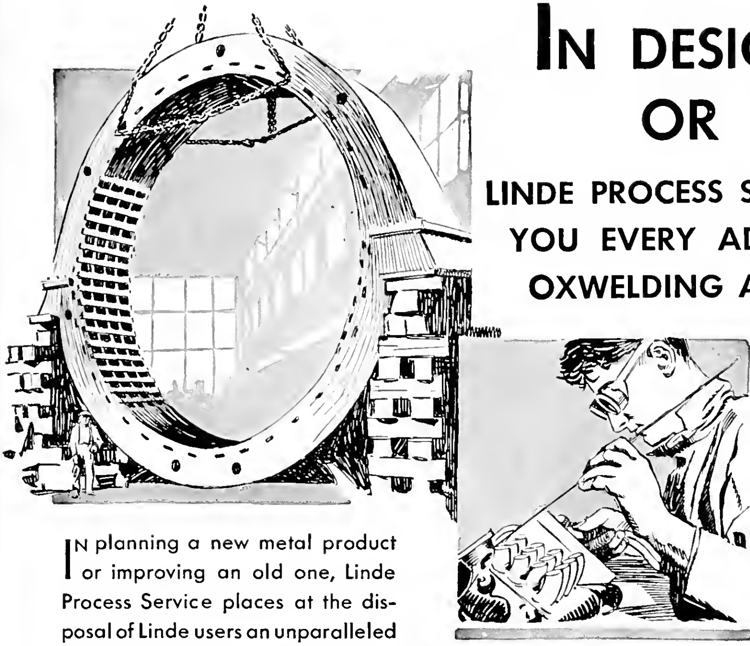
3. Determination of influence diagrams for the abutment reactions by giving one abutment predetermined movements, successively, of rotations, horizontal translation, and vertical translation, the other abutment being fixed, and measuring the accompanying vertical movement of arch rib at the various load points.

4. Determination of the relation between abutment movements and abutment reactions.

5. Determination of the load-carrying capacity of the arch rib.

The load-carrying capacity of the arch rib will be determined by adding loads to the loading platforms until failure occurs. The abutments will remain fixed for this test or, more practically speaking, since some movement will occur when the arch is loaded, the load will be applied in small increments and the abutments will be returned to their original position after each increment. Before beginning the test the suspension rods will be extended so that the loading platforms will rest upon the laboratory floor and the cross beams will be free from the loading shelves. The jacks on the weighing tables will be adjusted so that the level bubbles on the abutments will be in their mid-position and so that the two abutments will be on the same level. The links connecting the abutments with the horizontal weighing tables will be adjusted so as to make the span of the arch the same as it was originally. A complete set of readings will then be taken, including span length, all scale readings, strain gage readings on nine sections, and transit readings to determine the lateral position of the crown relative to the abutments, and readings of the hook gage to determine the elevation of each loading point with respect to the abutments. The suspension rods will then be adjusted so as to transfer the dead load from the floor to the arch rib.

After the dead load has been transferred to the rib a complete set of readings as enumerated above will again be taken. The arch will then be subjected to the design live load, this distribution being the one that will produce a maximum compression in the extrados at the section at the west springing. This increment of live load will be designated as "a live load." The abutments will be returned to their original position after the application of one live load by manipulating the jacks and the links connecting the abutments with the horizontal weighing tables. A complete set of readings will then be taken as enumerated above. After completing this set of readings, a second, a third, and a fourth live load will be applied and a complete set of readings will be taken after the application of each. Because the arch will probably fail at or slightly under five live loads, additional increments, after four live loads have been applied will be considerably less than "live load," the exact proportion of a live load constituting an increment depending upon the appearance of the structure as the test progresses. The object will be to have the total live load at failure distributed among the panel points in the same proportion as the one live load is distributed.



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THE TECHNOGRAPH

UNIVERSITY of ILLINOIS

MARCH 1952

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

THE TECHNOGRAPH

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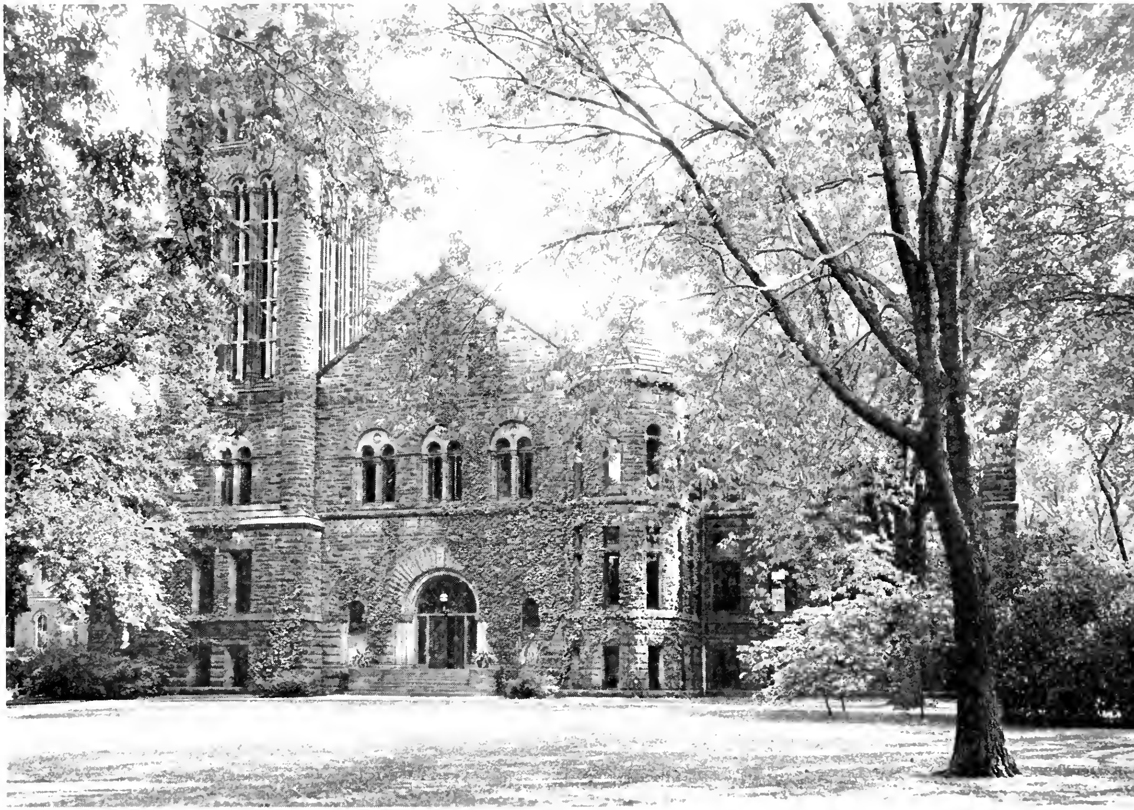

Alumni and undergraduates will all recognize this familiar view of the law building, one of the most beautiful on the Illinois campus

THE TECHNOGRAPH

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The River Des Peres Drainage Project of St. Louis

RICHARD W. SCHMIDT '22

THE River Des Peres sewer of St. Louis has been called the largest sewer in the world. Strictly speaking, however, a sewer is commonly defined as a closed conduit for carrying off domestic wastes. In that sense the River Des Peres is possibly not the largest sewer in the world, for only a small portion of the total discharge is foul water drainage. In its full sense the sewer is a drainage project. The open channel and closed sections actually carry the total flow of a river and its several branches, as well as foul water flow. The municipality has attempted, not as in New York City to bury a tube in a river, but to bury a river in a tube.

In 1876 St. Louis pushed its boundaries out to its present city limits. It included the stream called River Des Peres, meaning River of the Fathers, and so named by French Jesuit missionaries who established themselves at its headwaters near Florissent, Missouri, in 1817. It was not a large stream. Even now its dry weather flow is inconsiderable. However, at flood stage its small capacity was unable to carry the flow, with the result that the ostensibly quiet stream went on a rampage, leaving its banks and causing considerable damage. It is calculated that at the point in northeast St. Louis where the stream enters the city the flow approximates 9,500 sec. ft. This amount is increased in the stream's thirteen-mile trip around the city by various creeks such as Deer creek, Wherry creek, and Rock creek, until at the Mississippi river into which it empties at the extreme southeast end of the city it is discharging at the rate of 43,500 cubic feet per second. It is a sizeable stream requiring careful consideration.

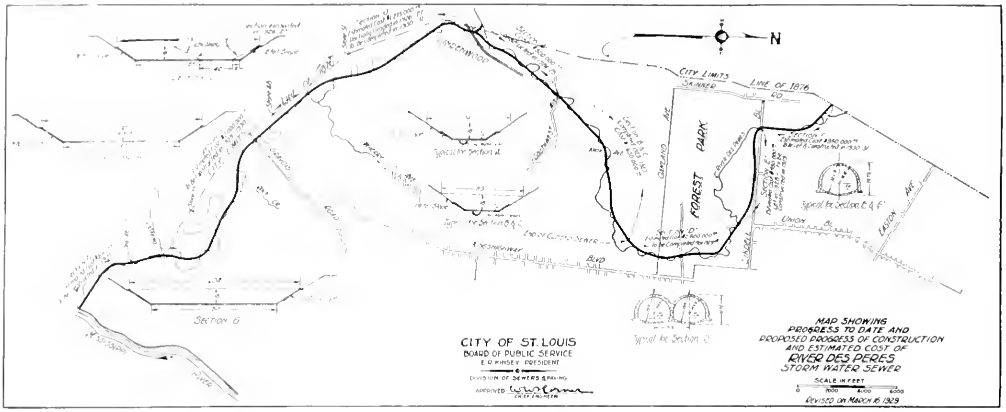
The watershed of the River Des Peres is something in the neighborhood of 110 square miles or, roughly, 70,000 acres. Virtually all of this area a half century or more ago was native forest. There were but few clearings and but little agricultural development. The stream at that time and because of the character of the valley may not have had the volume of discharge that it has today. It is safe to say it did not. We know of course that the stream was a clear, clean stream and that no very great inconvenience or damage resulted from its flood flow.

The city's populace moved westward with the opening of industrial sites, improvement of existing highways, extension of tramways, the construction of higher type pavement, and the general use of the automobile. Northwest St. Louis along the incoming railroads attracted manufactories and the small home builders. Adjoining Forest Park large private sub-divisions were developed for high class residence purposes. Along Manchester avenue, a transcontinental highway, and parallel to which run the Missouri-Pacific and St. Louis-San Francisco railroad, the steel industries, the lead companies, and the clay products producers located, bringing with them the small home owner. To the southwest and south development was slow. For the last forty years almost the entire expansion of the city has taken place in the valley of the River Des Peres.

The story of what happened to the once clear and clean stream is one that has its parallel in almost every growing city. Had St. Louis foreseen the types and extent of development that was to take place in the valley it could have by ordinance and comparatively small costs preserved the stream and a considerable portion of the surrounding lowland for park purposes, and in that manner with suitable engineering control utilized it for storm water flow.[1] But St. Louis' civic interests lay in the more populous sections of the city. And perhaps rightly so, for it was only twenty years before the River Des Peres valley was annexed to the city that St. Louis laid its first public sewer. The sewer was occasioned by an infectious epidemic which almost amounted to a plague, the cause of which was laid directly to unsanitary conditions. The needed sanitary development for this stricken area left Des Peres valley to grow up much as "Topsy." There was no concerted action in its development. Many of the small home owners could not afford expensive sewers and were not so minded. The industrial sections developed their own facilities and like the large real estate promoters often went the length of straightening out the river channel. In this way the stream that was once clear and clean became an uncontrolled and common dumping ground for industrial and domestic wastes.

It was soon apparent that St. Louis was encouraging a growing menace to health and convenience. A law suit in 1905 forcibly brought the matter to the municipality's attention when the plaintiff alleged that permitted encroachments on the river and increased run-off due to development without provision for control constituted a liability for damages. The construction of four large intercepting sewers followed rapidly in succession. Only one of these can be said to have been contemplated as part of a permanent plan. This was the construction of

[1] W. W. Horner, *City Beautiful*, December, 1930



six miles of the River Des Peres foul water sewer from Lindenwood to the Mississippi river which was completed in 1913. The others were temporary make-shifts to rid the River Des Peres of foul water that by now had turned the stream into an offensive nuisance.

Simultaneous with construction of the foul water intercepting sewers the city started investigations leading up to flood control. High water marks were taken in 1897. In 1905 the first reliable data was obtained. Later, in 1910, the city purchased and installed a number of water level gages. Automatic rain gages and gages for weir readings were located in selected sections of the city. In this manner data were collected from which rainfall curves could be plotted and a study made of the relation of rainfall to runoff.

The storm of 1915 is a milestone in the rainfall annals of St. Louis. This was a particularly violent storm coming as it did on the tail end of a gulf hurricane. While the intensity was not excessive (about four inches per hour) the duration exceeded anything the city had previously recorded.[2] The River Des Peres left its banks entirely and flooded the valley in every direction. Lives were lost and the damage to property was the greatest ever experienced. It did, however, supply the much needed data required for proper design against such flood repetition. Current-meter readings and high water levels were carefully observed at various places along the stream.[3] With this much needed information rainfall curves were revised and the rational theory of design adapted. In 1916 a comprehensive report was submitted to the president of the department of streets and sewers, and approved by him.[4]

View of the River Des Peres during dry weather. Clearing of trees and underbrush on the right-of-way has been started, but the stream bed is in its natural condition.

There was left to consider the manner in which the adopted plan should be financed. The estimated cost in 1916 for the improvement was six million dollars. The drainage area of the River Des Peres valley consists of some 70,000 acres of which but 16,000 lay within the city limits. The remainder extends out into the county and beyond the municipality's jurisdiction. If the benefit assessment method of financing were used, the burden of paying for the improvement would have to fall entirely upon the 16,000 acres within the city.[5] Obtainment of consent by the benefited area in the county to participate in assessments seemed impossible in the light of previous experience. Nor was the entire 16,000 acres able to bear the cost. In many instances the benefit assessment was double the assessed valuation of the property and therefore confiscatory in its nature. In view of the fact that the municipality had aided little in the sanitary development of the valley and by proportion much more in other sections of the city, it was decided that the accrued benefits belonged to the entire city and that the cost of the improvement should be spread by bond issue.

The year 1916 and the period of our participation in the war did not seem to be a proper time to float a bond issue. After 1918 prices of labor and materials were higher and it was necessary to re-estimate construction costs. In 1923 St. Louis passed an $87,000,000 bond issue in which was included an item of $11,000,000 for the River Des Peres improvement. During the intervening years since the 1916 report of W. W. Horner, who was then, as now, Chief Engineer of Streets and Sewers, only slight changes in the original plans were made. Thus, the passing of the bond issue found the department prepared and ready to start construction at once. A contract for section "A," River Des Peres was let and construction started in March, 1924.

Digressing for a moment, it is interesting to consider

[2] W. W. Horner, *Engineering News*, October 14, 1915.
[3] *Ibid*, September, 1915.
[4] *1915 Annual Report*, Department of Streets and Sewers.
[5] Note: Missouri law allows for the forming of a sanitary district where the watershed is included in more than one political jurisdiction, provided, there is mutual consent to form such a district. 1927 Mo. Supp. Art. III A Sec. 9502a.

some of the factors that enter into a comprehensive and economical design. Alignment is always of prime importance in flood control. By cutting through the bends and straightening out the river channel there is in many cases an economic saving. By shortening the river channel, friction losses are reduced and capacity is increased. If capacity were a fixed quantity, then the straightened channel would require less cross sectional area, which again may work for economy. However, there are limits beyond which there would be no saving.

Looking at the key map (Fig. 1) it is apparent that except for some minor straightening the new alignment follows the old stream bed quite generally. In other words, the new alignment follows the natural drainage course. During preliminary design, at one time, a tunnel was considered to eliminate the loop eastward from a point where the river enters Forest Park at Lindell boulevard. The tunnel was to meet the river again at a point near Knox avenue. This seemed obviously to be a wise plan. It would shorten the river and remove once and for all the obnoxious nuisance which threatened to destroy attractiveness in the park. Adoption of the plan, however, required the extension of existing sewers draining districts to the northeast, southeast, and south. The combined capacity of these sewers was equal almost to that of the proposed tunnel, and the extension would be against grade. Also, the small difference in natural elevation required these extensions to be almost as large as the main stem. Preliminary estimates proved that the tunnel plan, including extension of the existing sewers, would cost $700,000 more than the adopted plan of following the natural drainage course and, therefore, was economically unsound.[6]

The adopted alignment, nevertheless, included numerous instances where straightening was necessary and in keeping with good hydraulic principles. In most of these cases straightening was in the flood bottoms where ex-

A view of section H flowing partially full. Notice the sewer outlet into the channel

cavations would not be excessive. South of Lindenwood the alignment necessarily followed closely that of the River Des Peres foul water sewer, which as mentioned before was complete to the Mississippi river and a contemplated part of the system.

Another matter of economic design is the selection of types of structures best suited to the purpose. The engineer with his mind on the future would like to design for the maximum, whatever that may be, but it is the generation of today that usually pays for the project and he must bear that in mind. Should he want to design for a maximum storm the probability of which would not occur more than once in a hundred years the cost of such a sewer might be prohibitive as compared with one designed for a twenty-five year maximum rain. Again, his professional judgment might decree a separate sewer system (foul water enclosed and storm water in open channel), or a combined sewer enclosed through highly desirable property, with open channel in districts more diversified in development. Whatever the plan decided upon, the engineer must design adequately to fulfill the requirements of the present and future while costs must be kept within present ability to pay.

Construction of the 32-foot arch in front of the Jefferson memorial in Forest park at De Baliviere avenue

Looking again at the key map (Fig. 1) it will be seen that section "F" is designed for a closed conduit. Most of this sewer runs through a highly developed and valuable residential district. A portion of the stream was straightened years ago by private enterprise and confined to what should really be a public street leading into Forest Park. A veritable gorge separates this beautiful district into two parts and is unsightly and dangerous. Unquestionably, burying the existing open air sewer in a closed conduit is justifiable here. Section "F" is now under construction and nearing completion. It is expected that in the near future Des Peres boulevard will be constructed over the sewer.

Through Forest Park sections "E" and "D" were continued as closed sewers. The reason for this was mainly aesthetic. A combination of open channel for flood water and closed sewer for foul water was entirely feasible. However, the large area required for open channel would have meant a ruthless destruction of some of the finest features of this natural park. Even after construction it would have remained a detriment to the appearance and utility of the park. Conscious of the fact that public satisfaction is desirable, the closed conduit was continued through the park. In addition the alignment was shifted away from the existing river channel and located so as to follow closely the northern and eastern boundaries of the park. Construction of these sections was completed in 1928 and 1929. Where once the stream at flood level swept the stage of the municipal theatre, carrying away the scenery, and the fiddle boxes from the orchestra pit, there are now only beautiful lagoons. Excess excavation from the sewer trench was used to partially fill in the old stream bed.

South of Forest Park sections "B," "C," and "F"

(*Continued on Page 11*)

[6] W. W. Horner, 1916 Annual Report, Department of Streets and Sewers.

Mechanical Engineering—Field For Man or Robot?

W. N. Espy
Assistant Professor of Mechanical Engineering

This is the fourth and last of a series of vocational articles presented in the Technograph this year. Lack of space in the remaining issues makes it necessary to end the series this month. The Technograph hopes that this and the preceding articles may have been of value to the readers by offering them a bird's-eye view of several of the larger branches of the engineering profession.—Editor's Note.

(Cut by courtesy of *Mechanical Engineering*)

"NO OTHER profession has gone so far in the attainment of its goal and none has ever been so roundly abused for its success in doing this," is a statement made by Professor Elliot D. Smith in a recent address to the A. S. M. E., and one worth considering. The engineer does not need to justify his existence with words. When, however, will he become articulate enough to convince his dilettante critics that he is to be reckoned with outside his workshop or laboratory? That time will come when the engineer will take the trouble to organize his knowledge of the history of his field, that state of the art today, and boldly state by action and word his sincere and enthusiastic faith in its future. We could easily drum up an interest in mechanical engineering if we could go to an oracle and find out how far we are from the mechanical Utopia when all labor will be done by robots, operated of course by vacuum tubes, who are controlled by high powered executives seated at concentrated ease in sound-proofed, dustless, humidified, fatigueless rooms. These executives as universal dictators could by mere motion of the eyebrow control production so that it would always be "geared exactly to consumption" with continuous prosperity as an automatic result. These executives would necessarily have to be mechanical engineers, with a few electrical engineers as control room operators. No such oracle exists, however. These days it would be discredited if it really did. Seriously we wish only to suggest that mechanical engineering has an honorable and interesting history, a fascinating today, and a future worth one's best efforts.

"Mechanical engineering underlies all engineering—In these leading departments of industry which, at first thought, the public would deem quite outside of mechanical engineering, how completely is this art incorporated with their every detail."

This statement is not the screaming cry of the heckler who is trying to state the worth of his profession to a mob, but the studied expression of Alexander L. Holley, a great engineer, and one of the founders of the American Society of Mechanical Engineers, made in 1880 at the first meeting of the society. It is a statement made, not only without boasting, but also without false humility. Mr. Holley recognized fully that engineering and human endeavors are mutually inseparable.

It seems strange that industry, which has so accepted the machine, has been so long in coming to its present tendency to recognize the unique value to it of the mechanical engineer and to employ his services freely. In spite of all present criticism of the machine age, the world has accepted power and its tool, the machine, as a liberator from human slavery. We are, therefore, only concerned about the rate of introduction of the machine as it affects human relationships, and not the fact of its introduction. The true engineer always studies that affect before he suggests it. Once convinced of its ultimate value to our whole society, with true courage he introduces the machine and lives with it until its value is apparent to even the layman. Who can humanly condemn him if at times he is exasperated and swears at the barkings of those who do not understood the machine, its purpose, or its real value. While there is no limit to the possibility of the adaptation of a machine to the performance of any process performed by man or animal, there is a very definite economic reason for using it only when it performs the process better, quicker and cheaper. If there is no limit to the possibility of the production of power and the machine, there can be no limit to the demand for the mechanical engineer so long as he renders a worth-while service to society in creating and controlling both. The young man who, with proven talents for mechanical engineering, is steered away from it by the dismal cries of the inadequately informed "humanist" really hasn't the courage required by the profession.

Mr. Ray V. Wright in his presidential address suggests certain desirable qualities for engineers. He says:

"We need militant engineers—aggressive and constructive—who will enthusiastically devote their energies to building up the profession, raising it to higher levels, and will vigorously take the offensive in helping to find a solution of some of the great economic problems which we are now facing."

The machine age is ordinarily considered as beginning in the middle of the eighteenth century with the improvement of the steam engine to produce continuous unidirectional rotary motion. The real beginnings of our profession extend back into the dim past when man discovered how to make materials which could be used as tools to fashion raw materials. It is fascinating to contemplate on the ability of man to fashion by hand crude machines which he in turn uses to produce more easily, more accurately, new ones, and thus continue until we have our marvelously intricate and accurate ones made with so many new materials which the machine has made possible. No chicken or the egg, or the egg or the chicken riddle here.

Power from steam loosed industry from geographical location and made possible rapid transportation systems. The discovery of electricity and methods of its production and distribution further loosed these bonds until we can have at our finger tips power that taxes our best abilities to use and control it. Each discovery and development has opened countless possibilities for the machine and the engineer.

The day of the narrow interpretation of the mechanical engineer as one who runs an engine or locomotive (both honorable occupations, of course) has passed, but we still find a lack of general appreciation of the whole field. The functions of the engineer may be classified by referring to the branch of the industry in which he is engaged or by referring to his functions in any one branch. The engineer may be engaged in: 1. Machine tool industry, 2. production and distribution of power, fuel, and heat, 3. manufacture and maintenance of equipment for transportation, 4. production of basic materials of construction from raw materials. Or in any one group of industries he may be engaged in: 1. Design, 2. production and control, 3. operation, 4. management. It may be of interest to sketch briefly the development of the function of the engineer in each of the above.

The machine tool industry has had a marvelous development. We may see in this development our political tenet that we all have equal rights to material things and that our method of making such a tenet real was to build a machine to manufacture a large number of articles, much alike, but cheaply enough so that they might be purchased by a very large number. We needed accurate machine tools to make these machines. As new products were designed and new machines developed, new machine tools were needed and promptly produced. In such a state of development a machine was scrapped as soon as it became worn or too slow. This state gave the designer and builder of machine tools a marvelous opportunity and he made a great deal of it. What matters if at times we may have carried the spirit of change too far economically, as with the buying and selling of pigs at $4. The experience gained has been used in the design of machines which have been extremely valuable. This attitude of mind in industry and in the machine tool field led to the development of new basic materials, cutting materials and methods which in turn forced still more development of the machine tool. This field requires probably the greatest inventive skill, the most accurate knowledge of materials, both their strength and field of usefulness, and thorough knowledge of laws of mechanics and dynamics.

Accelerated perhaps by the report of the late W. S. Murray, America's most spectacular development mechanically has been exhibited in the growth of our large power producing and distribution systems. In spite of some popular opinions the development of the large system has been dictated by sound economical reasons. It has resulted in continuous uninterrupted service with a minimum capital invested in "standby" units; it has made possible the development and use of large efficient generating units, and the use of either steam, water, or oil where and when each is best suited to the demands. In fifty years, production of electricity has risen from nothing to 100,000,000,000 k. w. hour per year, the installed equipment from six 120- k. w. generators to an excess of 36,000,000 k. w. In the same period the cost of production of power has decreased from 3.1 cents per k. w. hour to 0.77 cents, even with an increase in the cost of materials, labor and fuel. A single boiler could safely produce 10,000 pounds of steam per hour then, and now one has produced in excess of 1,250,000 pounds per hour. The small 120- k. w. unit has increased to one of 208,000-k. w. capacity. With all this development the cost of the modern central station has cost only some $100 per maximum capacity. These achievements are due equally to the public acceptance of power as a substitute for human slavery and to the engineer's continuous work in adapting the best materials and machines to the production of the power plant.

The field of manufacture and maintenance of transportation equipment has been quite thoroughly surveyed in a previous article. There has been a tendency among mechanical engineers who have sought a connection with our railroads to hide the fact that they have had college training and to apprentice themselves in the school of hard knocks. Such a spirit among them destroys the very attitude of mind our railroads most need in their management, an attitude that permits the application of sound engineering judgment to the solution of problems that are continually arising. While it is true that the engineer must know the railroad as it is, he must also be willing to dream of what it may be in the light of our present day knowledge. The solution of this difficulty therefore lies as much with the engineer himself as with the industry.

In the production of basic materials of construction from raw materials, the mechanical engineer finds himself in perhaps the greatest of our industries. In no other field must he know so much about subjects he once considered outside his ken. He comes in contact with all branches of both engineering and science and succeeds in making himself eminently useful only as he is able to understand and bring all together to the efficient production of a good material through the best use of power and the machine. In this field we have found and will continue to find some of our greatest engineers.

"What is not yet, may be." This is the "creed" of every true designer. It is not just an expression of a condition of change. As human beings we all find difficulties, real or fancied, which we wish to overcome more easily, or forces which we wish to defy. The artist simply portrays man's longings and predicaments; the designer desires to satisfy the one and relieve the other by some new combinations of forces and materials. His designs may be radical and revolutionary, or just simple, obvious changes of existing bad ones. The designer must have an accurate knowledge of laws of mechanics and physics, the average and the peculiar properties of all materials, the short cuts to conclusions offered by mathematics, and perhaps most of all an appreciation of human behavior. Is it any wonder that measured by ordinary standards this true designer or genius is considered a bit queer? What additional queerness would the artist exhibit if he were to be so chained to an accurate knowledge of actual things? To suggest design as a life work for the student engineer is "taboo." What can one do if convinced of the peculiar fitness of the individual to this phase of engineering? What other decision can the individual make who finds himself so fitted? All designers do not have thick glasses, green eye shades, bent backs, short tempers, and shiny breeches, nor can they be replaced by efficient managers. Perhaps these truly imaginative and yet practical minds may develop into managers. "What is not yet, may be."

Production and operation offer about the same opportunities and require about the same characteristics in the

(*Continued on Page 15*)

What Graduate Students in Civil Engineering and Mechanics are Doing

D. J. Brumley, B. S. (c.e.) 1931
Graduate Student, Civil Engineering

Much as we dislike to admit the fact, many of the engineering graduates this year are going to be unsuccessful in their search for jobs this June. Consequently many of them will be interested in learning of the courses which are offered in the university graduate school, and it is primarily for their benefit that the following resumé of civil engineering graduate courses is given.—Editor's Note.

There seems to be an ever increasing interest in graduate study and research at the university. The number of graduate students has been increasing from year to year until this year there are 55 graduate students who are majoring in civil engineering and theoretical and applied mechanics.

The members of the civil engineering and theoretical and applied mechanics staffs who are teaching graduate work are: H. E. Babbitt, J. S. Crandell, Hardy Cross, J. J. Doland, M. L. Enger, W. C. Huntington, M. S. Ketchum, H. F. Moore, G. W. Pickels, F. E. Richart, F. B. Seely, T. C. Shedd, and H. M. Westergaard, all of whom have assisted the writer in the preparation of this article.

A candidate for a master's degree can do all his work in one field or he may select a major and one or two minors. At least one-half the work is taken in the major field.

The courses open to graduate students are of two classes: those for graduate students only, which are numbered 100 and upwards, and those for graduate students and advanced undergraduate students, which are numbered less than 100 and may be taken for minor credit only.

A course in highway construction, C. E. 103, includes a number of topics that are not indicated by the title of the course. In order to gain a proper prospective a study is made of location, width and arrangement of streets, traffic surveys, pedestrian movements, parking, interrelationship of highway, railway, waterway, and airway transportation, street traffic problems, and other factors affecting the type of construction of pavements. Following this a detailed study is made of the various pavements suitable for cities, towns, and villages. A number of practical problems are given, each of which may be solved in several ways, according to the skill and ingenuity of the student. This course is taught by Professor Crandell.

Municipal engineering, C. E. 104, under Professor Crandell, covers the field of the city manager and the city engineer. The first item considered is the important matter of finances. The city budget is studied and its many divisions are explored. The problem of zoning American cities is discussed, which leads to transportation problems such as bus terminals, airports, and rail and water terminals. Parks, playgrounds, and recreation areas are essentials of the modern town and are considered in this course. The more or less unromantic work of the city engineer is then examined, which includes the study of public baths, comfort stations, garbage, refuse and ashes, street cleaning, smoke prevention, fire prevention, and municipal asphalt plants.

The fields covered by courses C. E. 101, 102, 109 and 110 in sanitary engineering offered to graduate students and taught by Professor Babbitt, cover the design and construction of water works and sewerage structures, water purification, sewage treatment, the disposal of municipal and industrial wastes, municipal sanitation and engineering work in connection with the protection of the public health. The design and construction of water works and sewerage structures, the purification of water and the treatment of sewage occupy the greater part of the time and require the application of fundamentals studied in undergraduate work. For the past decade all graduate students specializing in sanitary engineering have based their theses on work done at the university sewage testing plant located on the campus. Some very original work has been accomplished there, including pioneer studies in sedimentation, sewage gas production, mechanical aeration of sewage, etc.

The field of knowledge involved in the study leads to methods of garbage disposal, the combatting of mosquitoes, sources of infection, epidemiology and immunity. Stream pollution is caused by the discharge of sewage and industrial waste into the streams, and causes important economic losses to the public. In Illinois the important polluting industrial wastes include tanneries, corn products plants, paper mills, oil refineries, and dairies. Some of the details of these industrial processes must be understood in order that their wastes may be properly cared for; hence, the breadth of the subjects covered in the study of sanitary engineering, which might better be named the engineering of public health. In addition to the graduate courses in sanitary engineering taught by the civil engineering staff, graduate students take advantage of the excellent courses given by the chemistry and bacteriology departments.

A review of the elements in the design of members of reinforced concrete is given in C. E. 105. The course attempts to correlate the results of laboratory tests and of fundamental theory with the codes and specifications in use. Detailed consideration is given to the origin and accuracy of the rules and methods of design with which the undergraduate becomes familiar in his courses in concrete design. This course is taught by Professor Cross.

Continuous structures of reinforced concrete are analyzed in C. E. 106, as taught by Professor Cross. The primary object is to present a means of analysis and design. Professor Cross has developed a method for the solution of bending moments in rigid frames which is easily and quickly applied; this he has called "moment distribution." He has also developed the column analogy. This method makes use of the fact that the bending moment in arches, rigid frames and similar structures may be computed by a procedure analogous to the computation of fiber stress in short columns.

Steel structures are considered in C. E. 108. Continuous structures, such as continuous trusses, steel arches, and suspension bridges are analyzed. Secondary stresses resulting in steel construction from the continuity of the members are computed and their effect on the design is discussed. There is also some study of the stability of structures in space. This course is taught by Professor Cross.

A course, C. E. 107, as taught by Professor Huntington, covers the conventional methods used in the solution of statically indeterminate structures such as continuous beams, rigid frames for bridges and buildings, continuous bridges, statically indeterminate trusses, and arches. It is an introductory course intended for those who have had no previous training in this field.

Masonry construction and foundations are discussed in C. E. 112. This course is devoted to a study of dams, retaining walls, abutments, piers, deep bins such as are used in grain elevators, shallow bins such as are used for the temporary storage of coal, ore, concrete aggregates and many other materials, culverts, and foundations for buildings and bridges. The various types of dams such as the solid gravity type, the single arch, slab and buttress, and multiple arch are studied, particular emphasis being placed on the solid gravity type. Consideration is given to the effect of uplift, ice thrust, and earthquake shocks on the design and details of gravity dams. The factors which enter into the selection of the type are discussed. Investigation of dams and reservoir sites, geological considerations, the treatment of defective sites are included. The methods which have been proposed for calculating earth pressure are studied and compared. The various types of retaining walls, abutments, and piers, and their design and field of usefulness are considered. The principles of design of deep bins for the storage of grain and hopper bins are studied. A study is made of the methods of soil investigation, of the principles of foundation design, and of the methods used in constructing foundations by means of cofferdams, box caissons, open caissons and pneumatic caissons. The choice of type of piles and methods of estimating their bearing power are considered. This course is taught by Professor Huntington.

Steel building construction, C. E. 124, given by Professor Huntington, is devoted primarily to the principles of design of tall buildings with skeleton steel frames. The loads which are to be provided for, the methods of stress calculation, and principles of design are considered.

The design of industrial buildings, as offered in C. E. 125, includes a study of the basic data, calculations of the stresses, and the details of design. For the most part the buildings considered have a self-supporting steel frame, with a light covering, usually fire resistant. In the calculation of structures attention is given the analysis of statically indeterminate building frames and other industrial structures by algebraic and graphic methods. Some time is given to a survey of experiments on the pressure of grain in bins and of earth fill on retaining walls, to methods of analysis and to the design of these structures. A study is made of specifications of industrial buildings and of economic conditions that control the design. The industrial buildings and structures covered in this course include steel mill buildings, steel head frames, steel coal tipples, steel tier buildings, steel stand pipes and elevated tanks on towers, self-supporting steel stacks, grain bins and elevators, bins, retaining walls, trestle towers for power and light cables, etc. Instruction is given by lectures, assigned readings, problems, designs and reports. Stress is laid on the importance of having such a command of methods of analysis and conditions covering the action of the structure that the student may use mathematical analysis of the stresses in the structure as an aid to the judgment and to appreciate the limitations of the theoretical design of most engineering structures. This course is given by Dean Ketchum.

Flood flows of streams and reservoir storage of water, which are the two principal phases of engineering hydrology, are studied in C. E. 130 under Professor Pickels. The designs of culverts, bridges, spillways, drainage ditches, levees, and flood-control reservoirs are based on the flood flows which may be expected to occur. The location, design, and operation of storage reservoirs for water supply, power, irrigation, and navigation are based on the yields of watersheds during one or more dry years. The engineer is concerned not only with the probable magnitude of stream flow, but also with the frequency with which flows of a given magnitude may be expected to occur, so that his fundamental assumptions may be economically sound. If stream-flow records were of sufficient length, say 50 to 100 years, the engineer could predict with considerable certainty the frequency of flows of a given magnitude, based on past experience. Unfortunately, stream-flow records in this country are short. The longest record is that of the Croton river in New York and is for 60 years. For Illinois streams continuous record of flow dates from 1914, with the exception of the Illinois river. The engineer, however, must make the best use of such records as are available, and the various methods in use of analyzing such data are studied in this course. The engineer must know, therefore, how to analyze stream-flow data and to estimate the maximum and minimum flows in order to formulate intelligently one of the basic assumptions upon which the safety and economic value of his structures depend.

The study of water power engineering, as given in C. E. 131, affords an opportunity for individual research and investigation along three principal lines: (1) the collection and interpretation of hydrological data; (2) the design of hydraulic structures; and (3) economic considerations. In this course the emphasis is placed upon the last two items because of the fact that a special course in hydrology is provided. In the design of hydraulic structures the emphasis is usually overbalanced either in structural or in hydraulic considerations. The graduate course encourages the investigation of design methods from the point of view of economic balance of the two features. Many economic questions arise in the study of water power developments. Special attention is given to the major economic problems such as: The comparison of power development costs between hydro and steam; the effect of load factor upon production costs; and the use of hydro plants for base loads and peak loads. This course is given by Professor Doland.

A graduate course, T. and A. M. 101, is given which takes up the study of the development of present-day ideas in engineering mechanics. This is studied from an historical viewpoint, and the class reads and discusses the work of Archimedes, Stevinus, Galileo, Huyghens, Newton, D'Alembert, and other giants in the development of general mechanics, as well as Coulomb, Hooke, Navier, St. Venant, Rankine, and the other outstanding men who have given us our present-day science of mechanics of materials. The place which mechanics has played in the general development of science is considered, and the assumptions lying at the base of the science of mechanics are critically examined. For the work in general mechanics Ernst Mach's "Science of Mechanics" is followed quite closely. This course is taught by Professor Moore.

(Continued in April Issue)

EDITORIAL

Scientific Thinking

A faculty member in the department of electrical engineering has said that the training received by the engineer in a university fits him not alone for engineering, but prepares him for almost any field of activity. In other words the university engineer need not confine himself to any of the innumerable things that engineers as engineers do.

And might not the profession point with pride to a few examples of engineers who have been successful in other fields? Hoover, though some may question his statesmanship, has certainly been a successful politician. Robert Louis Stevenson studied engineering, only to become an eccentric literati. Manuel Komroff is an engineer who deserted his profession to become a musician, an art critic, and painter, and who finally became famous because of his novel, *Coronet*. On our own campus one of the best students of electrical engineering we have ever had is teaching public speaking, and seemingly doing a proficient job of it. Other examples come to mind; but wait, before going on, let's see what lies behind this phenomenon of the leopard changing his spots.

There are two ways to look at the question: Does a man become versatile and professionally ambidextrous because of engineering training, or does a man do what is best suited for him despite his engineering training? From a rational viewpoint there is no choice but the latter. Obviously, an engineer is trained as engineer. He is supposed to learn, while he is in school, those things which will be necessary tools for him in practice. Where does the justification come, then, for saying that an engineer is fitted for work in almost any field? The answer is: *Scientific method of thought!*

The engineer is taught, or should be taught, to think. Of course, our critics still have much justification for the epithet, "handbook hound"; but engineering has now become so varied a profession, and the problems so wide and diversified that we of necessity (probably not of choice) have been forced to adopt what the philosophers call the scientific method of thought. Engineering training has come to be, and will be in the future, not the mere learning of facts but the learning of how to think.

We, as engineers, should not break the buttons on our vests. We haven't originated the idea. We are but adopting the system perforce. The great men of the past have been thinkers. The great men of the present are thinkers, and so—but there is danger in this line. We may think we are great because we have become thinkers. If so, we have failed in our purpose. Greatness is a tribute, thinking an attribute.

And as an attribute, thinking makes itself pay in any kind of work. Perhaps that is the connotation which the faculty member wished to have his statement depend upon. Nevertheless, the rules of the world still insist that it is the *man* who does the work, and not the work that makes the man.

—D. H.

Public Construction—Depression Relief

While individual enterprises are failing at so rapid a rate at the present time, it falls upon society—as a great body of peoples—to share in the reorganization and to lessen the economic burdens of business. Over-production of the post war decade has resulted in a vast surplus of manufactured products. Fortunately, in the realm of public works there has been no surplus of commodities, and contrary to public belief there is almost unlimited room for the extension and undertaking of governmental projects. Such a stimulus would go far toward enlivening the present dormant conditions of our large productive organizations. The great volume of human labor put to work under expansion of this nature would aid considerably in overcoming the handicaps of our present economic and political systems.

The needs of public construction in addition to normal requirements exist in great size. A common example may be seen in the flooded conditions of the lower Mississippi valley. Here the problem is acute. In the summer of 1931 as well as 1930, the life in agricultural communities throughout the country was endangered with the attack of severe drought. Insufficient water in western states has been in part the reason for the construction of the Hoover dam with its connecting waterline, and the planning of the Columbia river navigation and irrigation project. Hundreds of miles of dirt roads need the improvement of hard surfaces.

In local communities over three-quarters of the total suggested improvements of public works are found to be needed. Government buildings are inadequate and have been condemned in a large number of cases. Lighting, sewers, water, and streets, need developments in their own divisions. There are, however, innumerable cases of federal, state, and city governments where resentment against expansion of this nature has grown up as a result of money extravagance. The encouragement of social harmony and the reduction of political friction will tend to lessen the evils encountered in government and public affairs. Business in general is known to be in a weakened condition. The installation of increased public construction, through strenuous financial economy, seems fitted to bolster the physical structure supporting normal conditions of prosperity.

—B. B. J.

Attend the Electrical Show!

The biennial electrical show, the big event in the life of the E. E. department, will open the week after the Easter vacation, and it will be well worth your time and money to attend the show. Members of the department have been working for months to prepare exhibits which will illustrate the newer developments in the field. The opportunity will be provided members of the other departments to acquire quickly and pleasantly a fair bird's-eye view of the electrical field, and the opportunity should not be neglected. Let's give the electrical show our support!

River Des Peres Drainage Project

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were at one time planned as closed sections. The stream bed runs through a heavy industrial district. As mentioned before the steel and lead industries are located here. Clay products are also manufactured in this area, which includes a number of clay mines. Property values are far below those of section "F" and certainly one would hardly compare the aesthetic values with those of Forest Park. It was, therefore, designed and constructed as open channel with an enclosed foul water sewer to take care of dry weather and domestic flow.

From Lindenwood south and southeast to the Mississippi river open channel design was practically mandatory. At Lindenwood, Deer creek actually doubles the total flow and this is increased farther down the stream by the entrance of Wherry creek, Rock creek, and Gravois creek. When one realizes that this stream at flood level requires a section sufficient to carry a flow equal to that of the Mississippi river at low stage, it is quite clear that a closed section, economically speaking, would be out of the question.

It is not the purpose here to go into the mathematical details of theoretical design,[7] nor to particularize construction methods employed by contracting companies who executed the plans. But it would not be amiss to give a dimensional description of the types of sewer sections used and a few of the field problems that required engineering judgment and treatment.

The first section to be placed under contract was section "A," which was let in 1924. Work was started at this point rather than at the lower end for several reasons: 1. It was important to commence the work where the danger of flood damage was the greatest. 2. Work on the sections in Forest Park and north could not be started until a foul water outlet had been provided. 3. By starting construction on section "A," the already completed foul water sewer to the Mississippi river could be used and extended as the work progressed. 4. It was not necessary to start at the Mississippi river and work upstream, as these contracts could be let and construction progress independently of sections above.

The cross sectional dimensions of section "A" are given in Fig. 1. Side slopes 7 feet 6 inches high at 1½ to 1 were constructed of concrete placed over wire mesh. Underneath the floor, which was of concrete and wire mesh reinforcement, a semi-circular sewer was constructed with a cross sectional area equivalent to that of a six-foot circular sewer. The purpose of this arrangement was to carry separately and inclosed, the foul water drainage during dry weather. During storm periods dilution is sufficient to prevent a nuisance.

Perhaps the most unusual and striking feature in the construction of section "A" is that the new channel was dug nine feet in elevation below the flow line of the existing stream bed. The immediate effect was to lower correspondingly, the water table in the surrounding area. Unsatisfactory progress due to failure to provide adequate methods for drainage and flood control caused the first contractors to fail. A subsequent contractor excavated for ditches an amount almost equal to that of the finished channel. The work progressed rapidly and most satisfactorily.[8] The experience while not profitable to the first contractor, was of inestimable value to all future contractors. Proper drainage to condition the right-of-way is a prerequisite to satisfactory progress during construction.

The first section of closed conduit was section "D." It was a triple arch composed of two twin 29-foot arches and a 16-foot arch. The 16-foot arch is the outlet for the Tower Grove storm sewer and does not continue the full length of the contract. These conduits are combined sewers. There is no separation of foul water and storm water. Several feet back of the point where these tubes discharge into the open channel large interceptors are built into the invert to trap off the foul water flow. From here the foul water is passed to the sanitary sewer below the open channel lining.

The twin 29-foot arches require an average excavation of 3,500 cubic yards, and the placing of 330 cubic yards of concrete, and 20 tons of steel for each 30-foot section. Under good working conditions this constitutes a day's work and costs the city about $8,000.[9]

Above the junction of the 16-foot sewer at Union avenue, the twin 29-foot tubes are reduced to a single 32-foot tube. To visualize the size of this reinforced concrete arch section, the following description is offered: "Two railroad trains can be run abreast on the bottom of the sewer, leaving plenty of room above for a traffic way for vehicles; or again, that an ordinary two-story house could be set in the sewer without entirely blocking it."[10] No special difficulties were encountered during construction on these sections ("E" and "F"); in fact, the best progress so far made was on section "E." Section "F" is still under construction and because the new arch is being built in the old stream bed, in a narrow right-of-way, progress is somewhat slower. Blasting of rock and a tendency for the clay to slide has resulted in the complete destruction of several large residential structures. A fine point in law has been raised as to whether city (protected by a contractor's bond) or the contractor is liable for such property damage.

In open cut channel one of the economies practiced is to rip-rap and gunite to save the cost of concreting. Under favorable conditions there is a saving of 25 per cent. If, for instance, the cut is in rock, the bottom is trued to grade and the seams gunited. The surplus rock is sized up for one-man stones and used to rip-rap the side slopes.

Considerable trouble in section "H" was experienced due to slides in the side slopes. The trouble was occasioned by the presence of water in the ground behind the embankments. Reducing the side slope gradient did not in all cases alleviate the trouble. It was expensive to clean out the finished channel each time after a heavy rain had soaked the embankments. As a last resort ditches were dug behind the embankment. This provided a drain for both the side slope and the adjacent property. Such drainage was then carried by pipe sewers through the embankment to the channel.

In the lower reaches of the channel a novel experiment is in progress. Because of the characteristic nature of the fill, which is soft and easily scoured, there is some apprehension as to whether the river at flood stage can be held in the channel and yet not seriously injure the embankments. To maintain these side slopes the city let a contract for Iowa or Highland willow poles. These poles, some of them 40 to 50 feet long, are laid on the embankment normal to the center line of the channel with butts in the water. Between the poles a willow brush mattress is laid and the whole is then anchored with woven wire net work. Over this there is put a six-inch covering of mud taken from the river. The process is a patented one and the contractors guarantee that

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[7] For concrete arch design see E. Sharp, *[illegible]* A. S. C. E. August, 1925.
[8] W. W. Horner, *Engineering News*, August 4, 19[illegible]
[9] W. W. Horner, *Engineering News*, August 21, 19[illegible]
[10] St. Louis Star, October 21, 1928.

ALUMNI NOTES

C. E.'s of the class of 81 can once more point with pride to that outstanding member of their class, Dr. A. N. Talbot, professor emeritus of the department of theoretical and applied mechanics. On March third he was awarded an honorary membership in the American Concrete Institute "in recognition of his noteworthy contributions through research in the manufacture and uses of concrete."

Dr. Talbot has been the recipient of numerous honorary awards and degrees among which are the Washington award of the Western Society of Engineers, the Turner medal of the Western Concrete Institute, and the Henderson medal of the Franklin institute.

PROF. A. N. TALBOT

Quite appropriately the new honor was conferred by President Duff A. Abrams, c.e. '05, formerly a member of the theoretical and applied mechanics department.

Prof. Talbot is already an honorary member of numerous other engineering societies, including American Society of Civil Engineers, American Society of Testing Materials, Illinois Society of Engineers, American Water Works Association, Western Society of Engineers, and the Institute of Structural Engineers.

P. E. (PAT) LEWIS, chem. e. '30, is studying law at nights at John Marshall law school in Chicago, while working as chemical engineer for the Standard Oil Co. at Whiting, Indiana. Pat plans to specialize in patent law. He and his wife live at 512 Belden avenue, Chicago.

M. E. '31's are organizing an alumni group of their own and will soon issue a news letter. M. C. LOBSTEIN, 1401 South Highland avenue, Berwyn, Ill., is secretary.

MAJOR W. C. LEMEN, c.e. '95, after an absence of many years, returned to his alma mater in the fall of 1928 to take charge of the engineering unit of the University R. O. T. C. After graduation he took a position with the U. S. Engineers and soon went into the regular army with the engineers' corps. Most of his time has been spent in governmental construction and in river and harbor work. His work has carried him all over the United States and just previous to his transfer here he was department engineer in Hawaii. Major Lemen is married and has three children.

MAJOR LEMEN

The military ball and the highway short course flooded the campus with familiar faces of recent grads as well as bringing back a large number of old timers. From all appearances there seemed to be as many second "looeys" at the ball as there were R. O. T. C. cadets.

The short course would seem to indicate that the state highway department is helping to relieve the depression for a lot of the Illini grads. Among the alums seen over the week-end were Johnny Curtis, Bud Haworth, Stew Brown, Mike Reynolds, all of the class of '31, Red Hoffman, Al St. John, Binyon, and several other members of the class of '30.

JOHN R. (BOB) WELSH, c.e. '24, stepped into a job with L. E. Myers construction company and at last reports was still with them. Bob was married in 1925 and now has two children. When last heard from in 1929 he was in charge of the construction of a 10,000-kw. power plant addition to the La Palma station at San Benito, Texas. While in school he was editor of the Technograph, a member of the Engineering Council, and Theta Tau.

JOHN R. WELSH

FRED W. SPENCER, a.e. '97 was with D. B. Burnham and Co. until last summer. He has been structural engineer on numerous sky-scrapers in several cities but finds the depression hitting hard. However, he's sitting tight and refusing to rock the boat.

HOWARD L. CHENEY, arch. '12, prominent Chicago architect, has been appointed a member of the Plym Fellowship committee for 1931-32.

Another engineer has joined the ranks of the newlyweds. RAYMOND H. (RAY) TIMMONS, r.e.e '29, was married on October 10 to MARY TRENCHARD, also of the class of '29. Miss Trenchard was assistant dean of women until her resignation last August.

DEPARTMENTAL NOTES

Engineering Societies

Chi Epsilon is following the plan of student discussions that was started last semester. At each monthly meeting several members give talks on varied subjects. Titles of some of the discourses include, "Origin of Windows," "Leonardo da Vinci, Scientist and Engineer," "Refining of Petroleum," "Construction of a Water Pumping Station," and "Modern Railroad Construction."

Other activities have been planned which will be carried out toward the end that the organization will continue to fulfill the purposes of its creation and existence.

Mechanical Engineering

Prof. G. L. Larson, formerly from the University of Illinois, recently visited Prof. A. C. Willard. Prof. Larson is chairman of the American Society of Heating Engineers's committee on research. Prof. Willard is the technical adviser of research work for the society.

Mr. Arthur H. Barker, a noted consulting heating and ventilating engineer of London, England, and his son, H. P. Barker, visited the university on Tuesday, February 2, and inspected the research work in heating and ventilation conducted by the Engineering Experiment Station in the department of mechanical engineering. Mr. Barker was formerly director of the laboratory of the department of heating and ventilating engineering at the University College, University of London, but is now engaged in private practice as consulting engineer, with headquarters in the city of London.

Theoretical and Applied Mechanics

The American Concrete Institute has announced the election of Professor Arthur N. Talbot to honorary membership in the Institute, "in recognition of his noteworthy contributions through research in the manufacture and uses of concrete." The honor was formally conferred at the annual convention of the Institute at Washington, D. C., on March 3.

T. G. Taylor, graduate student in T. and A. M., has constructed 10 reinforced concrete frames. Vertical loads are applied at the third points. The horizontal thrust of the legs and the plastic flow of the concrete are being measured. The results of these tests will furnish Mr. Taylor with material for his master's thesis.

Architecture

From among several hundred drawings sent in from all over the country to the Beaux-Arts Institute at New York to be judged, those of three Illinois architectural seniors received very outstanding awards. The drawings were submitted by W. F. McVaugh, who was given a first medal, and F. D. Kay and H. Frenberg, each of whom was given a second medal.

In addition twelve mentions and thirteen half-mentions were received by members of the class.

W. H. Scheick, of the staff of the department of architecture, is one of the four men selected from two preliminaries to take part in the finals of the nation-wide competition for the 25th annual Paris Prize. M. B. Kleinman '29 and Max Abramowitz '29, Illinois alumni, were chosen as alternates to compete in case none of the four regulars qualify. Kleinman is working in New York, and Abramowitz is teaching at Columbia.

The Paris prize is a fellowship for two and a half years' study abroad. Eighteen months are spent at the Ecole Nationale des Beaux-Arts in Paris, and twelve months are devoted to travel.

Physics

Prof. R. F. Paton and A. E. Hershey of the physics department were the speakers at the first weekly meeting of the Physics Colloquium held this semester. They spoke February 11, in 119 Physics Laboratory, on, "Temperature Measurements in Engines by Reversal of Sodium Lines." At the Colloquium meeting of February 18, Prof. F. W. Loomis spoke on, "Transformation of Resonance Spectra into Band Spectra." Prof. C. T. Knipp was the speaker at the meeting on February 25. His subject was, "Recent Electrodeless Discharge Experiments."

Chemistry

Prof. Muskat, formerly of the University of Chicago, and at present Chemical Director of the 1933 World's Fair, was the speaker at a meeting held February 15, under the direction of the American Chemical Society. His topic was "The Chemical Exhibit at the 1933 World's Fair."

Highway Short Course

The nineteenth annual short course in highway engineering, offered by the department of civil engineering, was held on the campus from February 22 to 24. It was held under the direction of Prof. C. C. Wiley and Frank T. Sheets, chief highway engineer of Illinois. Talks were given by the leading highway engineers of the state, as well as some from out of the state, before the three hundred and fifty odd delegates, representing the state, counties, cities, and townships.

Some of the outstanding talks were given by the following men: A. R. Hirst, U. S. Bureau of Public Roads; H. E. Surman, Illinois division of roads; G. A. Quinlan, Cook county superintendent of highways; F. T. Sheets, chief highway engineer of Illinois; S. E. Pierson, director, Illinois department of agriculture; V. L. Glover, Illinois division of highways; and H. H. Cleavland, director, Illinois department of public works and buildings.

River Des Peres Drainage Project

(Continued from Page 11)

the willows will root and in a few seasons completely stabilize the banks.[11] A sufficient time has not elapsed to state definitely the results, but it is known that the process has been quite successful in a number of other localities, notably the power canals around Buffalo, New York.

Having carried along through the investigations, elements of design, and construction features, there remains only to say a word about how the improvement is performing. To date the project has not been put to a real test. It is true there have been some heavy rains, but the test will come only when the heavy rains are of long duration and the Mississippi river is at flood stage. Such a coincidental condition has not as yet occurred. In September, 1931, there was a 4-inch rain that ordinarily would have been sufficient to flood the valley. In section "F" the velocity was great enough to wash a 10-foot steel carriage, belonging to the contractor, some four miles downstream. The closed sections were only one-third full and the area usually flooded experienced no inconvenience. The newspapers gratifyingly expressed their belief that the test had been successfully met. Previous to this, popular comment by laymen was, that the project had been overdesigned and that money so spent had been wasted. But the full use of the improvement is only in its infancy. There are large unimproved and semi-improved areas in the fifty odd thousand acres in the county that are tributary to this river. Much of this area is unsewered, some of it is being considered seriously for extensive drainage improvement, and all of it some day will make its full demand on this improved channel. It is, however, firmly believed that with perhaps some additional foul water outlet facilities the improvement will perform satisfactorily as designed.

[11] Post Dispatch, Magazine Section, March, 1930.

Mechanical Engineering

(Continued from Page 7)

engineer. In each field the man must have his knowledge at hand so that he can act immediately when and as conditions arise. He will be denied the dilettante's pleasure in leisurely contemplating and balancing certain facts against others. He will be required to find his joy in his work, in the action required and in the variety of new condition that he must meet. This requirement will bring a great deal of responsibility and will involve a tendency toward arbitrariness which the individual must keep under some control.

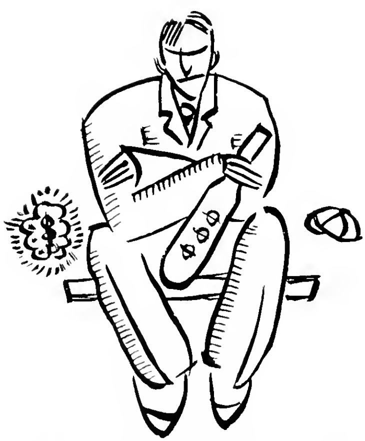
Just as management has been the final chapter in the life work of most of our great engineers, our consideration of this field has been reserved to the last. We might dismiss the subject by saying that leaders are born, not made. This simply begs the issue. Even our great leaders started life, as you and I, without much of an idea of the world. They and we acquire these ideas somehow. If we can assume any development of the thinking processes through use, it may be fair to assume that thinking about materials and their relation to each other in a machine or process may result in a development of man's capabilities in directing into effective channels the efforts of others.

Structural Stresses in Doormats

GEORGE Y. PHLATPHUT
Head of the Department of Foot Wiping

Prof. Phlatphut has been around the University the last eighty-four years (man and boy), and it's about time!—EDITOR'S NOTE.

It has been believed for some time that the doormat, or doormat, as some prefer to call it, is a rugged structure, capable of withstanding great amounts of weight, heat, light, and rent without injury. In a study made of various doormats around Engineering Hall, it has been discovered that this is not so, and that they are, after all, human like ourselves, and cannot endure being trampled upon (see Fig. 1). Fig. 6 shows the graphs of various



PROF. GEO. A. PHILATPHUT, M. F. W., AS A STUDENT

doormats, piston displacement being plotted against area. The blurred line is the graph of the doormat at the east end of the building; the helical curve, that of the mat at the west end; the ink-spots, a free-hand sketch of Prof. Willard, and the various numerical calculations which are scattered about the chart are the graphs of several unidentified foot wipers.

From a study of these data, it may readily be observed that the wear which the average doormat must withstand is something fierce (Fig. 13).

When all this is reduced to pounds per square inch by the use of Euler's formulas and a slide rule, we obtain .0035 pounds per square inch of doormat:

$$6 \times 2 = 11.9$$
$$x + y + 11.9 = \$2.98$$
$$\sin \theta = \pi r^2 = 23.7\ cc$$

And the rest of the calculations are obvious (Fig 8).

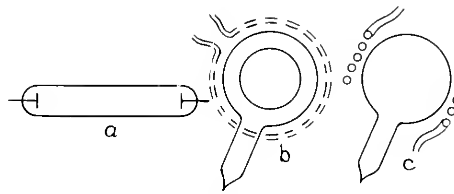


Figure 6

Thus, we come to the conclusion that unless people are careful to step over them, the doormats in Engineering Hall and other University buildings will some day wear out (Fig. 27).

The other diagrams accompanying this article have been omitted for lack of space, but will appear in the July issue.

* * *

Wife: "Dear, tomorrow is our tenth anniversary. Shall I kill the turkey?"

Hubby: "No, let him live. He didn't have anything to do with it." —*Utah Humbug.*

* * *

Mistress: "Mary, you were entertaining a man in the kitchen last night, weren't you?"

Maid: "Thank you, ma'am, that's not for me to say, but I did my best." —*Elk's Magazine.*

* * *

The warm interiors of radios have proved to be ideal nesting places for roaches. If insect powder fails, try Russ Columbo or Bing Crosby. —*Life.*

* * *

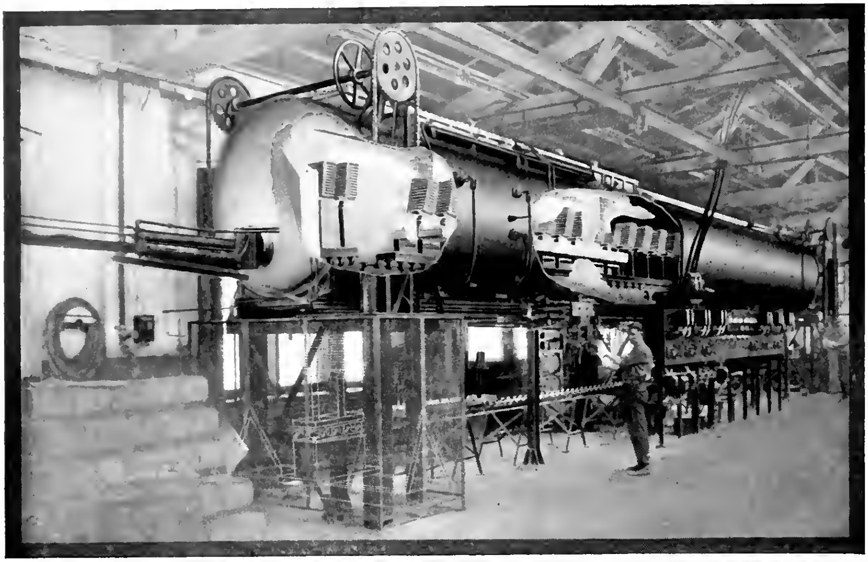
Hindu (walking into a Westinghouse sales room in New York): "I would like to look at some of your medium priced turbines."

* * *

"Bill, the fireman, made a grave mistake yesterday."

"How come, George?"

"He neglected the feed water pump on the high pressure boiler."



-p. 4

THE TECHNOGRAPH

UNIVERSITY of ILLINOIS

APRIL 1932

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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THE TECHNOGRAPH

UNIVERSITY OF ILLINOIS

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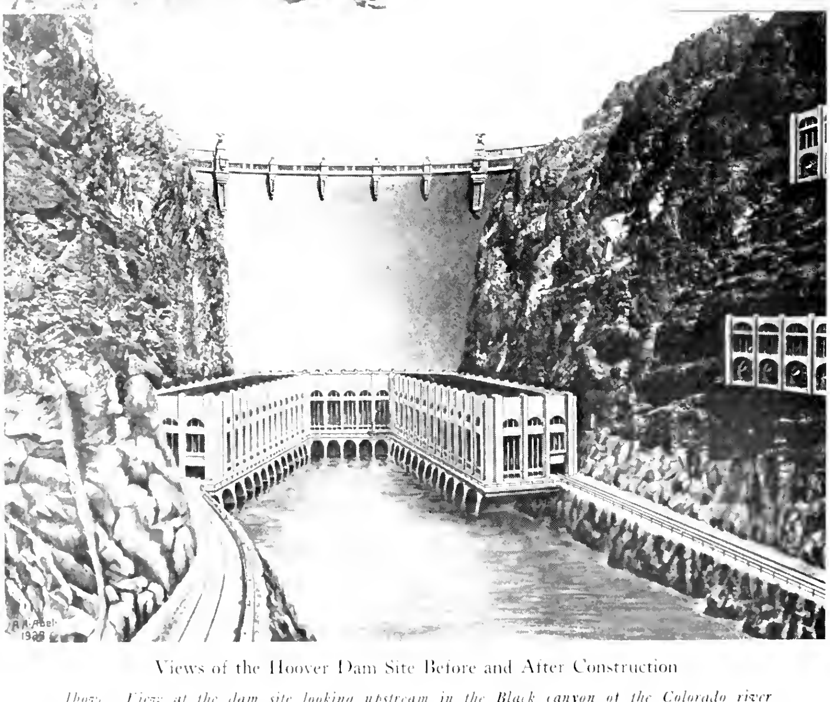


Views of the Hoover Dam Site Before and After Construction

Above: View at the dam site looking upstream in the Black canyon of the Colorado river
Below: Artist's conception of the Hoover dam and power plant as they will appear when completed

THE TECHNOGRAPH

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

VOLUME XLVI | URBANA, ILLINOIS, APRIL, 1932 | NUMBER 6

The Hoover Dam Project

W. E. GREEN '30

"BELIEVE it or not," the Hoover dam, which is the principal unit of the great Boulder Canyon project, is not to be constructed in the Boulder canyon, but in the Black canyon farther downstream and nearer to Las Vegas, Nevada.

The original name, Boulder dam, was discarded on September 17, 1930, when Secretary of the Interior Ray Lyman Wilbur officially named the proposed structure the Hoover dam, and drove with inexperienced blows the silver spike marking the inauguration of railroad construction operations.

THE MAGNITUDE OF THE PROJECT

Not since landslides harassed courageous engineers at Panama has the United States government attempted such a colossal enterprise. The immensity of the Boulder Canyon project has been reflected in the widespread notice and comment accorded it by the press and technical engineering literature. This situation has left the average person with at least a hazy knowledge of the magnitude of this great engineering undertaking. The following facts concerning the various features of the project may serve to clarify the mind and convince the most skeptical of its great size.

The Hoover dam will be the world's highest dam, thrusting its proud crest hundreds of feet above its nearest competitor. It will reach 727 feet above the foundation rock, have a crest length of 1,180 feet, a base thickness of 650 feet, and contain nearly as much concrete as the Bureau of Reclamation has thus far placed in all of its construction. The body of water impounded by the Hoover dam will be by far the largest artificially created lake in the world, extending 115 miles along the course of the present river and containing more than 30,000,000 acre feet. The maximum capacity of the Hoover dam power plant will be 1,200,000 horsepower, which is more than double that developed on the United States side at Niagara Falls.

During the construction of the dam, the river will be diverted around the damsite by passing it through four tunnels which will be driven through the canyon walls, two on each side of the river. Each tunnel will have a diameter of fifty feet and an approximate length of 4,000 feet. The spillway structures of the completed dam are designed to discharge a total maximum of 400,000 cubic feet per second. It is well to note here that the greatest flood experienced in Boulder canyon, which occurred in 1884, was estimated at 300,000 cubic feet per second, and is believed to be the maximum which can be expected during a 200-year period.

The All-American canal, the construction of which was authorized by the Boulder Canyon project act, will extend from a point five miles above Laguna dam on the lower Colorado river, to a point 10 miles west of Calexico, a total length of 80 miles, making connections with the present system of the Imperial Valley irrigation district. The capacity of this canal will be 15,000 cubic feet per second, just double that of the system now in operation.

A BRIEF HISTORY

In order to obtain a more complete background for a picture of the entire Boulder Canyon project, it may be well to review the important events which have transpired in its development.

The Colorado river has always been the blacksheep of American streams, unsuitable for navigation, so spasmodic in its flow that irrigation often suffers from water shortage, and so unprincipled and destructive in its floods that $10,000,000 has been expended since 1905 in an effort to control it. In short, its alternate floods and droughts, deposits of silt and changing channels, early brought people of the southwest to agree that "something should be done about it."

In 1902 and 1903 the lower Colorado river was mapped and five possible damsites located. In the years following there were continual investigations, surveys and water supply studies being conducted.

Congress in 1920 authorized a thorough investigation and report on the conditions on the Colorado, with the view of determining some possible solution of the ever increasing difficulties. The result was known as the Davis report, which recommended the construction of a dam on the lower Colorado.

After the war the investigations centered on two possible damsites, one in the Boulder canyon and the other in the Black canyon. In 1923 drillings and geological examinations of the two sites were completed and detailed studies and comparisons undertaken by the Bureau of Reclamation.

The Colorado river compact was drawn up in November, 1922, at Santa Fe, New Mexico, by the representatives of the seven Colorado basin states, under Herbert Hoover as chairman, who represented the United States government in the position of secretary of the department of commerce. This compact was ratified by Colorado, New Mexico, Utah, Wyoming, Nevada and California, but not by Arizona.

In 1928 Congress directed the secretary of the interior to appoint a board of consulting engineers and geologists to report on the safety, economy, and feasibility of the plans of the Bureau of Reclamation for the control

Panoramic view showing Boulder City, Nevada

and development of the lower Colorado. This board submitted a favorable report in November of 1928, and on December 21, 1928 President Coolidge placed his signature on the Boulder Canyon project act, which became effective on June 25, 1929 in spite of objections by the state of Arizona.

The initial appropriation of $10,660,000 was made by Congress and approved on July 3, 1930 by President Hoover, who urged that all possible haste be made in preparing the plans and specifications so that actual operations could be started at an early date and work provided for many of the unemployed.

March 4, 1931, found R. F. Walter, chief engineer of the Bureau of Reclamation, opening the bids before a throng of bidders, representatives of the press and interested spectators. The contract was awarded on March 11, to Six Companies Inc., who submitted the low bid of $48,890,995.50, and immediately construction activities were begun.

A brief tentative construction schedule follows:

Stripping canyon walls of loose rock, June 1, 1931, to November 1, 1933; diversion tunnels, May 1, 1931, to May 1, 1932; cofferdams, December 1, 1932, to May 1, 1933; excavation for dam, February 1, 1933, to April 1, 1934; placing of concrete in dam, January 1, 1934, to January 1, 1937; spillways, February 1, 1932, to November 1, 1933; intake towers, January 1, 1933, to July 1, 1935; outlet works, February 1, 1933, to August 1, 1937; power house, February 1, 1933, to November 1, 1937.

The Purposes

The purposes of the project, in order of importance are: (1) Controlling floods, improving navigation, and regulating the flow of the Colorado river; (2) storing and delivering stored water for reclamation of public lands and other beneficial uses within the United States; and (3) generating electrical energy as a means of making the project self-supporting.

"Other beneficial uses within the United States" include the use as water supply for the Metropolitan water district, which embraces Los Angeles and its satellite municipalities. The proposed Los Angeles aqueduct will transport to the Metropolitan water district its allotment of not more than 1,050,000 acre feet annually. This aqueduct is not a part of the Boulder Canyon project but will be constructed during the same period and completed at about the same time as the Hoover dam. It will consist of 226 miles of main aqueduct and 155 miles of feeder lines, with tunnels totaling 111 miles. A bond issue of $220,000,000 was authorized on September 29, 1931, to cover the cost of the construction of this great water supply enterprise.

The Cost

The Boulder Canyon project act provides for an appropriation of $165,000,000, subject to subsequent appropriation acts. This amount is distributed among the major features of the project as follows:

Dam and reservoir	$ 70,600,000
1,000,000-horsepower development	38,200,000
All-American canal	38,500,000
Interest during construction	17,700,000
Total	$165,000,000

It is estimated that the government will spend about $2,000,000 in the construction of Boulder City, the town which is being built near the dam to accommodate the federal forces and those of the contractor during the construction period, and the operating forces after the project is completed.

Sufficient contracts have been obtained for firm energy, secondary energy, and water, that the entire estimated cost of the project, including $25,000,000 allocated to flood control, will be repaid, including interest charges, within a period of about thirty-four years.

The Damsite

The Black canyon site was finally selected because the dam at this location can be built at less expense. Although lower on the river than the one in Boulder canyon, it will have, for the same elevation a somewhat greater reservoir capacity. This site is closer to the Union Pacific line and also to the southern California power center, thus involving a shorter transmission line, which will be used to bring power to the dam during construction and to carry it in the opposite direction after the power plant is put into operation.

The geology of the Black canyon site is more favor-

(Continued on page 9)

What Graduate Students In Civil Engineering and Mechanics are Doing

D. J. Brumley, B. S. (c.e.) 1931
Graduate Student, Civil Engineering

The following resume of civil engineering graduate courses is the conclusion of the article started in the March issue of the Technograph.—Editor's Note.

An advanced course in hydraulics, T. and A. M. 103, is open to students who have had an undergraduate course in hydraulics. The effect of viscosity and density of fluids on the flow is considered, and a critical study is made of the classical experiments in hydraulics. Among the topics taken up for consideration are friction of water and other fluids in pipes, water hammer and related phenomena, and the hydraulic ram. A study is made of the use of models for predicting the performance of full sized structures. The same material is not given every year but variations are made to fit the varying interests and preparations of the students. This course is taught by Professor Enger.

General experimental work in the materials testing laboratory includes work in metals and applied mechanics under Professor Moore in T. and A. M. 107, hydraulics under Professor Enger in T. and A. M. 108, and reinforced concrete and building materials under Professor Richart in T. and A. M. 109. The subject matter varies from year to year, and consists of a laboratory investigation and reports on one or more projects of current interest. Each course may thus be varied from a series of advanced problems to a single investigation approaching in character the usual master's thesis.

The courses entitled "Experimental and Analytical Work in Reinforced Concrete," T. and A. M. 110 and 111, extend over two semesters and are planned to carry the student into a critical study of test data relating to reinforced concrete members and structures. The object is that of examining the fundamental data upon which theories of stress analysis and of structural design are based, rather than to study these theories themselves. The courses are normally divided into: (1) Problems involving flexure, bond, and diagonal tension with a study of available date on tests of beams, footings, frames, and the like; (2) a study of columns, combined stresses, two way and flat slab structures. A gradual change in subject matter from one year to the next is affected through the introduction of new test information and applications of current interest. One feature of the entire course is the study of documents, such as the Joint Committee report on the Joint Standard Building Code, with a view to determining the extent of the supporting data.

Courses in advanced structural mechanics, T. and A. M. 112, and in graphical methods of structural analysis, T. and A. M. 113, are taught by Professor Westergaard. The mathematical theory of elasticity and its application to engineering problems, T. and A. M. 114 and 115, are also taught by Professor Westergaard. The call for engineers who can handle the more advanced methods of stress analysis is becoming more and more insistent year by year and such courses as those mentioned above meet a growing demand from the engineering profession.

The topics considered in T. and A. M. 116 lie just beyond those usually included in a first course in resistance of materials or strength of materials. The increasing use of analytical methods, in contrast with empirical rules, in solving the engineering problems that are continually arising in engineering industry has, in recent years, created a need for further training in the analysis of stresses and strains in various members of engineering structures and machines. There is likewise a need for a better understanding of the significance of calculated stresses in relation to the usable resistance of a member subjected to different types of loading. The main objects of the course are: (1) To review and make more useful the methods and results presented in the first course—strength of materials; (2) to show the limitations of the ordinary formulas of strength of materials, to consider the conditions under which these limitations are significant, and to extend the subject to include a variety of important topics more complex than those usually considered in a first course; (3) to acquaint the student with various sources of information and thus to give him an opportunity to appreciate how knowledge has grown; (4) to change the usual attitude of the student from one of dogmatic confidence in the methods employed and results obtained to one in which the methods and results are viewed as merely approximations but such that under certain conditions they become reliable and useful. The subject is divided into four parts as follows: (1) Preliminary considerations, consisting mainly of a discussion of the fundamental concepts involved in the subject, and a review of some of the more important methods used and results obtained in the usual first course in strength of materials; (2) special topics, consisting of the analysis of stresses in a number of types of members not included, as a rule, in the first course; (3) discussion of stress concentration and localized stresses in which non-mathematical methods of stress determination are emphasized; (4) an introduction to the analysis of statically indeterminate stresses, in which methods involving elastic strain energy are used. This course is taught by Professor Seely.

Important changes are occurring rapidly in the field of engineering materials. In T. and A. M. 117, given by Professor Seely, the materials of special properties, of methods of treating materials to produce the desired properties, and of methods of testing to determine properties are studied. The course attempts to cover this field as follows: (1) A brief review of engineering materials; their manufacture or production, and their general uses and importance; (2) engineering properties of materials; the conditions under which the properties are of special importance; methods of testing to determine properties and the relation of test results to service conditions; (3) methods of modifying properties and of producing special combinations of properties, as in heat treating of metals, alloying, etc.; influence of internal structure and constitution, etc.; (4) discussion of specifications and inspection of material; the problem of formu-

(Continued on page 14)

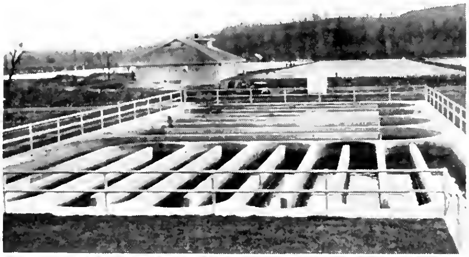
St. Louis County Water Supply Problems

Herbert O. Hartung
Engineer in Charge of Purification

THE engineering profession is credited with many remarkable and astounding achievements. One of the greatest of these to our present form of civilization is the modern method of large quantity purification and sterilization of polluted and contaminated waters. The health and safety of millions of individuals is dependent day after day on that engineering accomplishment. To think of civilization without it is too hypothetical and imaginary to consider, for almost all community life is built around a safe and adequate water originally obtained from an infected supply.

The American public has generally accepted the importance of the water utility. It places faith and confidence in its engineering service. Unquestioned dependability is taken as a matter of course. Purity is not doubted. Unlimited supply is taken for granted regardless of the quantity of water consumed. Adequate pressure at all taps is constantly assumed, regardless of rates of consumption.

Inasmuch as this service, so faithfully accepted by the public, is an engineering service, the importance of the waterworks engineer to community life is at once established. Insofar as he represents the water utility, his services are indispensable. He protects both life and property. He adds to every home both comfort and luxury.



View of the mixing basin, as seen from end baffles

The task of the waterworks engineer is becoming more intricate every day. Growing centers of population and increased stream pollution create new and larger problems in water purification and distribution. A large number of water utilities in the past ten years have had to rebuild or make improvements because of an insufficient system.

St. Louis County Water Company

The St. Louis County Water Company supplies water to all the suburbs of St. Louis in St. Louis county with the exception of one. Its territory now supplied has twice the area of the city of St. Louis. It has 200,000 consumers taking water from 39,000 services, or on an average, five consumers per service.

Spread out in a net work over its entire territory is its distribution system comprising 630 miles of pipe owned by the company and an additional 80 miles owned and maintained by others. The largest of these mains, a feeder from the river to the purification plant, has a 42-inch diameter. Consumers are so widely scattered over the territory that for each service tap on the distribution system there is on the average 96 feet of pipe. The farthest consumer is some thirty miles from the purification plant.

Topographical conditions in St. Louis county are not at all conducive to a simple distribution system. The difference in elevation between the lowest and highest consumer is nearly 260 feet. This difference is equivalent to 112 pounds per square inch in pressure; yet, every consumer must have adequate and not excessive pressure at his tap.

If rates of water consumption could be made uniform from hour to hour and from day to day, problems of distribution and pumping would be much easier and large economies would be effected. Daily consumption rates, however, vary nearly two hundred per cent. The average daily consumption amounts to 60 gallons per capita. The maximum daily consumption has equalled 101 gallons per capita, while the minimum daily consumption has been as low as 42 gallons per capita. The fluctuations in hourly consumption rates are even greater. The maximum hourly consumption has been at a 175-gallon-per capita-per-day rate. Minimum hourly consumption rate is recorded as one gallon per capita per day.

It is interesting to note when these periods of maximum and minimum consumption occur. As might be expected, weather conditions influence consumption. Maximum consumption occurs in summer time, and minimum consumption generally, but not always, occurs in the winter. Both the maximum and minimum daily consumption records for 1930 were in the month of June. The weather was exceedingly dry and hot on the day of maximum consumption and wet and cool on the day of minimum consumption.

The maximum hourly consumption occurs between 7 a. m. and 8 a. m. about sixty per cent of the time. Twenty per cent of the time it is between 8 a. m. and 9 a. m. Minimum hourly consumption, obviously, occurs at night. Sixty-five per cent of the time the minimum hour is from midnight to 1 a. m. and twenty-five per cent of the time it is between 1 a. m. and 2 a. m.

Another general deduction taken from consumption statistics is that more water is consumed on Monday than on any other day of the week. In contrast, less water is consumed on Sundays. Second to Monday for maximum consumption is Saturday. The inference is at once apparent; wash days are a boon to the water utility.

On Sundays and holidays the maximum hourly consumption comes about 10 o'clock. The daily habits of people of St. Louis county are easily detected from this knowledge of consumption.

Non-uniformity in consumption, scattered consumers, and variations in static head have in large measure been compensated for by the use of booster pumps, a storage reservoir, and standtowers located in strategic points in St. Louis county. As the county grows and water consumption increases, additional aids in distribution will be built.

Missouri River Water

The St. Louis County Water company takes its water from the Missouri river. This water eventually becomes an excellent water for drinking, domestic, and industrial use, but first requires elaborate purification treatment. The raw water is muddy, polluted, hard, and infected; and is transformed into a clear, sparkling, soft, and sterile liquid.

The characteristics of the raw water are never the same from day to day. The chemical and physical properties are constantly fluctuating between wide limits. Because of the extensive drainage area of the river almost an infinite variation in water is encountered, the kind depending upon the area in which rainfall has been heaviest, the extent of dilution with water already in the river, and the coefficient of runoff.

The greatest variation in the river water is in the amount of suspended matter or turbidity that it carries. However, the appelation "the Big Muddy" is applicable at all times. A turbidity of 8000 parts per million parts of water for the river is considered a high turbidity. A low river water turbidity is a turbidity of 100 p. p. m. of water. A turbidity greater than 5 parts per million is objectionable to the average consumer in drinking water.

The river water also fluctuates greatly in hardness. Hard water is that "which requires an excessive amount of soap to form a lather, or which forms much incrustation on vessels in which it stands or is heated." The division line between a hard water and a soft water is merely arbitrary. In a general way some writers have classified soft waters as those having less than 100 parts of hardness per million parts of water, and hard waters those having above 100 parts of hardness per million parts of water. The Missouri river is known as a hard water stream. Its hardness will vary between 100 and 300 parts per million.

Color in Missouri river water is almost unnoticeable. Color varies between five and twenty parts per million. A color in excess of fifteen parts per million is noticeable to the close observing consumer. Variation in mineral content is frequent, yet the Missouri river is not generally classed as a high mineral water. Dissolved solid content will range from 250 to 600 parts per million. A content above 500 p. p. m. of dissolved solids has a salty or brackish taste detectable by most people.

Temperature of the water varies between freezing and 85° F. High bacterial pollution is almost always certain. Bacterial counts have often been reported as high as 100,000 per cubic centimeter of water. Tastes and odors in the water are infrequent, but yet must be constantly guarded against. Algae and spring and fall turnover of the water are the cause of most of these tastes. The water also at times may acquire a property which will cause a taste when chlorine is added to the water. Such tastes do not render the water unfit for use, but bring many complaints from consumers.

Wide variations and fluctuations in pH, alkalinity, fineness coefficient, etc., are also always certain.

The wider variations and fluctuations in river water characteristics create numerous purification problems. A different treatment condition occurs almost every day. Changes in chemical dosages applied to the raw water are made daily. Successful treatment and purification demands of the engineer constant vigilance and supervision coupled with intelligence and experience.

Purification Treatment

In treatment of the Missouri river water the St. Louis County Water company attempts to do the following things:

1. Free the water from all infection.
2. Convert the muddy water into a clear sparkling liquid.
3. Remove excessive hardness.
4. Create chemical balance; i. e., to produce a water that is neither depositing mineral matter nor corroding the mains.
5. Prevent the formation of tastes and odors.

Disinfection is accomplished with comparative ease by the addition of chlorine. Chlorine is added until the living "B" coli, intestinal organisms, number less than two per 100 cc of water, which is a quality considered safe by sanitarians and the Missouri State Board of Health. This disinfection with chlorine is facilitated by the use of ammonia. The ammonia with the chlorine prolongs sterilization. It also prevents the formation of chlorine tastes and allows the use of larger quantities of chlorine.

Clarification is produced by sedimentation. A large quantity of the turbidity carried by the river water is

Settling basin, showing pipe system through which sludge is bled

easily removed by plain sedimentation; i. e., by settling without the use of chemical coagulants. As much as 85% of this suspended matter has been removed in that manner. The basins in which plain sedimentation is accomplished remove on the average of 45 tons of dirt each day.

The colloidal or semi-colloidal matter is removed by the aid of chemical coagulants. The chemicals which are added react chemically with each other or with the dissolved mineral matter in the water to form a precipitate or floc. This floc, upon settling to the bottom of the basin, entrains the remaining turbidity. To use an old illustration, clarification by the use of coagulants and sedimentation is analogous to the clarification of the atmosphere by a snow storm.

The dirt or sludge which is deposited daily in the settling basins must be constantly removed. The plain sedimentation basins are equipped with link-belt continuous sludge-removing machinery. This equipment, consisting of scrapers attached to an endless chain, drags the sludge into a hopper built on one end of the basin, from which the sludge is pumped or drained. Much of the dirt collected in these basins has been used for filling low ground.

The sludge from the coagulation basins is bled from the bottom through sewer openings. At regular intervals these basins must be drained and flushed out with a fire hose. The chemical sludge taken from these basins is often times mixed with the incoming raw water to facilitate settling.

Hardness in water is almost entirely due to the presence of the salts of calcium and magnesium. To remove the hardness means to remove these two minerals.

(Continued on page 11)

Worth Thinking About

Time is the most important element that we know of. But why must youth bow to it? We are thinking particularly of engineers who are forced to cram an education into four short years, instead of being able to spend five years at the task.

In having but four years here at college, the budding engineer is confined wholly to a specific technical education. He has little or no time to learn anything of the other related branches of engineering, nor has he any time to venture south of Green street and learn something of Shelley and Byron, of the causes of the Spanish war, or how the silver standard fluctuates, etc. His time is spent in a more or less strict adherence to the preparation for his chosen profession.

Why cannot the engineering curricula be lengthened to five years? There are two general types of five-year courses that are being adopted by engineering schools. Institutions that have the good fortune of being located close to a center of industry use what is termed a "co-operative" plan. This means that the students spend a certain period of time in the class room, and then are given an opportunity to apply their knowledge as employees of some of the local industrial firms. Among the many engineering colleges that have adopted this plan is Marquette University, located in Milwaukee, Wisconsin. Being so close to Chicago, the students here have an excellent opportunity for employment by the numerous industrial firms there. The practical experience gained at the same time the students are studying is, clearly, quite an advantage in making clearer their studies.

In the instances where the institution is not located near any large industrial center the curricula in engineering can be lengthened to five years and thus allow time for electives, which are otherwise not included in the curricula. The general tendency of the student engineer is to take those courses only which are closely related to his chosen branch of engineering. If he would stop and consider it a moment, he would realize that any knowledge he had along the other lines of engineering might prove very valuable to him some day. As an example let us consider an electrical engineer whose job it is to design a power plant. Unless he has a pretty good knowledge of the generation of steam and its properties he cannot perform his job well. To learn something of steam he must divert from his immediate field for this knowledge. Thus we can see that a good engineer must be versed along lines of engineering other than his own.

Upon further consideration of the matter, we realize what an advantage there is in knowing something of the social studies, as well as economic studies. The social studies tend to broaden a man out and to help round out his education, while any knowledge he might have of economics, business law, etc., would more than likely prove invaluable to him in later years when he will be practicing his profession. —R. A. F.

Advanced Military in Engineering

Every year the basic military student debates the advisability of taking advanced military training; whether it would benefit him, or be of any use after graduating from the university. More thought should be focused on the benefits that are derived from such a course of training, instead of merely regarding the basic course as a necessary evil and looking forward to its conclusion. The military training received in the advanced military corps is one of the fundamental necessities in the development of an engineer. It gives him his first opportunity to command men, to place himself on his own responsibility, and to see an organization function at his command. And is not this precisely the position that an engineer is expected to occupy in business? Is he not a planner, an organizer, a builder? As such, he will need to direct men, to accomplish a desired objective in the simplest way. And training in military command affords the perfect opportunity to meet the requirements of an engineer in actual life.

Besides the importance of advanced military training in engineering pursuits, one cannot neglect the necessity of trained men if a state of war did exist. Undoubtedly, any future war would be almost entirely a matter of engineering ingenuity; so naturally, the engineer who has a thorough knowledge of military tactics is the man who will direct operations. So coupling an engineering education with the ability to take command of any group, we will have men who are invaluable in peacetime as well as in wartime. Sophomores who are now completing the basic course of military education this semester, will find it beneficial to consider these points before dropping military training for their remaining two years at the university. —F. E. S.

Mineral Research and the State Survey

The program of the mineral research inaugurated by the Illinois State Geological Survey marks a forward step in developing the vast natural resources lying within the state. Throughout its broad domain, geology rests upon the two great fundamental sciences—physics and chemistry, and mineralogy itself is closely related to mining metallurgy and many of the technologic arts. One has only to mention a few of the industries dependent upon, for example, beds of pure gypsum or coal—and the importance of mineral study is foreseen.

A complete investigation will be made of the composition and economic possibilities of important mineral and rock bodies occurring within the state. The members of the survey are to be commended for they have undertaken this work in a manner which will be of scientific and economic importance as well. Included in the study will be the movements of mineral materials into and out of the state with relation to their marketing opportunities. Without a doubt, this investigation will have some bearing on the betterment of conditions through this part of the country. —B. B. J.

The Hoover Dam Project

(Continued from page 4)

able than that at the Boulder canyon as there is less jointing of the volcanic rock, which is tougher and yet more easily worked and safer than the granitic rocks of the Boulder canyon. There are some fault planes in the Black canyon, but water-worn pot holes have been found, high on the canyon walls, crossing these planes, proving that there has been no movement during the time it has taken the river to erode its channel several hundred feet to the present depth. Since all of the fault lines are well cemented and since there are no indications of recent activity in the region, it is felt that there is no possibility of danger from this source.

The Hoover Dam

The dam is of the arched-gravity type, and designed by the trial load method, which has been developed by the Bureau of Reclamation in the past seven years. The methods used in the design of the Hoover dam take into consideration the effect of radial sides of cantilever elements, temperature changes in the concrete, transverse shear in both arch and cantilever elements, tangential shear and twist, foundation and abutment deformations in both arch and cantilever elements, and Poisson's ratio.

Special investigations and exhaustive studies are being made of certain factors which in all probability have never before been considered in dam design. These factors are: the effect of volumetric changes due to water-soaking of the concrete near the upstream face; plastic flow of concrete; non-linear distribution of stress between the two faces of the dam; and spreading of the canyon walls due to filling of the reservoir.

The most unique feature of the design of the dam is the cooling system. Drawings showing this system make the dam look as though it were "reinforced" with pipes. These pipes are installed for the purpose of carrying cooling water to all parts of the dam during the period of setting of the concrete; they are spaced ten feet apart vertically and about eleven and one-half feet apart horizontally.

If the dam were not cooled artificially, the heat which is generated in the chemical process of setting of the concrete, and which often amounts to 50 F., would not be dissipated from this extremely massive structure until many years after its completion; cooling at such a time, with its attendant shrinkage, would open cracks and reduce the safety of the structure.

The first step in the construction of the Hoover dam is the driving of the four diversion tunnels, two on each side of the river, which will by-pass the river flow during the building operations.

These tunnels will be excavated to a diameter of 56 feet and then lined with a three-foot thickness of concrete, leaving a finished tunnel of 50-foot diameter. The contractor is making rapid progress and at the present time (March 15, 1932) is well in advance of the schedule, having holed through and completed excavation with the exception of the lower 15 feet, in three of the tunnels. The fourth will be holed through in the near future.

After the completion of the diversion tunnels the cofferdams across the river channel will be erected, one above the damsite and another below. These must be completed during one low water season and be ready for the spring flood flows when they begin. With the cofferdams above and below the site and the stream flow being passed through the diversion tunnels, the excavation of the canyon bottom can be made for the dam.

The dam will be constructed with outlets at river level for passing the low water flow while the diversion tunnels are being plugged.

After the completion of the dam all of the tunnels will be plugged, the two inner tunnels will be used to connect the reservoir with the power penstocks and the canyon wall outlet works, and the two outer tunnels will be used for spillway outlets.

The amount of silt carried by the Colorado river, and its effect on the Boulder Canyon project, has long been a point of comment and conjecture. The silt-laden

Upstream view showing tunnels on the Arizona side through which the Colorado river will be diverted during dam construction

waters of the Colorado have often been described as "Too thick for swimming and too thin for plowing."

The annual silt deposit of the river at its delta has been variously estimated at from 80,000 to 250,000 acre-feet. Careful studies have been made and it is now believed that within the 50-year period after the completion of the project the reservoir will not accumulate more than 3,000,000 acre feet of silt. An accumulation of 5,000,000 acre feet could occur before encroaching on the storage supplies held for power and irrigation purposes. During this 50-year period there will undoubtedly be upstream dams and reservoirs created and these will reduce the capacity needed at Hoover dam for flood control, thus balancing the loss of capacity caused by the silting up of the reservoir.

The All-American Canal

The All-American canal, as the name implies, is to be constructed entirely within the limits of the United States. This feature of the Boulder Canyon project is not physically connected directly with the Hoover dam and the power plant in Black canyon, but its construction

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ALUMNI NOTES

Prof. A. C. Callen, head of the department of mining engineering, has recently been named as a member of the American Institute of Mining and Metallurgy's engineers' advisory committee to the museum of science

Prof. A. C. Callen

and industry in Chicago. He was also elected as one of the three executive members of the coal committee of the institute at its annual meeting. Prof. Callen, although not a graduate of Illinois, took graduate work here from 1914 to 1917 and has long been connected with the mining department.

H. H. (Hank) Lane, c.e. '31, is now a second-lieutenant with the U. S. Marine Air Corps and is at present located at Pensacola, Florida.

George Macdonald, e.e. '29, is an engineer with General Electric at Schenectady, N. Y.

Harold T. Larsen, c.e. '23, is technical engineer for a publication of the American Society of Civil Engineers.

James Barr, m.e. '90, who has been with Armour & Company for many years, is now superintendent of construction of meat packing plants for the Russian government, and will be in Russia for two or possibly four more years. His present address is: Miasohladostroi, Rojdestvenka No. 21, Moscow, U. S. S. R.

James Mellutish, c.e. '93, is employed as an engineer for Parrish & Co. He was sent to Barranquilla, Columbia, in 1928 to organize preparatory forces and plans for 20 miles of paving and the construction of sanitary sewerage, a project estimated to cost over $7,000,000.

Here's an M. E. that many a graduating senior will envy. Keene Richards, m.e. '12, is consulting engineer and general manager of Vassar college. That's a job with many interesting sidelights.

Who said depression? Ira Rush, arch. '15, has opened another office at Bismark, N. D. Ira also operates an office in his home town of Minot, S. D.

Art Logan, c.e. '31, was on the campus for a few days on his way south a short time ago. Art was president of Tau Nu Tau, engineering military fraternity, last year. He's in search of a new job, as his last employers went on the rocks recently.

B. Kendall, ch.e. '30, is assistant in the paper sensitizing department of the Eastman Kodak company. He has been doing experimental work on photographic papers.

W. B. Pierce, c.e. '29, has an interesting position in a new field. He is sales engineer for the Aluminum Corporation of America with offices in Philadelphia, Pa. The corporation has brought out a number of new struc-

W. B. Pierce, c.e. '29

tural uses for aluminum in sky scraper erection, construction of car bodies and numerous other industrial applications of the lighter alloys.

While on campus Bill was one of the most widely known engineers on the campus. He was a member of numerous honorary organizations, served on all the major class committees and in his senior year was president of the A. S. C. E. student chapter.

Frederick J. Thielbar, Arch. E. '93, has been recently elected trustee of Northwestern university. Mr. Thielbar is one of Chicago's well-known architects (Thielbar & Fugard). Some of his products are the Cyrus McCormick residence, the Trustees System building, the McGraw-Hill building, and the Parke-Davis and Henry apartment buildings. He has been consulting architect for various other structures.

Otto Haier, m.e. '30, was recently appointed varsity fencing coach at Northwestern university. "The best fencer Illinois has ever had; he dominated the conference for two years, and established a record that is unbeatable," Coach Craig has said of him. Haier held the conference championship in foils for two years. His first title victory was wrested from Friedman of Chicago with a score of 5-0, the mose decisive margin by which the title had ever changed hands.

Captain of the squad in 1930, his team won the conference championship with the highest possible score of 15 points. Red Seibert, epee, and Chalmer "Doc" Gross, sabre, assisted him in running up the perfect count by annexing the individual titles in their division. Dr. Riebel, fencing coach at Ohio State university, has declared this team the strongest college varsity combination in the United States at the time.

Haier is aiming for a place on the United States Olympic team which will compete in the "World's Premier Sport Spectacle" at the Rose Bowl in Los Angeles next summer.

D. J. Porter, ch.e. '30, is teaching freshmen chemistry at State College, Pa., and is working for his doctorate.

The Hoover Dam Project

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has been considered for a number of years and it has been deemed wise to include it in the larger projects. The canal has been allotted $38,500,000 of the $165,000,000 appropriated to the Boulder Canyon project.

At the present time the Imperial valley of California receives its irrigation and domestic water supplies from the Colorado river by means of the Imperial canal. The water enters the canal through the Rockwood gates, about a mile north of the Mexican border, and is carried southward into Mexico following the ancient channel taken by the Colorado river when it was discharging into the Salton Sink basin. The canal proceeds in a southwesterly direction, then curves to the northwest, re-enters California, and serves the Imperial valley after traversing about 50 miles of foreign territory.

The proposed All-American canal will eliminate international disputes, avoiding the obligations and difficulties entailed by a location on foreign ground. The intake for the new canal will be located about 15 miles northeast of Yuma, Arizona, and five miles north of Laguna dam, which is the present diversion dam for the Yuma irrigation project. From the intake the main line will run southwest to a point immediately north of the international boundary, thence westward paralleling that line until it connects with the Imperial valley system about 10 miles west of Calexico. The total length of the main canal is 80 miles.

The Coachella branch leaves the main canal about 45 miles below the intake, and heading northward passes on the east side of the Salton sea and ends north and west of it, near the town of Indio. This branch will have a total length of about 130 miles.

The advantages of the new system are: (1) Complete control and freedom from international negotiations; (2) higher elevation, bringing the Coachella valley under irigation by gravity and increasing the total irrigable area from 500,000 to 900,000 acres; (3) possibilities of power development at drops along the canal; and (4) improved diversion facilities and desilting works.

The maximum section of the main canal will be 134 feet wide at the bottom, 200 feet wide at water surface and 22 feet deep. It will be necessary to line with concrete four miles of the main canal and possibly 47 miles of the Coachella branch. It is estimated that the total excavation will be between 60 and 65 million cubic yards, of which two and one-half million cubic yards will be rock.

Probably the greatest problem to be met in the construction of the All-American canal will be that imposed by the shifting sands. For ten miles the main canal passes through a ridge of sand dunes where cuts as deep as 100 feet will be necessary. If no preventative measures were taken, winds blowing the sand into the channel would soon reduce its capacity. Several solutions of the problem, one or more of which will be used, are as follows: (1) growing of vegetation in a zone on each side of the canal, using small pipes to irrigate the growth; (2) spraying the sand with crude oil; (3) covering the dune sand with material from the canal excavation which is too coarse to be blown by the wind; (4) maintaining a berm 30 feet wide along each side of the canal at mesa floor level.

Boulder City

The selection of a site for the town which will accommodate the workers engaged in the construction of the dam, was a problem which required careful thought. The points considered were: accessibility to the damsite, presence of soil for vegetation, cost of water supply and sewerage system, climatic conditions, and scenic values. The final choice is a site which is about six miles from the location of the dam; at this particular place the temperatures are much more moderate than at other points nearer the dam.

The completed town will afford facilities for about 4,000 people, will be entirely modern, with water, electrical distribution, and sewerage systems, sidewalks, curbs, and surfaced or paved streets.

The government is building an office building, a dormitory and a number of residences for its employees. It will also construct a post office, school and a garage.

A portion of the town has been set aside for use by the contractor. Six Companies Inc. has spent $750,000 for buildings in Boulder City. Eight dormitories have been finished, each of which provides separate sleeping quarters for 172 men. There are also 358 workers' cottages, two administration buildings, a hospital, a commissary, a huge mess hall, a large recreation center, and innumerable warehouses, laundries, garages, and so on.

The permanent government buildings will all be of the Spanish type of architecture and like the houses will be especially adapted to the extremely hot summers which prevail in this territory.

Boulder City will cover an area of about 200 acres, and be located at a point southeast of Las Vegas, Nevada, 24 miles by highway and 37 miles by railroad. It is situated at an elevation of 2,500 feet above sea level and experiences average temperatures ranging from 20 to 120 degrees Fahrenheit during the course of the year.

As the dam and reservoir will attract a large number of tourists and as a sizeable force will be needed to operate the power plant and reservoir, it is expected that the town will be a permanent fixture upon the desert landscape.

DEPARTMENTAL NOTES

A motion picture, "Forging Machine Operations," was shown at the regular meeting of the American Society of Mechanical Engineers, February 25. Mr. Harmon was the speaker, sent by the National Machinery Co. At the March meeting a General Motors film concerning their testing and proving grounds was presented

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During the past month the student chapter of A. S. C. E. has had the good fortune of hearing talks by several prominent engineers. Included among these men were: Dr. H. Von Schrenk, consulting timber engineer; C. E. Paine, consulting bridge engineer; and H. E. Blythe, assistant to the president of The Goodyear Tire and Rubber Co. During the month of April additional prominent men in the field of engineering are scheduled to speak before the chapter.

On Saturday, April 2, the student branch of the A. I. E. E. held their annual tri-school meeting with Rose Polytechnic Institute and Purdue University here on the campus. In the morning Dr. C. E. Skinner, national president of the institute, spoke before a joint meeting of the three branches and the Urbana section. His subject was, "The Institute and the Electrical Industry—What of Their Future?" At noon President Chase spoke before a luncheon meeting of the three branches. Talks were given by several of the visiting guests and by R. L. Dowell, manager of the electrical show, who invited all of the visitors to attend the afternoon session of the show.

In the afternoon the meeting was concluded with a tour of the campus and a matinee performance of the show.

The following men took the examination for membership in Tau Beta Pi, Tuesday, March 22, 1932: R. J. Whitesell, I. L. Wissmiller, W. E. Lindquist, F. W. Mast, G. K. Green, A. M. Daily, J. E. Somerville, E. E. Stephens, P. S. Bickenbach, B. M. Hess, A. Zemaitis, C. Endris, W. W. Brooks, L. H. Berkelhamer, H. M. Bieritz, N. A. Monson, E. N. Angell, N. A. Collora, G. B. Righter, F. R. Matson, H. P. T. Tideman, W. E. Compton.

Mu San, municipal and sanitary engineering fraternity, informally initiated nine men, March 17, at the Urbana sewage treatment plant in true Mu San style. Formal intiation took place at the Inman hotel, March 23, with Prof. H. E. Babbitt as toastmaster. The principal speaker of the evening was W. H. Walraven, superintendent of the Springfield, Illinois, sewage treatment plant, whose subject was, "Power from Sewage Gas." Those initiated were: S. W. Benedict, G. L. Carr, G. W. Chinn, F. Fisher, R. A. Forsberg, I. L. Wissmiller, E. L. Wittenborn, W. L. Yarger, and G. D. Zintel.

SIGMA XI

Announcement has been made of the election to Sigma Xi, national honorary inter-scientific fraternity, of twenty undergraduate students. Included among these were six engineers, namely: S. U. Benscoter, J. M. Nash, J. B. Tiffany, W. P. Jones, W. J. Bobisch, and W. E. Bohn. Prof. E. E. Bauer, of the civil engineering department, and Prof. D. R. Mitchell, of the mining engineering department, were also elected to membership.

During the month of March, two faculty men spoke before Theta Tau. On March 5, Prof. H. E. Babbitt, of the civil engineering department, gave an illustrated lecture on China and Manchuria. March 17, Prof. H. B. Ward, head of the zoology department, presented a series of slides taken during his trip to Alaska, and gave a talk on, "Salmon, Its Relation to the Engineer."

At a meeting of the Railway club held Tuesday, February 24, J. S. King, r. e. e. '32, was elected president to succeed Lib Panichi '32. Other officers elected were: L. J. Rettinger '33, vice-president; M. O. Starr '35, secretary; and S. H. Pierce '32, treasurer. Plans for the participation of the Railway club in the forthcoming electrical show were discussed. A complete automatic railway with automatic signals, switching, lighting and several other features will be presented by the members. C. S. Steele '32 will be in charge of the exhibit.

Mechanical Engineering

Prof. Macintire of the department is the author of the chapter on Mechanical Refrigeration in O'Rourke's *General Engineering Handbook* which has just been published by McGraw, Hill & Co.

Theoretical and Applied Mechanics

Prof. Westergaard gave lectures on "Stresses in Dams" at the University of Michigan, March 22-24.

J. L. Bisesi was in Indianapolis, March 3, making tests for the "Rail Investigation."

Prof. Seely's new book, "Advanced Mechanics of Materials," has been reviewed by Charles J. Tilden, professor of engineering mechanics, Yale University. Prof. Tilden states, "Prof. Seely in his 'Advanced Mechanics of Materials' has done a great service not only to the engineering profession but to those who are engaged in teaching, in bringing together in a concise and readable volume the major results of investigations and adapting them, in itself no small task, to teaching and study. As an example of engineering design the book is a model."

Graduate Engineering Courses

(Continued from page 5)

lating and enforcing specifications of materials; the influence of specifications on manufacture and design. A study is made of certain A. S. T. M. specifications of material for specified uses.

Graduate students in civil engineering and those in theoretical and applied mechanics take advantage of the graduate courses offered by both departments, which courses may be applied to the credit required in their respective majors.

In addition to the courses described in this paper there are many courses in other colleges open to graduate students, especially those in mathematics and economics.

Each candidate for a master's degree is required to present a thesis on some subject approved by the professor in charge of his work. The thesis ordinarily will demand one-fourth of his time and may not exceed one-third of it.

The thesis may be either experimental or analytical, or a combination of the two. While the student is advised rather carefully as to subject, general testing methods and technique, he is given all possible latitude for the development of initiative and individual methods in the planning and conduct of the thesis and is made to feel the responsibility for the accuracy and value of the results obtained. Thus, in general, students are not assigned a portion of a regular Experiment Station project as a thesis subject since the planning and conduct of such work is usually very definitely controlled by the faculty member in charge. However, many regular projects of the Experiment Station have grown out of the work of graduate students on their theses. The thesis, probably more than any other formal academic work, should develop power in organizing and planning work, perception, judgment, scientific accuracy in performing tests, and most of all, ability in analyzing, correlating, and interpreting results.

There are twenty-eight men on the research staffs of the two departments. In addition to these, many of the members of the teaching faculty devote part of their time to research and many assistants are employed from time to time. Excellent facilities are offered in the well equipped laboratories in the new materials testing laboratory.

Recent research projects in the Experiment Station and subjects for master's theses which are being carried on include: The bearing value of rollers, runoff characteristics of Illinois streams, biaxial stress, sewer pipe jointing materials, reinforced concrete arches, joints in wide plates, aeration of sewage, load distribution by timber floors, thin cylindrical shells as columns, admixtures in concrete, bearing value of knife edges, laminated timber arches, the bearing power of piles, the strength of wind connections, the effect of thickness on the properties of steel sections, studies in wind stresses, proportions of concrete arches, continuous concrete frames, sewage treatment by activated sludge process, the Sheffield method for aerating sewage, net sections of riveted joints, strength of bridge pins, concrete columns, concrete masonry walls, concrete made with light aggregates, long-time tests of concrete beams, columns and frames, stresses in railroad track, rail investigation, stresses in car axles, stresses in elevated railway structures, fatigue of metals at ordinary and at high temperatures, creep of lead, strength of cast iron pipe, phenomena of flow in pipes, radial flow between plates, torsion in channels and Z bars under transverse loads, the resistance of concrete to two-and three-dimensional loadings, the plaster model method for determining stresses in complicated shapes.

St. Louis Water Supply

(Continued from page 7)

Most of the calcium and magnesium present as bicarbonates can be removed with the application of lime. The calcium is then precipitated as calcium carbonate, and the magnesium is precipitated as magnesium hydroxide. Lime softening is used whenever the hardness is in excess of 125 p. p. m.

Soft water, besides being a convenience and a luxury, brings a direct monetary gain to the people of St. Louis county. They save in the amount of soap consumed on the average $140 per day or $51,000 per year, because of this lime softening treatment. The value of this soft water as compared to hard water is best appreciated by the consumer who formerly used hard water.

The creation of chemical balance is the most difficult task of the purification plant. To keep the water from neither depositing nor corroding means a careful manipulation of chemical dosages. Chemical balance is considered to exist at the solubility limit of calcium carbonate. A water that is saturated with calcium carbonate is neither corrosive nor incrustant, but is in equilibrium; one that is super-saturated is incrustant, and one that is under-saturated is corrosive.

The elimination of tastes and odors is always a laboratory study. Fortunately, such studies have not had to be frequent. Tastes, when they do occur, are so different from each other, that treatment is as varied as a doctor's prescriptions. Copper sulfate, potassium permanganate, and ammonium sulfate, have been applied as taste preventatives or antidotes.

Importance of Chemical Tests

Control of the entire purification plant is centered about the chemical laboratory. Daily chemical and bacteriological tests are the sole basis for operation. Tests must be made upon the raw river water, the pre-settled water, the chemically treated water, the water as it leaves the plant, and then again upon the water taken from the center of the distribution system some fifteen miles from the purification plant. High standards of quality in the water delivered to the consumers are thus assured by these frequent tests.

The most interesting of all the laboratory tests is the one from which chemical dosage is determined. River water brought to the laboratory is tested with various amounts of coagulants and then agitated in a stirring machine. Actual plant operation is predicated on these tests.

Dosages are determined in grains per gallon of water treated. At this writing the chemical dosage is 5½ grains of lime and 2 grains of ferrous sulphate per gallon of water. One pound is equivalent to 7000 grains.

Routine tests made in the laboratory also include the following determinations: turbidity, alkalinity, pH, hardness, residual chlorine, dissolved solids, suspended solids, and bacteriological quality.

Mr. W. H. Henby is president and general manager of the St. Louis County Water company. Mr. W. V. Weir is assistant general manager, and V. C. Lischer is superintendent of production.

Undertaker: "Depression? I'll say so! Why, I haven't buried a living soul for a month!"

—*Christian Register.*

* * *

"I suppose your home town is one of those where every one goes down to meet the train."

"What train?" —*Juggler.*

High-Speed Aluminum Cars Installed on Interurban Line

Electric interurban railways are giving more consideration to the usage of light-weight equipment and high operating speeds by the installation of high-speed aluminum cars, as told in the September Railway Mechanical Engineer. The Indiana Railroad System, an electric line owning more than 5,000 miles of track in Indiana, has ordered the purchase of 35 multiple-unit cars. These cars, 21 of which were built by the Pullman Car and Manufacturing corporation and 14 by the American Car and Foundry company, are capable of speeds in excess of 70 miles per hour.

Designed for interurban service, the new cars can be operated in either single or multiple-unit trains. When used as single units, the cars are arranged for one-man operation. The main passenger compartment carries 20 bucket-type seats, each accommodating two persons. A toilet room, wash basin, and water cooler are provided.

Fourteen of these new cars are equipped with observation-lounge compartments, taking up the rear third of the car, and having a seating capacity of ten. The interior of the cars is arranged for maximum comfort and convenience, the coach chairs being covered with genuine leather. Wide windows provide maximum light and visibility, while the circulation of air is cared for by means of ceiling ventilators, aided by two bracket fans on front and rear bulkhead.

In colder weather, automatic electric equipment will insure comfortable temperatures under all conditions. Lighting in these cars is provided by a double row of ceiling lights of high illumination which will permit reading without appreciable eye strain. The lighting system is designed to provide a steady interior light free from trolley fluctuations. The compartments, decorated in two-tone shading on walls and ceilings, are furnished with thick carpeting, deep upholstering chairs, solid American walnut furniture, reading lamps, and tapestry davenports. These luxurious comforts are available to all passengers without additional charges.

The height of something or what have you: The man who started a dirty magazine and cleaned up.

* * *

Father: "No, son, I can't send you to college, but I'll buy you a raccoon coat." —*Wall Street Journal.*

* * *

A life insurance agent called upon a big business man at the close of a busy day. When the agent had been admitted, the big fellow said:

"You ought to feel honored, highly honored, young man. Do you know that today I have refused to see seven insurance men?"

"I know," said the agent, "I'm them!"

—*Penn Mutual News Letter.*

* * *

"What started the Grand Canyon?"

"A Scotchman lost a penny in a ditch."

—*Carolinian.*

Bucket and Shovel

With this issue a new organization bursts forth on a long waiting campus. Children cry for it and professors yodel their joy at the prospect of a new honorary as is an honorary. *Bucket and Shovel* will devote itself to the promotion of astounding thought and action, to the reward of the meritorious and to the recognition of original contributions to science and engineering by student and faculty alike. Members lucky enough to be awarded honors will have something to point back to when and if they are fathers of future Illini.

The name is symbolic (all names always are). The Shovel, long a worthy tool of engineers both in school and after graduation, we'll use to gather all the dirt on engineers from the dirtiest corner of the M. E. foundry to the attic in Engin' hall. The Bucket will catch the dirt and then—why then as befits our position of *Tooter of the Sacred Lunch Whistle* we'll tip the bucket over.

Unidentified Ballot Box Stuffer at B. and S. election. He's a member when we find out his name. Who is he?

Here's the list of charter members and their new official capacities. Kick the Bucket! Here they are:

Ray (Bear Mountain) Brown by virtue of his size, Tau Sigma and the fact that he is a senior C. E. has been unanimously elected to the office of *Wielder of the Sacred and Honored Shovel.* Bear Mountain in addition to this cherished position has also been awarded a further recognition for his search for the truth, his latest effort being marked by his questioning Mr. Oliver as to the kinds of threads to use on rivets. He will receive by mail, C. O. D., a brand new double-acting rotary lollipop holder with single lap-riveted joints.

John R. Conner, frosh M. E. (Mr. Conner to you) has shoveled his way into the position of *Majestic and Respected Bearer of the Bucket.* Mr. Conner (Johnnie to you) recently displayed the true brilliance that distinguishes all B. and S. men in a recent chem quiz. In reply to the request for the formula for acetic acid John R. asserted that he thought (?) that all acids were acidic. As a symbol of his new and honored office we donate free of charge an automatic valve-in-head reciprocating cork extracter and a special invitation to be chairman of Arrangements at the Geo. Washington Tri-Centennial blow-out.

Since he is only another lowly frosh Herbert C. Zilly, (yes that's Herb's last name and no foolin') can only be a *Shovel Swinger* for the time being. Still there's plenty of time as Herbie is a C. E. Mr. Zilly recently confided (to someone he shouldn't have) that he thought that a transit was a kind of conveyance. (Ain't that Zilly?) To enable him to ride about in the latest kind of a transit we award him the only streamline kiddie kar this side of the Siren office.

W. D. Boone (Booney to you and you) is hereby blackballed from the list of charter members, for although by virtue of a number of things well known to his fellow senior ee's he was in direct line for a high position in B. and S. he is forever barred as he was recently convicted of wearing a Bobbie pin (fancy name for a hair pin to them as don't read ads) in his curly locks. Too bad, too bad.

Phil Anderson squeezes out several other prospective members as holder of the title *Master Lover of B. and S.* by his excellent performance and demonstration of his prowess in front of Engineering Hall with some unknown blond on the afternoon that Easter vacation ended. To Phil, the co-ed members of the organization, in connection with Thundermug Kahn, offer a transparent concrete umbrella so that he may enjoy more secluded surroundings.

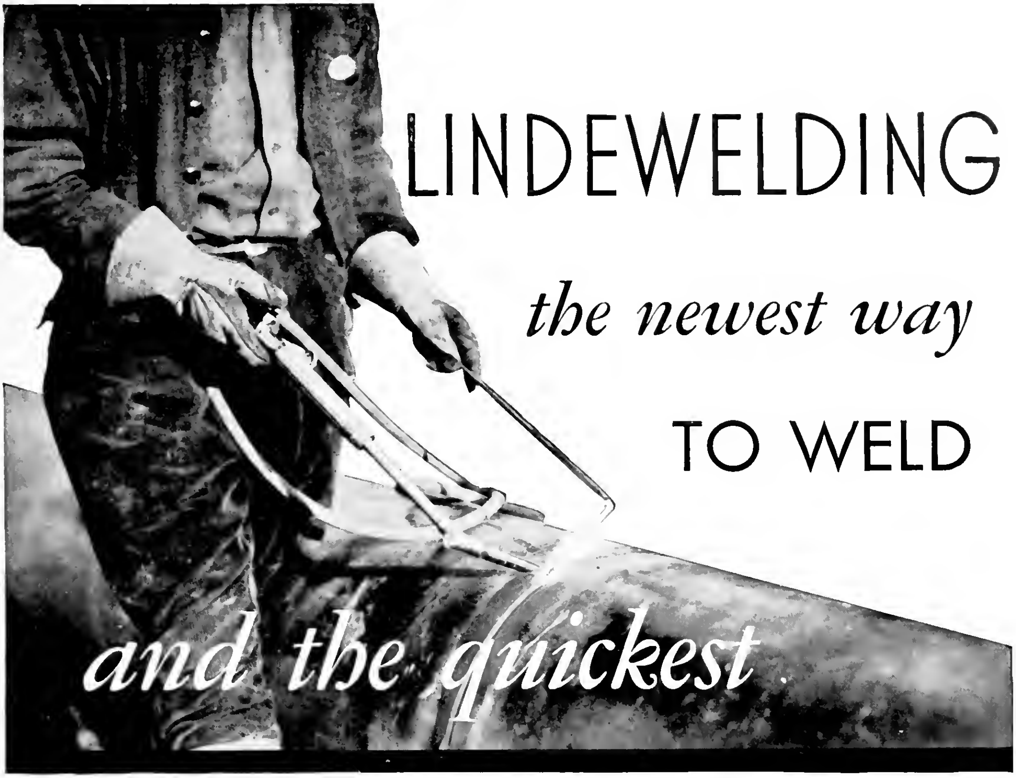
Bennett Burgoon, Tank Rogier and two other E. E's (names withheld on payments of five dollars) hereby are declared simple *Bucket Bearers* because of their recent experience in Kenosha, Wis., on an A. I. E. E. convention trip. E. E's will understand and those who don't should find out at first hand.

That's all the B. and S. members to be announced this month. Look out for next month; you may become a member overnight. Help your friends to rate a great honor and they'll do the same for you. Keep the Shovel swinging and the Bucket full. Kick the Bucket, Sid. Meetin's adjourned for this week.

* * *

"How do you like your new daddy, Johnny?" the son of the grass widow who had recently tript up to the altar again was asked.

"Oh, he's all right in some ways," replied the kid, "but he can't do my home work as good as the other one did." —*Cincinnati Enquirer.*



On 15 major pipe lines completed in East Texas, 50 per cent. of the total oxy-acetylene welded mileage is Lindewelded.

Why, in scarcely more than a year, has this new method of oxy-acetylene welding been adopted by leading pipe line builders in every part of the country?

The answer is: Because it saves from 30 to 60 per cent. of the time required by ordinary methods of welding.

Because it reduces welding material consumption 35 to 40 per cent. Because it produces stronger and more ductile joints.

Lindewelding can be done with ordinary blowpipes or with special apparatus which makes welding almost automatic and further increases its speed.

Several valuable and interesting technical booklets describing the application of the oxy-acetylene process of welding and cutting in design, construction and fabrication are available. Tomorrow's engineers will be expected to know how to apply this modern metal-working process. Write us if you are interested.

Motion Picture Shows details of Lindewelding

Lindewelding technique differs from neutral flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. The actual steps in making a Lindewelded joint are shown in our motion picture, "The Lindeweld Process for Pipe Line Construction." This will be loaned free of charge to schools, pipe line officials and welding or engineering societies. It is furnished in 16 mm. and 35 mm. safety film and can be obtained by writing to any Linde District office.

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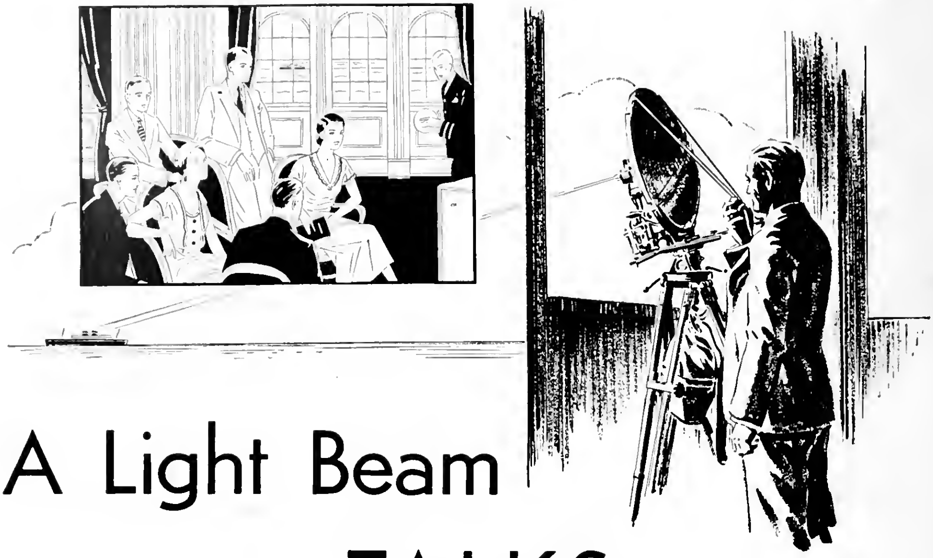

A Light Beam TALKS

FROM the flickering light of a neon tube on the skyline of New York City, a speech was sent to the *S. S. President Hoover,* 3000 feet away. The small neon tube changed the electric impulses from a microphone into light waves, which were directed to the ship in a narrow beam. A photoelectric tube in the center of a receiving mirror on the ship changed the light impulses back into sound, and the speech was heard on board.

The use of light that can be heard, and of sound that can be seen, has many applications. It can be used for speech communication; it can serve in fog to guide aircraft on their course and into port; and it can be used for radio and television broadcasting.

The development of future forms of transmission, whether in sound or light waves, will largely be the responsibility of college-trained General Electric engineers. To-day, these men are planning, producing, and testing electric equipment which will help maintain General Electric's leadership in its field.

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THE TECHNOGRAPH

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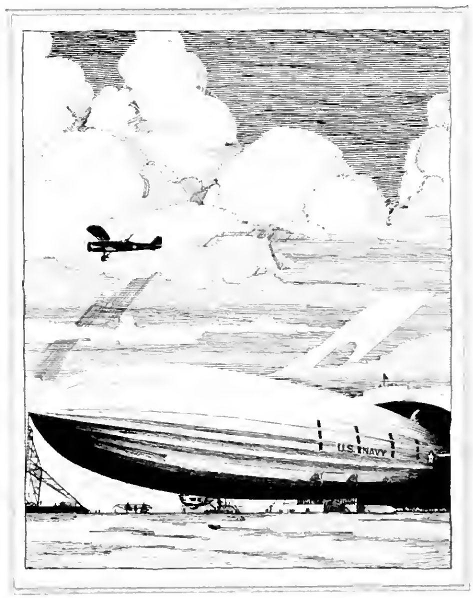

MAY 1932

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

THE TECHNOGRAPH

UNIVERSITY OF ILLINOIS

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[illegible] of the sundial with the east tower of University Hall in the [illegible]ground is familiar to all Illinois engineers

THE TECHNOGRAPH

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

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Bright Prospects Predicted for Lighter-Than-Air Transportation in the Future

HARRY E. BLYTHE

Assistant to the President of The Goodyear Tire and Rubber Company

Members of the A. S. C. E. will remember hearing Mr. Blythe speak on this subject at a recent meeting of the organization. According to Prof. J. J. Doland, all attendance records for the society were broken at this meeting.—EDITOR'S NOTE.

AMERICA is preparing for an era of aerial navigation, and the program outlined may savor of a Jules Verne fantasy, but as sure as Fate the idea conceived in the mind of President P. W. Litchfield, of the Goodyear Tire and Rubber Company and the Goodyear-Zeppelin Corporation, will in time bear fruit.

In Akron, the home of Goodyear, the project to establish and develop trans-oceanic air lines is regarded simply as the sober plan of a well-established business, nearly ready for the launching. When the giant airships are in operation on a commercial basis we shall see huge helium-inflated crafts, the length of an ocean liner, making weekly flights across both the Atlantic and the Pacific. These leviathans of the sky will not fly for adventure but for service, taking the full responsibility of carrying passengers, express, and the United States mails.

Although romantic as the plan appears, some of the larger industries and long-established financial concerns of the country, like Goodyear of Akron and the National City Company of New York, with certain steamship interests and other corporations, are behind the venture and are represented in two companies formed for trans-oceanic service. Only a few days ago the Graf Zeppelin returned to Friedrichshafen from one of its regular trips to South America. The various flights the Graf has made to Rio de Janeiro and back to the homeland clearly indicate the wonderful possibilities that lie ahead for commercial airships.

The first commercial ship intended for service between America and Europe, will have a helium gas capacity about 1,000,000 cubic feet greater than that of the U. S. S. Akron, which was built in the Goodyear-Zeppelin airship dock at Akron and a few months ago turned over to the United States Navy, and the U. S. S. Macon, which the company now has under construction and plans to deliver to the Navy early in the year 1933. The length of the coming giant air liner's frame, holding the lifting gas chambers, would be somewhat greater than that of the Mauretania or the Ile de France. And we all agree that means bigness.

Just where to put the limit in size of the merchant airship of the future is not expressed even by Dr. Karl Arnstein, vice-president and chief engineer of the Goodyear-Zeppelin Corporation, who designed some eighty Zeppelins for Germany before and during the World War, Dr. Arnstein says the merchant airship might be double the size of the Akron or Macon, for, unlike airplanes, airships gain in efficiency as their size increases, up to a point which has not been determined.

According to tentative plans, the merchant Zeppelin will have cabin space for 80 to 100 passengers and some 25,000 pounds of mail and express. There will be glassed-in promenades. Deck windows will swing out from the lower sill, so passengers can look down on the surging sea below. Goodyear-Zeppelin engineers have made sketches of the staterooms and salons which hint of aerial luxuries. The dining room looks much like any other dining room, but the furniture will be of duralumin because of the desire to refrain from adding any more weight than is absolutely necessary. The engines, as in the Akron and Macon, will be built within the hull.

Courtesy Westinghouse Electric & Mfg. Co.

The 127-h. p. motor which drives the portable mooring mast for the Akron

While the feasible speed of all forms of surface transportation, such as railway trains, motor cars and steamships, is necessarily restricted on account of physical and geographical conditions, the big airships will not only carry tons of passengers, mail and express much faster, safer and more comfortably than any other known mode of transportation, but they will not be restricted to the geographic limitations of earthbound conveyances. A craft of the type of the U. S. S. Akron can go practically anywhere, and it has a cruising range of nearly 11,000 miles without refueling. Even if the ship runs out of fuel and its motors stop, it does not have to come down, for the helium gas holds it up. It soars like a balloon.

Strolling on the enclosed deck of a proposed air liner

As for actual performance, the airship of tomorrow, operating on the commercial airship lanes, will be far more nimble than the steamship. Tilting propellers, such as those on the U. S. S. Akron, enable the giant ship to go not only backward and forward, but to rise or drop vertically under control at a 45-mile speed. The normal traveling rate of the huge commercial ship will be from 80 to 90 miles an hour.

Already a vast amount of testing has been done. Officials of the International Zeppelin Company and the Pacific Zeppelin Transport Company talk as if trans-oceanic flights had already been made many times by their projected merchant fleet. Even the weather has been taken out of the realm of guesswork in the preparations made by the two companies. In order not to be taken unawares, meteorological experts of the Goodyear-Zeppelin Corporation made 520 "theoretical crossings of the Atlantic." They studied the actual weather conditions as reported on government maps for 520 days, charted a course for an airship to avoid storms and take advantage of winds on each day, and came to the conclusion that three-fourths of the time the ships would come through on time or ahead of schedule.

The significance of the organization of the two trans-oceanic airship companies mentioned lies in the fact that it represents a serious survey by responsible transportation and financial groups into the possibilities of commercial airship operations. These companies have built no hangars or docks, bought no airports, ordered no ships, set no rates for passengers or express. But they have made a careful study of these and other matters, such as legislation, weather, revenue, operating costs, routes, personnel and terminals.

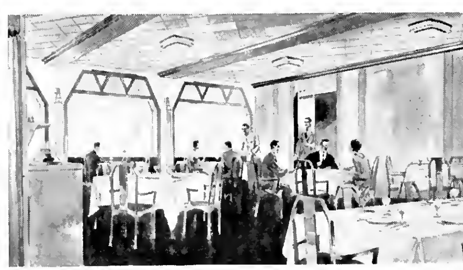
While statements as to rates and operating costs would be premature at this time, the companies were organized on the theory that the quickening of trade relations between widely separated points, especially over water, offers such advantages to commerce and industry that a permanent and profitable business at reasonable rates can be built around such a service. This has been the history of other carriers—the railroad, the steamship, the automobile, the airplane.

The Pacific line, the planners of the project have announced, is to start with operations between California and Honolulu, if all goes well, with a hangar base on the California coast and a mooring mast in Hawaii. This would permit a weekly round trip service with one airship. The California-Hawaii route should prove both an ideal training ground for initial operations and develop sufficient traffic to render such operations reasonably profitable. On the basis of experience with one airship and two terminals, an extension to Manila and the Orient could be considered with some degree of confidence.

Some very interesting information has been divulged by Commander Jerome C. Hunsaker, vice-president of the Goodyear-Zeppelin Corporation and president of the Pacific Zeppelin Transport Company, relative to conditions affecting the operation of the proposed trans-Pacific airship line.

Commander Hunsaker says that the general circulation of air over the north Pacific in an approximately elliptical orbit manifests itself in prevailing winds. It is possible to take advantage of these winds in arranging an airship route. Starting, for example, at Seattle, the prevailing wind down the coast to Los Angeles is northerly. From Los Angeles, the route to Honolulu runs through the trade wind belt and an airship may count with certainty upon a favoring wind and fair weather. In fact, this portion of the route is perhaps the most favorable for airships of any stretch of equal length in the world. The 2,200-mile run to Honolulu from Los Angeles should require less than a day and a half.

From Honolulu to Manila, the entire 4,800 miles of route follows the trade winds. A favorable wind may be counted on and a passage of about three days. In certain months typhoons are to be expected near Manila. These storms are of great intensity, but local in extent, following a well-defined track. To avoid a typhoon appears to be a readily arranged matter, as with modern radio methods the storm center can be tracked and its subsequent source predicted a day or more in advance.



The dining room on a projected air liner

From Manila to Yokohama is a 1,500-mile run, with head winds to be expected part of the time. An airship should make this course in less than two days. From Yokohama to Seattle or San Francisco, the prevailing westerly wind will often carry the ship along. On a given passage westerly winds are certain for part of the time.

In winter, for at least part of the route, weather

(Continued on page 14)

Dynamite Being Used In Road Construction Through Wisconsin Swamps

ANDREW KLESZEWSKI '33

Credit is due to E. I. Du Pont De Nemours & Co. for information received through the "Blaster's Handbook." Credit is also due the "Highway Engineer & Contractor" for cuts.
—EDITOR'S NOTE.

THOSE of us who live in densely populated regions have had little or no experience with dynamite, while those who have been brought up in rural communities have some idea of its importance. Every farmer knows the full value of this explosive. Now the knowledge of dynamite should be of no less importance to the engineer who uses this explosive in so many classes of field work which are directly under the supervision and guidance of engineers.

Dynamite, which has taken the place of gun-powder, consists of a powdered substance partly saturated with nitro-glycerine and a fluid produced by mixing glycerine with nitric and sulphuric acid. The nitro-glycerine present constitutes the explosive body of dynamite. It has a specific gravity of about 1.6 at 60° F., is odorless, nearly or quite colorless, and has a sweet burning taste. As the material is poisonous, even in very small quantities, the handling of it causes severe headaches for which there seems to be no antidote.

The action of dynamite is similar to all explosives in that it can be instantly converted, by a spark or shock through a percussion cap, into a large volume of gas. There is nothing mystifying about its action. Essentially, the reaction is analogous to the conversion of water into steam, though the action is almost instantaneous. Dynamite, after explosion, almost completely changes into a gaseous form having an extremely large volume. This action of the blast, with the great volume of gas which in escaping tries to get out through the path of least resistance, tears and pushes with such a pressure that everything shatters in its wake.

There are innumerable uses for dynamite, and almost any article we handle has had contact with some sort of explosive before its manufacture into a usuable commodity. Mining and construction engineers head the list in the use of this great stored up energy, and to them, without a doubt, dynamite is most vital. Inasmuch as construction covers a broad field, the discussion will be narrowed to the use of dynamite in road building in Wisconsin.

The road construction job was a five-mile stretch of 20-foot concrete pavement on state route No. 26, between Three Lakes and Eagle River, Wisconsin, in the north end of Oneida County. Incidentally, this is one of the most scenic parts of northern Wisconsin. In working with the dynamite crew in every capacity, of holing, loading, and blasting, and at the end of a 15-pound wooden sledge maul, I became quite familiar with the reaction of this lively substance called dynamite. There were two bad swamps holes in this five-mile stretch, and one, only 600 feet in length, required 18 thousand pounds of 50 per cent dynamite.

The survey showed this swamp to have about 18 feet of muck under the old road bed. This swamp had to be blasted throughout an entire width of the 100-foot right-of-way, and well filled before the concrete slab could be laid upon the settled foundation.

Half of the roadway was undertaken at a time. Two different methods of blasting were used. First, a ditch was blasted about 30 feet from the center line, and then the slope of the fill. After both sides of the road were blasted in this manner, the center was loaded, together with both ditches at the right-of-way, and then the road was again filled and allowed to settle. No further blasting was needed. However, in some cases, such as the swamp through the Menominee Indian reservation, a final blasting was needed. The method of attack, upon this swamp was to put about 10 feet of sand-fill on top of the old road bed and to spread it out 30 feet from the center line. Then ditches were blasted on either side of the fill. This ditching was done by the propogation method.

Tests showed that a depth of three feet and a spacing of 16 inches was most suitable. Our man used an improvised two-inch cast iron T pipe for holing. This he

(Continued on page 9)

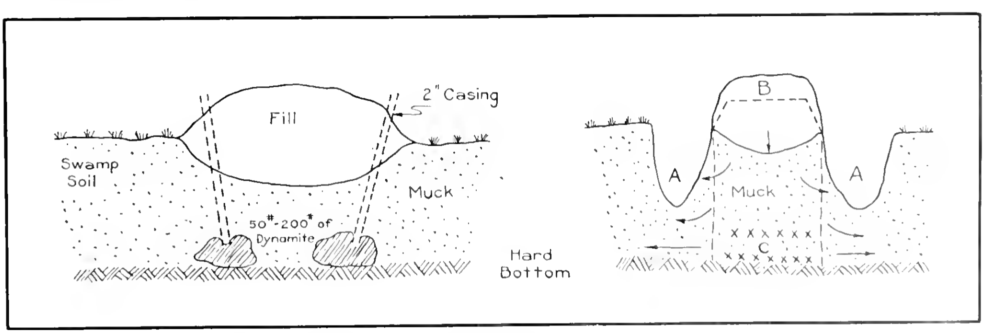


Figure 1
Ditches A-A are blasted to relieve the side pressure, allowing the fill to push out the muck underneath. Charge C augments the movement in a lateral direction

The Electron Tube in the Modern World

F. M. Deerhake '32

The following was a prize-winning article submitted before the Urbana section of the I. I. E. E. in competition with students of the university and Rose Polytechnic Institute.—Editor's Note.

SINCE discovery by Thomas Edison in 1883 of the *Edison Effect*, which indicated that electrons would flow in an evacuated tube from a heated cathode to a positively charged anode, a steady trend of development has existed in the field of electronic emission in both vacuum and gas filled tubes. Not until the last ten years, however, has the electron tube become a product of great commercial importance. The use of two, three, and later, four element tubes in radio communication has so increased demand and stimulated research that the usefulness of the electron tube has been extended to many fields in which its use was hardly thought of five years ago.

Figure 1
A radio frequency pentode intended for d. c. operated receivers. Courtesy *Radio News*.

The electron tube is suitable for use in control devices. It has entered two fields; first, that of performing more efficiently a duty that might be performed in some other manner, and second, that of performing a duty which could not successfully be performed in any other way. The outstanding examples of this second field of progress are radio broadcasting, television and sound transmission on a light beam.

The electron tube affords many advantages over mechanical control devices. It offers operation that is very rapid, practically instantaneous under proper conditions; it requires small actuating energy which may be amplified to a high degree; it is highly accurate and dependable, operates quietly, and is in general free from moving parts and mechanical contacts which leads to long operative life. In addition to the operational advantages, the use of the electron tube possesses a very important quality in that the actuating stimulus may be supplied by any of a large number of physical or electrical effects. Operation may be made to depend upon any of such effects as change in resistance, change in capacitance, change in inductance, variation of phase angle or frequency, rise or fall in temperature, variation of intensity of light, sound, or color, or change in radio or carrier currents.

The simplest operation of the electron tube, and the one with which we are most familiar in connection with radio, is its use as an amplifier of electric signals. (Figures 1 and 2). Here the tube merely transforms an input signal of a given intensity into an output signal of greater intensity. While the amplifier tube is one of general use, it finds a particularly useful field in communication work. The amplifier tube used in repeater stations has made possible the development of long distance telephone communication. It has given us our modern radio set, made possible sound motion pictures, public address system, and assisted in countless other types of electrical experimental work. Use of the vacuum tube as an oscillator and as a modulator of electric signals has formed the basis of the highly developed radio broadcasting system of the present day. Its use as a rectifier of alternating currents, which is commonly demonstrated in the modern light socket radio, makes it possible to obtain a reasonably large amount of direct current power from an alternating current source. The use of such a tube as a detector of electric impulses is another of the pillars upon which the modern radio receiving set is built.

Vacuum tube control has recently been applied successfully to the synchronizing of large generators. Manual synchronizing has always been a job requiring skill and experience on the part of the operator. Even under the best conditions its accuracy is subject to serious question. The vacuum tube synchronizer may be set to operate automatically and accurately without supervision from the operator.

The unit which has opened probably the largest field for developments of all kinds is the photo cell, familiarly known as the electric eye. No more fitting title could have been applied to this cell which distinguishes between slight variations of light intensity or color with an accuracy beyond the possibilities of the human eye. This simple cell consists of two elements: a cathode which emits electrons in proportion to the amount of light striking it, and a positively charged anode which attracts the electrons. It does, with more than human accuracy and dependability, everything from counting units in the production line to protecting valuables with an invisible burglar alarm.

Figure 2
A voltage amplifyer tube having an amplification factor of 30. Courtesy *Radio News*.

The photo cell may be conveniently adapted to the job of counting in any of a number of ways. Wherever it is possible to intercept a beam of light with a series of objects, the cell handles the job very effectively with the expenditure of a negligible amount of power, and hardly any wear on counting mechanism or object. By such means, numbers of people, traffic, or articles of production may be ascertained with great accuracy and little supervision. In the steel mill a properly located photo cell reverses the rolls after the steel being rolled has passed in one direction.

Another cell, placed in the smokestack of a steam plant, not only watches the smoke density at any instant but keeps a complete graphic record. The density of the smoke at any instant determines the amount of light reaching the photo cell from a light source on the opposite side of the smokestack. Another cell may be made to observe the temperature of a heated object by the brilliancy with which it glows. Still another watches the armature of a rotary convertor. Any tendency to flash over is immediately detected by the photo cell, which then operates protective apparatus. In the paper mill or in the newspaper printing office a photo cell watches the continuous sheet of paper passing over the rolls so as to detect breaks before they may cause a serious delay. When the paper is to be cut for wrapping in such a way that a certain amount of printed matter is to appear on each package, it is difficult to operate the cutter so that the printed matter appears in the proper place on each sheet. The photo cell not only provides for cutting at the proper time, but may even go ahead and supervise the wrapping of the packages as the articles are produced.

When used with a light source of standard intensity the cell provides a standard for measuring transparency. The transparent object being tested may be classified according to the current flowing in the photo cell when the light has been intercepted by means of the object. A similar system may be set up for the classification of colors, which allows the drawing of a permanent color characteristic for a sample, and standardizes the comparison of one sample with another.

The problem of illumination in offices and factories has always been one of great importance. Too little illumination brings poor working conditions and a corresponding loss in efficiency. Too brilliant illumination is unnecessarily expensive and is likely to cause glare. The photo cell watches these conditions carefully. It turns on the number of lights necessary to give proper intensity and turns them off again when they are no longer needed. It performs a similar operation in connection with street lighting, turning the lights on during that part of the day when daylight intensity lies below a certain value.

The advent of automatic traffic signals raised the problem of the intersection where traffic is distinctly heavier on one thoroughfare, but where some provision should be made for traffic on the cross street. Again photo controlled apparatus has supplied a practical and successful solution to the problem. Across the side street on either side of the intersection is a beam of light concentrated upon a photo cell. As long as this light remains uninterrupted the main street retains the go signal. A car approaching upon the side street asks for the green light by stopping in front of the photo cell and cutting off the light. The green light turns to the side street long enough for the car to pass and then returns once again to the main thoroughfare. This system provides for a minimum of delay to all concerned.

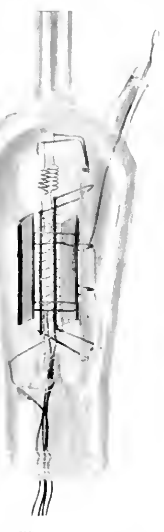


Figure 3

An [illegible] meter used to measure with [illegible] degree of accuracy the pressure in a [illegible] Courtesy [illegible]

The photo cell even enters the field of the motion picture theater. Films of different sizes produce light areas on the screen of different sizes. Velour curtains are provided around the screen to frame it to the proper size for each picture being shown. Two photo cells, which seek a point of equilibrium when the outer one is dark and the inner one lighted, locate each curtain exactly at the edge of the illuminated portion of the screen. If a larger image is thrown upon the screen, the outer cell receives light and moves the curtain outward until the edge of the light is reached; while if the image becomes smaller, the inner cell receives no light and moves the curtain inward until the light is reached once again.

The photo cell may be used to protect people or valuables. For example, a beam of light shining across the door of an elevator falls on a photo cell. Should the car be about to start when a person steps through the door, the interruption of the light on the photo cell holds the door open and keeps the car from moving. The photo cell may be constructed of a light sensitive material particularly sensitive to ultra-violet light. Such a cell together with a beam of ultra-violet light invisible to the human eye may be used as a burglar alarm. Any object such as a person's body interrupting the ultra-violet beam sets off the alarm. Any number of minor or even freak duties are or may be performed by means of photo cells. The automatic opening of garage doors when a cell is operated by automobile headlights, or the operation of a drinking fountain when a person intercepts a light beam by bending over to drink, are examples. An interesting projected use is that of switching on the complex illumination system of the 1933 World's Fair in Chicago by means of light from the star Arcturus concentrated upon a photo cell by means of the powerful telescope in the Yerkes observatory.

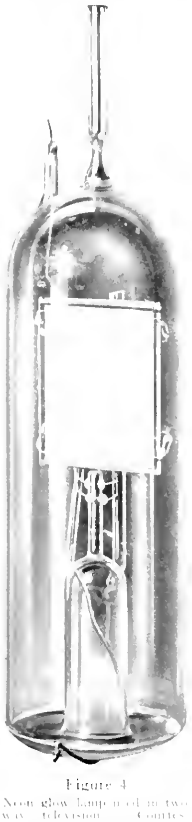


Figure 4

Neon glow lamp used in two way television. Courtesy *Bell Telephone Laboratories*

In television and the transmission of pictures by wire, the photo cell converts the light impulses created at the transmitting station into electric impulses. How are these electric impulses to be re-converted into light at the receiving station? The glow tube has been developed to meet this need, because of its property of producing a light intensity continuously proportional to the intensity of the electric impulses used to operate it. (Figure 4). This tube produces light by means of an electronic dis-

Continued on page 11

Geology and the Engineer

During the World War engineering geology became widely though tardily recognized as having a great importance upon military operations, and since then its importance has been steadily increasing until now it is one of the most important features of engineering. It is related to practically all branches of engineering, including mining, civil, ceramic, and railway. Geological features of the terrain are of primary importance in such construction work as bridges, dams, tunnels, reservoirs, and water supply. It must be taken into consideration in mining and ceramic work, and also in railway location.

A study of geology is also of a cultural value to the engineer, affording him an opportunity to learn something of geological history and time—a most interesting subject. It would be well for every engineer to learn something of geology, if not for the engineering value, then for the cultural value it offers. —R. A. F.

Make Summer Profitable

With the termination of final exams the question is asked, "How should the summer be spent?" The final hours are drawing near, and as individuals we will enter into new environments.

Those students who are financially able will benefit from enrollment in summer sessions here or at other schools. Advanced hour standings can be obtained in this manner giving additional free time in the regular school years to follow.

Unfortunately there will be a scarcity of individuals so fortunate as to be in line for summer work. These few will be granted the opportunity of facing actual problems confronting the industries.

Others will be lured by the pleasures and advantages found in traveling. Many an engineer can be better rounded by journeying into more remote parts of the country. Not only will the student enlighten himself by viewing and studying canals, bridges, buildings, highways, dams, power plants, etc.—but, at the same time he will be made to enjoy the opportunities of meeting and acquiring new friendships so essential to social development.

For the comparatively unfortunate individual, who will merely loiter around the old home town, there is little hope. As far as his future is concerned, he will be found lacking in these experiences so vital to the successful engineer. Then why not get out of this dormant summer condition? There are profits in store for those who will. —B. B. J.

Ocean-to-Lakes Waterway

Negotiation of a United States-Canada treaty respecting the 115-mile international section of the St. Lawrence river between Kingston, Ontario, and Montreal is a preliminary to the realization of a $300,000,000 dream that engineers and shippers alike have had for many years. The improvement, which was recommended by an international joint commission in 1921, after an eighteen months' investigation, will include a series of nine locks, besides many miles of canals, and river and lake channel improvement, the whole project to extend over a period of eight years. Small vessels have made frequent journeys from European ports to the Great Lakes, but now ships 800 feet long can be accommodated by the proposed locks.

The advantages of this project can not be over-estimated. Besides a tremendous reduction in freight rates due to the eliminating of unnecessary handling costs and a lowering of the time of transportation of the goods, it will afford employment to hundreds of men. These men will be employed not only on the actual St. Lawrence river development, but also by the large Great Lakes ports in the improvement of their harbors and docks to make provisions for taking care of the large ocean freighters. Many of these cities are already preparing for the dawn of their day of world trade, and many more are laying their plans for it. This enterprise should aid materially in relieving the present condition of the country. —R. A. F.

Our Swan Song

It is with a mixed feeling of rejoicing and sorrow that we watch the last issue of the *Technograph* go to press. Rejoicing because of the completion of a job which demanded attention, sometimes when time was difficult to find. Sorrow because of the passing of a valuable experience. Rejoicing because of the achievement of certain aims which we set out to accomplish last fall. Sorrow at our failure to accomplish others.

In the October issue last fall we set out certain planks as our platform for this year. We were going to specialize on student-written articles. We were going to distribute the feature articles so as to cover all engineering fields to a somewhat equal extent. We were going to present to our readers a continuation of the engineering history started last year in the *Technograph*. We were going to present a vocational series of articles. We were going to emphasize economics in these columns. We were going to make the *Technograph* such a well-balanced magazine that all Illinois engineers would find an interest in it.

On some of these aims we have scored well, and on others we have not done so well.

Now it is time for us to turn over the reins to our successors. We wish you the best of luck. May the subscriptions and advertising come in at such a rate as to swamp you with funds. May the copy be given to you in such quantities that you will never have to stir around in quest of material.

To our readers: We hope that the magazine has been sufficiently interesting to you that you will be among next year's subscribers.

1932-33 Technograph Staff Chosen

We take pleasure in announcing that Randall A. Forsberg has been chosen as editor, and A. E. Wanderer as business manager of the *Technograph* for next year.

Figure 2

A perfect fill settlement blast, which the camera caught at the peak of its rise

Dynamite in Road Construction

(Continued from page 5)

would lift high enough to obtain sufficient driving force for jabbing into the ground. Immediately after pulling it out, the second man dropped two or more sticks of dynamite into the newly made hole, the number of sticks depending upon the nature of the ground. The swamp being wet and soft, no tamping was needed other than a mere stamp with the man's heel. The man driving the T kept a straight line parallel to the center line of the road and was careful in keeping the spacing of his holes uniform. About 150 feet of ditching were loaded at a time to prevent any danger. Only the end three holes were primed with electric blasting eyes, the concussion from this being sufficient to set off the whole line of charges. Only straight dynamite should be used for the propogation method, as other kinds are not sensitive enough to be detonated by the shock from a single primer. This method can be practiced in the roughest of swamps, even where the swamp is covered with stumps and several inches of water. The charge described above was strong enough to lift and push the swamp, adjacent to the fill, about 4 feet up and from 8 to 15 feet over. The simplicity of the propogation method and the excellent results obtained must be actually seen in order to be fully realized.

The fill from the center out to these ditches was allowed to settle for 24 hours, after which the center was blasted. This required loading the dynamite down at the hard bottom, blasting the sides first, and then setting off auxiliary charges in the center. Some blasters believe it better to fire both sides and the center at once. However, this is still debatable and is based purely on personal experience.

The method was primarily simple in procedure, consisting of four steps in its completion. (See figure 1). Two-inch casings were driven, either with a small portable pile driver or usually by hand with a 15-pound wooden maul, down through the fill and muck, to the hard bottom underneath. The pipes, at an angle on the slopes of the fill, were driven about every 18 feet. A small charge of about 2 pounds was dropped down 22 feet to the bottom and blasted to create a cavity for the main loading, which took from one to four 50-pound boxes of explosives. Through the center of the fill, lighter charges varying from 25 to 100 pounds were placed in the same manner. The charge, of course, necessitated perfect tamping to solidly fill the cavity, and this was done with a long limber wooden rod at each loading of five to ten half-pound sticks.

All that was left was the wiring and discharging. Usually eight or ten such casings were fired at once. The mud underneath the fill was pushed out to the side. When the center fill material dropped back, it went down through 15 or 20 feet of muck to hard bottom and was compacted by its fall. The fill continued to compact and fall for many hours afterward. All the blasting was done with dynamite, in small half-pound sticks, of 50 per cent gelatin. These proved most successful on this particular job. A higher explosive lifted the fill too high, and a weaker type did not push the muck far enough in the lateral direction. Figure 2 shows a blast at the height of its rise.

A small swamp, which needed only the surface moss removed, was efficiently blasted by poking sticks of dynamite all over the required area. The sticks were placed within 18 inches of each other so as to be detonated entirely.

The use of dynamite, for the removal of soft unstable material, is of value to the engineer and his profession in many other fields. Railroad officials are eliminating the attack of constant moisture and water insects on wood trestles in swamp regions by subduing the elements of nature with this chemical energy. In cities, many desirable industrial centers and factory sites have been passed by because of their soft swamp conditions. The future looks bright for the engineer who can harness dynamite power, and solve his problems more economically under these conditions.

Architecture

C. T. Masterson '30 won first place in the nineteenth competition for the Francis J. Plym Fellowship in Architecture. Arthur Bassin '31 won second place. Announcement of the awards was made the latter part of April. The problem for the competition was entitled, "A Monument to Aviation."

ALUMNI NOTES

A letter from California informs us that M. A. Earl, c.e. '93, is a consulting engineer in Whittier, a "Quaker community, close to the mountains, orange groves and beaches." He has gone into the real estate business to a considerable extent lately.

Another '93 man who has appeared in this section more than once is E. E. Barrett, who has recently been elected president of the University Board of Trustees. Graduating in civil engineering, Mr. Barrett has long been active in his profession and is now president of Roberts and Schaefer Company, builders of coal mining machinery.

Herbert C. Arms, a.e. '95, died January 23 at his home in the Georgian hotel, Evanston. He was vice-president of the Central Scientific Company, world's largest manufacturers of laboratory supplies and scientific instruments.

While in school, he became a member of Shield & Trident, Glee and Mandolin clubs, both of which he helped to organize, Architects' club, and president of the Students' Dancing club. He was treasurer of the freshman class, editor of the first Illio, which he named, associate editor of the Illini, and chairman of the committee for class day programs. As a member of Sigma Chi fraternity he became a prominent leader, holding many national and local office. In 1927 he was elected grand president—the first member of the Illinois chapter to become national head of the fraternity.

Immediately after graduation he became an assistant architect with the Illinois Central, leaving there after three years to become manager of the Chicago Laboratory and Scale Company. In 1904 he became vice-president of the Central Scientific Company, which position he held at the time of his death.

Among the busy architects of the class of '91 are Fred Clark, who is located out in Omaha, and Walter Shattuck, who is in Chicago.

Ben Stakemiller, c.e. '00, recently suffered a severe injury to his foot when his auto fell from a service station hoist and crushed it. Mr. Stakemiller is now a councilman in Long Beach, California, where he moved 15 years ago ago after having been city engineer of Alton, Ill. He has made a fortune in oil.

F. J. Arnold, c.e. '03, is an engineer with the Commonwealth Edison Company in Chicago.

Another versatile engineer is H. C. (Hank) Ackemann, c.e. '09, who is head of Ackemann's department store in Elgin, Ill. Quoting from a recent letter from the class secretary: "an accomplished pianist; honor student in civil engineering; a stalwart officer in the university brigade—who would have thought he would become a prince of merchandising?"

From the Canal Zone comes word that A. K. (Al) Fogg, c.e. '15, is located in the 15th Naval District, Balboa, Canal Zone, with his wife, Florence Hunt Fogg, an Illini of the class of '17. He is lieutenant-commander in the civil engineers corps of the U. S. Navy.

Tom Pope, c.e. '27, is now a telephone engineer with the Bell laboratories in New York City. Tom says his hobbies are chess and bowling and then a little motoring through the eastern states to keep things from becoming monotonous.

"Boone" Hudson, c.e. '31, who is with the city of Chicago in the experimental water filter plant, told us last week that Red Waller, c.e. '31, who is also with the city, recently got caught in an underground tunnel and called out the Chicago fire department, from a phone in the tunnel, to get him out. The story got a big play in the papers, of course. That sounds like Red all right.

John DeWolf, r.e.e. '30, who was one time editor of the Technograph and one of the best known and liked activity men the engineering campus has turned out, is spending a few weeks on the campus with his father, Prof. DeWolf of the geology department, before leaving for an ocean cruise. Johnnie was with General Electric

in New York until the recent reduction of their engineering staff . In addition to the editorship of the Technograph, he was senior Theater Guild manager, a member of Tau Beta Pi, Scabbard and Blade, Pi Tau Pi Sigma, Mask and Bauble, National Collegeiate Players, and Sigma Epsilon.

DEPARTMENTAL NOTES

After a hectic Wednesday night of informal initiation, preceded by three weeks of pledge life, ten Theta Tau pledges were formally initiated Thursday evening, May 5. The next evening, Friday, the new and the old members were the proud escorts of their several "best girls" at a dance given in conjunction with Sigma Tau and Scarab at the Sigma Phi Epsilon house. The new members are: W. F. Barnes '34, A. H. Beasley '34, J. H. Bradish, Tr., R. A. Forsberg '33, H. G. Heubach '34, B. B. Josi '33, C. E. Missman '33, G. O. Pohl '33, and H. S. Shott '34.

Following a dinner at the Theta Delta Chi house, April 12, Sigma Tau selected its officers for the coming year. W. C. Nelson was elected president; A. M. Daily, vice-president; E. E. Turnipseed, treasurer; S. W. Benedict, corresponding secretary; and W. M. Avery, recording secretary and historian. A rushing smoker was held, April 26, at which several rushees were present. Pledging will be announced at a later date. Sigma Tau co-operated with Theta Tau and Scarab in holding an informal membership dance at the Sigma Phi Epsilon house, May 6.

Chi Epsilon held a formal initiation at the Inman hotel April 10. The following men were initiated: R. S. Brown, Joseph Kempston, and L. I. Miller. Prof. Knight was the speaker of the evening and Prof. Crandell acted as toastmaster. Prof. A. N. Talbot was presented with national honorary membership for outstanding work in the civil engineering field. He was the fifth to receive this award, and the second of the University of Illinois faculty. Dean M. S. Ketchum received the first award of this kind ever presented by the organization.

On April 27 Dr. R. J. Wiseman, chief engineer of the Oakanite Callender company, was guest of the electrical engineering department. He spoke at the ten-o'clock freshman lecture on electric cables, and at eleven o'clock he talked on "The Manufacture of Impregnated Paper Cables" before a meeting of the student branch of the American Institute of Electrical Engineers. In the afternoon Dr. Wiseman presented a four-reel picture showing the manufacturing and installing of 75000-volt cable for the Delaware river crossing at Wilmington, Delaware.

D. B. Allabough, ee '32, gave an interesting account of his trip to Muscle Shoals at a meeting of the branch on Tuesday, May 3. His talk was illustrated with slides of snapshots he had taken while visiting the dam during the mid-semester recess.

At a meeting of the student branch of the American Ceramic Society, which was held at the Acacia house on Thursday evening, April 21, Dr. J. C. Bailar of the chemistry department gave an interesting description of the Coors Chemical Porcelain Company. For several summers, while still a student, Dr. Bailar worked at this plant, which is located at Golden, Colorado.

Prior to Dr. Bailar's talk, a regular business meeting was held and officers were elected for the coming year. The officers elected were: E. G. Porst, president; W. P. Keith, vice-president; and J. C. Swartz, secretary-treasurer.

J. B. Tiffany, Jr., and William E. Bohn have been awarded first and second prize in the Ira O. Baker civil engineering award for 1932. The prizes are $75 and $25, and the names of the winners are placed on the bronze plaque in Engineering hall.

TAU NU TAU

A formal military ball was given by Tau Nu Tau, honorary military engineering fraternity, Saturday night, April 16, at the Delta Sigma Phi fraternity house with Ted Price and his orchestra playing. Formal initiation was held Sunday morning, April 24, for the following men: R. H. Vandevelde '34, D. S. Noecker '33, L. P. Morgan '33, S. Stoshitch '35, M. B. Jaseph '33, K. B. Welsh '34, and F. W. Svoboda '34. W. R. Baldwin had charge of the initiation.

"Boulder Dam," was the subject of an interesting talk, April 13, delivered by Prof. J. J. Doland. An unusual account of his experience while in charge of the "Preliminary Survey for the Nicaraugua Canal," was given on April 19, by Col. Dan I. Sultan. At a special dinner meeting on Sunday, May 1, H. S. Crocker, president of the A. S. C. E., was the guest of honor and speaker.

Prof. Hottes talked April 20 on, "Wood, Its Origin, and Use as a Structural Material." Through the courtesy of the National Tube Co. the student chapter saw a film on "Walls Without Welds," on May 4.

Mu San members were entertained by Prof. H. E. Babbitt at his home, April 28. Prof. Coleman R. Griffith delivered the address of the evening, entitled, "Psychology in Athletics." April 14 Prof. Crandell spoke on, "City Planning and the Future of the Civil Engineer in that Field."

For the first time in several years, an engineer has been chosen as valedictorian of the senior class. The committee on class day arrangements has chosen J. B. Tiffany, Jr., a civil engineer, as valedictorian of the class of 1932.

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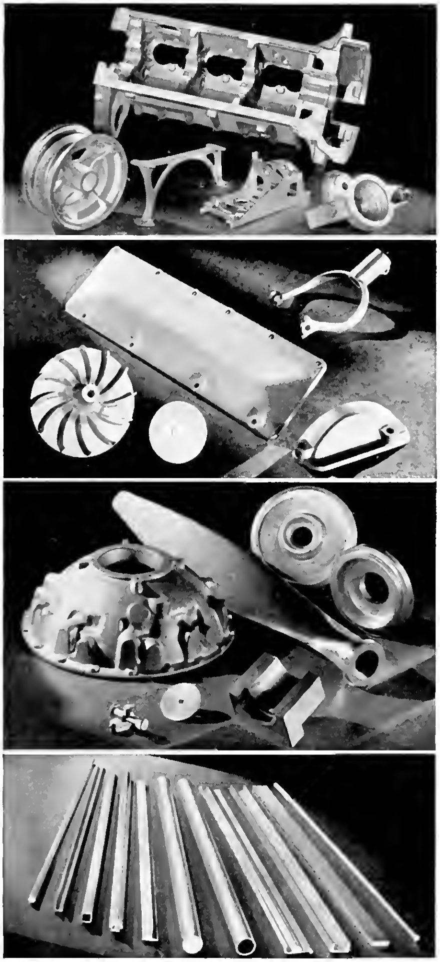

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The Electron Tube

(Continued from page 7)

charge through the gas with which the tube is filled. The fact that no filament light source could follow the rapid variations of signal intensity makes the glow tube indispensable. A combination of the glow tube and photo cell also allows the transmission of sound over a beam of light for quite a distance. This affords a method of secret communication which may be conveniently used for short distances, such as between ships or between a ship and the shore.

The glow tube also makes possible the stroboscope. This is a device which requires a light source which will have a high intensity, but will remain lighted for a very short interval. By properly timing the frequency, with which the tube lights, it is possible to view a rotating or oscillating object as though it were standing still. For example, if it were desired to observe a shaft rotating at 1200 RPM, the cell could be made to light at a frequency of 1200 times per minute, whereupon the shaft would appear to the eye to be motionless. The stroboscope allows the study of deformations and reactions in movable machinery which could be obtained in no other way.

From the glow tube was developed the power grid glow tube or thyratron. This was accomplished by adapting the elements of the tube to the handling of larger amounts of power, and by adding a third element or grid, through the use of which the break-down voltage of the tube can be varied. The discharge in such a power tube takes the form of an arc rather than a glow. The internal voltage drop in the thyratron arc is quite low, being about 15 to 30 volts, depending upon the type of the tube. As a result, the tube is a highly efficient device for use in power control. Its chief characteristics are high efficiency and the ease with which it allows the control of large amounts of power. Laboratory developments include a mercury cathode type of grid glow tube which can break a current of 300 amperes at 550 volts as rapidly as 100 times a second without the burning of contacts that would inevitably result from an attempt to use any mechanical device for this purpose.

The application of the thyratron to stage lighting control has proved to be of great value. Three large installations have been attempted, the Civic Opera House in Chicago, the Severance Memorial Hall in Cleveland, and a Los Angeles theater. Some three hundred to six hundred thyratron tubes control the illumination of all the lights on the stage, by varying the saturation of the cores of reactors in the lighting circuits. The whole system is operated from a centralized organ console type of control which may be connected with the lighting circuits by means of a flexible cable, so that the control console may be operated from any convenient place. This type of control not only makes for easier handling, but allows the pre-setting of entire scenes, so that no manual control is necessary. A similar system may be applied to the floodlighting of buildings with many artistic effects resulting. In many industries, as for example that of wire drawing, very accurate speed control of motors is necessary. The thyratron provides an efficient and accurate speed control for such uses.

These are but some of the more recent electron tube developments. Other more intricate uses are being discovered from time to time. Television has still to be developed into a commercially practical form. Work is being done at present on the use of the thyratron in connection with high voltage direct current power transmission. The possibilities of power distribution by radio offer great difficulties, but form an interesting problem. Meanwhile the electron tube continues to support a great deal of our communication system, to control our industrial processes, and to help amuse us in our leisure time.

Lighter-Than-Air Transportation

(Continued from page 4)

conditions may often resemble those of the northern Atlantic. However, by effective organization of radio weather reports from vessels giving actual weather ahead, the airship commander will vary his course to take full advantage of the winds. A passage from Yokohama to California should take from four to six days, depending on the season.

According to Commander Hunsaker and others who have collaborated with him in making a study of weather conditions, it appears feasible for an airship to fly from Yokohama to Honolulu (3,400 miles) in three days in severe winter weather.

While no definite announcement of plans regarding the airship lines, either over the Pacific or Atlantic has been made, it is understood that it is proposed to operate first from California to Honolulu, on the Pacific route, extension of the service to Manila and the addition of further airships to be undertaken as soon as the Hawaiian section of the route is operative on a sound basis. When the Pacific company has three ships on the route between California, Hawaii, Manila and Japan, a sailing can be made every ten days. Passengers and mails will then reach the Orient in less than a week instead of the usual three weeks now required.

What has been done in making a survey of the Pacific situation is equally true of the Atlantic, and just at this time much interest is focussed on the United States Congress, which has for consideration the merchant airship bills introduced in the House by Congressman Robert Crosser of Ohio, and in the Senate by Senator Charles L. McNary of Oregon.

In the McNary and Crosser measures, Congress has before it legislation designed to encourage American capital to engage in the building and operating of airships. Excepting the ship loan feature, which is omitted, these bills suggest legislation which is practically identical to legislation which Congress has enacted in the past to encourage American capital to build and operate steamships. The bills give legal standing to the airship, fix its liabilities, and authorize it to carry mail on the same basis as steamships now do.

There is no doubt that the hundreds of successful flights of the Graf Zeppelin, Los Angeles and other airships, indicate that well-built and well-flown crafts of this type will have an important role in expediting transoceanic transport. However, capital will only be available to utilize these advantages when legislation is enacted along the lines of that provided by the McNary and Crosser bills.

On April 4 Prof. Moore and Mr. Bisisie rode from Springfield to Dayton, Ohio, on the Sperry test car. This car is electrically equipped for the location of transverse fissures in rails.

The Ricker prizes in architectural history, which are given by the Alpha Rho Chi society, have been awarded to William Horowitz, Thaddeus J. Glaza, and John E. Terry.

Bucket and Shovel

Tank Rogier is herewith forever relegated to that dusty corner of the building which houses the talking skull, for he is no longer a member of *Bucket and Shovel* in good standing. We won't have any softies in this mob. Tank, for the past week, has been wearing a certain co-ed's honorary key. After all, this is leap year, but there's got to be a limit.

We discovered the identity of the ballot box stuffer whose picture we printed in the last bucketfull. No less than forty-nine and one-half engineers (the half was Stubby Crawford) called personally at the headquarters of the *Chief Tooter of the Sacred Lunch Whistle's* office to inform him that the mysterious individual was none other than Ed (Curly) Stevens, the new Union director and mighty man of the M. E.'s (mighty little, that is). He's herewith awarded our choicest underslung rotary squirrel cage paperweight for his new desk, as well as the title *Salubrious Supervisor of B. and S. Elections*.

Below we print an exclusive interior etching of Handsome Dick Heberling, M.E. prodigy, which proves that after all he does study at times, contrary to

Handsome Dick Heberling

all popular rumors. He is herewith accorded a niche in the B. and S. *Hall of Infame as Most High and Mighty Scholarly Bearer of the Bucket of Midnight Oil*. In case Richard (Handsome Dick to the girls) receives no other reward for his labors, we reserve a cadmium-plated paper door knob with helical gearing for his study room.

For his extreme adeptness (the result of at least a year's constant practice) in breaking chem glassware, James Skores, c.e. '35, is donated free of practically all charges what we believe to be the only double-barreled, rim-fitting whisk broom in captivity. (That skores one for him). Furthermore James (or Jimmy as we have playfully nicknamed him) is hereby appointed *Invincible Furbisher of the Most Holy Bucket*.

Jimmy (James to you) Carpenter, senior E.E. marvel, has firmly entrenched himself as *Supreme and Exalted Magnetician of B. and S.* for his recent remarkable experiment in demagnetizing an iron rod by dipping it in salt water. Yea verily, such a truth-seeking mind should be rewarded, and we herewith bestow upon him a triple-phase, double induced, magnetized reciprocating walking stick.

Thundermug Kahn just missed B. and S. this month as he was on the wrong end of a snappy bit of repartee in the Specialists' course. Anyhow, when Anderson's pal asked Babbitt what a winch was he got the startling answer, "Why that's an old-fashioned name for a girl." We refuse to admit any faculty members in this here now organization as there has to be a limit on the number of members.

Dick Nelle, would-be sanitary engineer, jokester, and stellar trackman, we reserve an exclusive place for a brilliant remark of some time ago in M. E. 1. Asked what a steam table was, Smiling Richard blurted out that a "steam table was what they used in restaurants to keep the food hot." There are no secrets from the *Chief Tooter*, and sins of the past will find you out.

We print herewith an exclusive telephoto of Dickie at the tender age of four when he was just beginning to walk the tightrope. Although he has followed the straight and narrow ever since we fear that they ain't done right by our little Nelle. Dickie (Mr. Nelle to the boys) has been unanimously elected to the office of *Righteous and Rapid Bearer of the Sacred and Honored Shovel*. Just to keep him happy and contented through finals we will donate a spare butt-welded polyphase squeegee that we found in the corner of the office.

For generally well known reasons, several men have been elected to the lowly but significant membership classification known as *Shovel Swingers*. Nominations are: Chuck Ennis, Lib Panichi, Johnnie Holstein, Joe Tiffany, Stud (P. E.) Hurt, Judge (Slide-Rule) Morse, John Swarner, Stumpf Blakeney, and Bob Slaughter.

Farewell, O Illustrious Members of Bucket and Shovel! We leave great responsibilities on your shoulders and with a feeling of grandiloquent confidence we place the *Honored Shovel* in your hands and the *Sacred Bucket* also. May you use them well.

Farewell, faculty and student readers of the activities of B. and S.; friends and enemies alike. When we meet again may we all be friends.

Yours in B. and S,
Bob Webb,
Chief Tooter of the Sacred Lunch Whistle.

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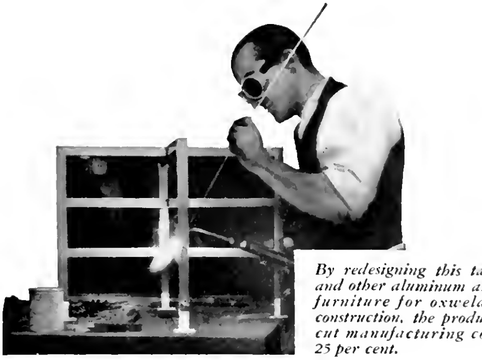

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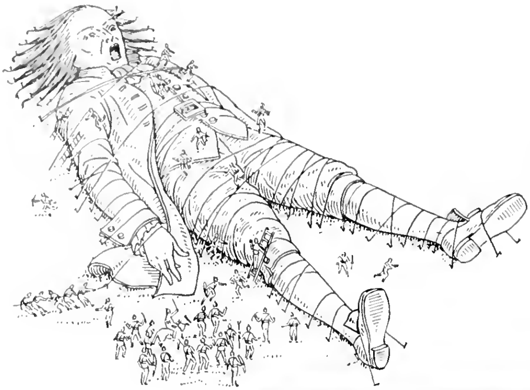

An Electrical GULLIVER AMONG LILLIPUTIANS?

160,000-kw. G-E tandem-compound turbine-generator set on test.

No — but the immense size of this 160,000-kilowatt turbine-generator dwarfs the 44 test men who test such apparatus. This turbine-generator for the Brooklyn Edison Company — the largest single-shaft unit yet developed — is capable of furnishing muscle power equal to all the inhabitants of New York City. Its 214,400 horsepower operates both day and night, lifting heavy burdens from human shoulders, and supplying electric energy to countless devices in homes, in offices, and in factories.

The 44 test men shown above represent 31 colleges and universities from New Mexico to New Hampshire, including the University of Porto Rico. Each year many college-trained men join the General Electric Testing Department, which trains them for future responsible positions and electrical leadership on land, on sea, and in the air.

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