The Wisconsin engineer. Volume 18, No. 2 November 1913

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

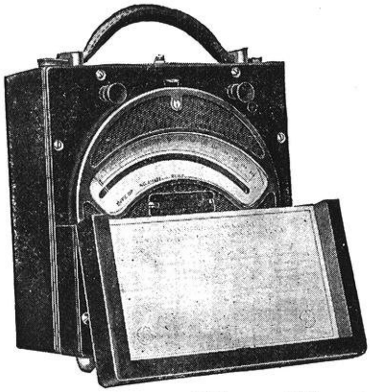
https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

The Wisconsin Engineer

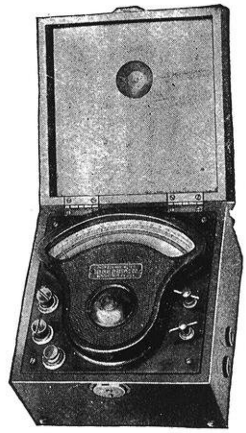
NOVEMBER, 1913

Vol. 18 No. 2

Portable Testing Instruments



Direct Current Ammeters, Voltmeters, Mil-ammeters and Milli-voltmeters



Alternating Current Voltmeters, Ammeters, Single-phase and Polyphase Wattmeters

High Grade Instruments for Electrical Testing

Type P-3 Instruments for Alternating Current

Light weight instruments which maintain a high degree of accuracy under all ordinary conditions of service.

Not affected by stray fields, or by variations in wave form or frequency. Voltmeters and wattmeters can be used on direct current.

Needle fluctuations are effectively damped.

Each instrument accompanied with an accuracy curve showing calibration.

Type DP Instruments for Direct Current

D'Arsonval type, legible uniform scales.

Protected from stray fields, indications perfectly dead beat.

Magnets are made of best quality steel, and are carefully aged and hardened. Certificate of accuracy furnished with each instrument.

General Electric Company

Largest Electrical Manufacturer in the World

General Office, Schenectady, N. Y. Sales Offices in fifty-four cities

3874

The Guarantee of Excellence on Goods Electrical.

Volume 18 **Founded 1896** **Number 2**

The Wisconsin Engineer

$1.00 a Year **20c a Copy**

Entered as second-class matter Sept. 26, 1910, at the postoffice at Madison Wis., under the Act of March 3, 1879.

CONTENTS

NOVEMBER, 1913

Published monthly from October to May, inclusive, by the WISCONSIN ENGINEERING JOURNAL ASSOCIATION, Engineering Bldg., Madison, Wis.

Address all communications to The Wisconsin Engineer.

Subscription price $1.00 a year if paid before February 1; $1.25 a year after that date. Canadian subscriptions, $1.25 a year. Foreign subscriptions, $1.50 a year.

The Wisconsin Engineer

VOL. XVIII NOVEMBER, 1913 NO. 2

THE FLOW OF STEAM IN PIPES.

D. E. Foster.

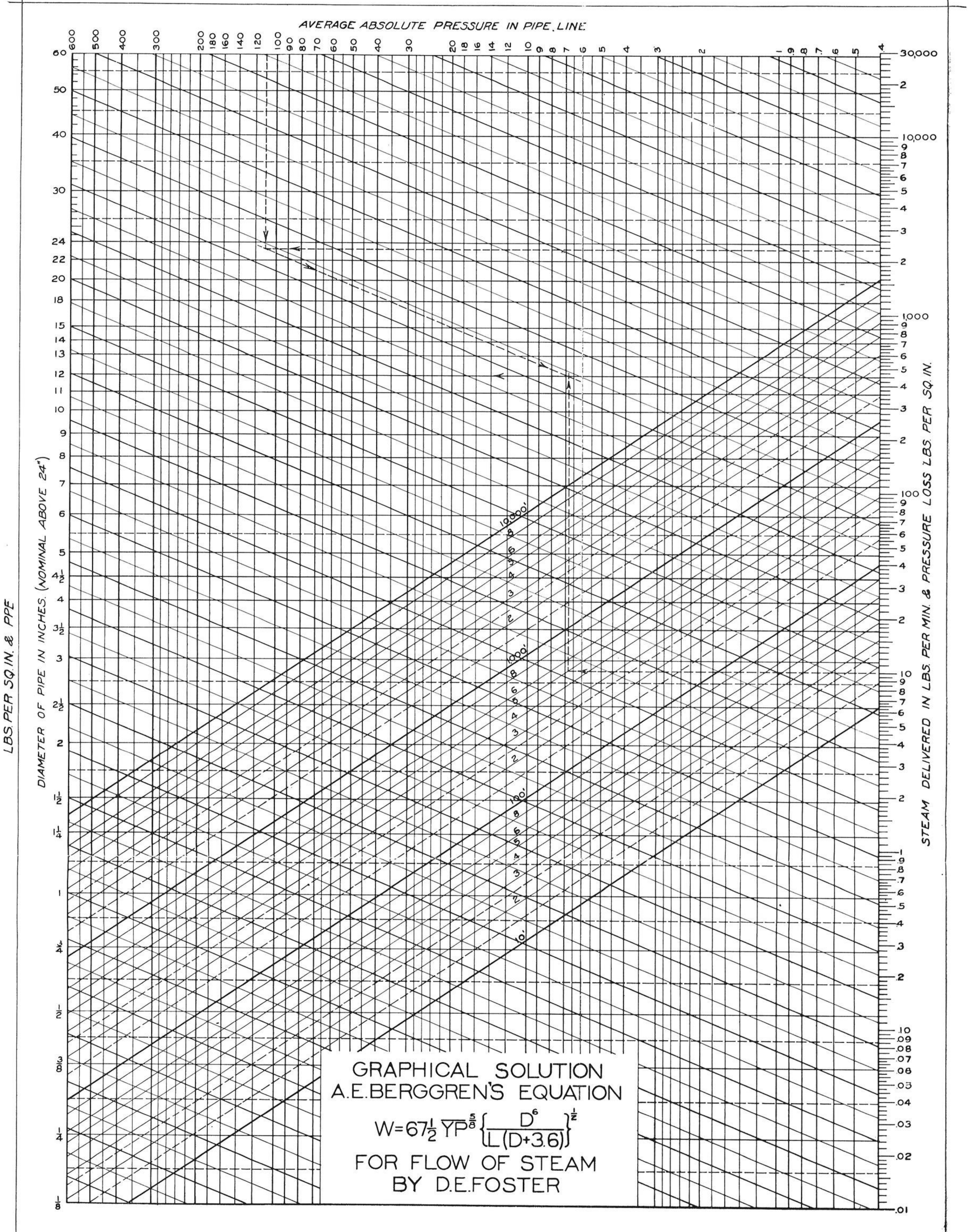
Professor of Mechanical Engineering, State College of Washington. Pullman.

In the March 1913 number of the Wisconsin Engineer appeared an article under this same title by Mr. A. E. Berggren, Instructor in steam and gas Engineering at Wisconsin. The writer has charted the equation derived by Mr. Berggren so that it will be an easy matter for those interested in the selection and installation of steam pipe lines to determine the proper size of the pipe without the necessity of going thru the somewhat difficult solution of the equation.

The writer has taken the liberty of changing the value of the constant 70 to 67.5. He feels justified in doing this because Mr. Berggren used the nominal diameter of the pipe instead of the actual one in determining the value of the constant. The error involved by this neglect amounts to nearly four per cent and would tend toward the selection of an undersized pipe.

The use of the chart is comparatively simple. As a general proposition the engineer has a machine demanding a certain quantity of steam, located at a given distance from his source of supply, the initial pressure of which is a fixed quantity, and he wishes to allow a certain drop of pressure between the source and the machine, this drop as a rule being between one half and four pounds per hundred feet of pipe. With this data in hand he must determine the size of the required pipe. Suppose that 2300 pounds of steam are required at a machine 500 feet away from the boiler which is under 115 pounds pressure absolute and that the total drop of pressure is to be 10 pounds or two pounds per 100 feet. The average pressure in the pipe line then will be 110 pounds. Referring to the chart we find that the intersection of a horizontal representing 2,300 pounds of steam with a vertical representing 110 pounds average pressure in the pipe line will determine a diagonal. The intersection of this diagonal with a second vertical determined by the intersection of a second horizontal representing 10 pounds total loss of pressure, and a second diagonal representing 500 feet of pipe line will determine a third horizontal giving 12 inches as the proper size of pipe. The solution of this problem has been indicated on the chart by dashed lines and arrows.

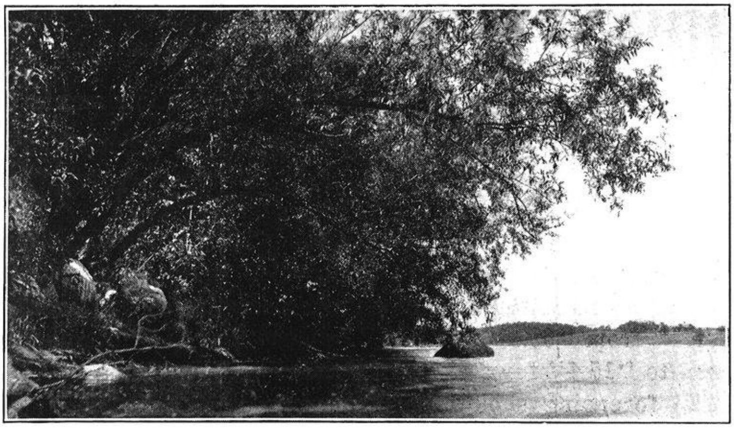
The chart may be used to determine quantity when the other four are known or assumed. Suppose that the demand in the problem given above be increased in the future to 3200 pounds by the installation of a larger machine. If the initial pressure remains the same the drop in pressure will have to be considerably increased. In this case we must estimate what the drop will be before we can proceed. If it be assumed to be 18 pounds the average pipe line pressure will be 9 pounds less than the boiler pressure or 106 pounds Following thru the chart as before we will find the probable loss to be 17 pounds. This value is so close to the assumed value that it will be unnecessary to check it. As another example let us assume that the demand be increased to 5000 pounds per minute, that the pressure at that machine be increased to 140 pounds, and that the initial pressure necessary to deliver this quantity is desired. It will be seen that the drop in pressure in this case is also unknown. Hence the probable loss will have to be estimated again. Assuming that it will be 20 pounds, the average pipe line pressure will be 150 pounds. Using this data we will find the loss corresponding to be 25 or 26 pounds, which indicates that the initial pressure should be about 165 pounds. Using an average pipe line pressure of 152.5 pounds, we find by further check that this figure is about right. It will be noted that in the first problem given, the solution gave 12 inches ex-


AVERAGE ABSOLUTE PRESSURE IN PIPE LINE
LBS. PER SQ. IN. & PPE
DIAMETER OF PIPE IN INCHES. (NOMINAL ABOVE 24")
STEAM DELIVERED IN LBS. PER MIN. & PRESSURE LOSS LBS. PER SQ. IN.
10,000'
1000'
100'
10'
GRAPHICAL SOLUTION
A.E. BERGGREN'S EQUATION
$W = 67\frac{1}{2}\, \overline{YP}^{\frac{5}{8}} \left\{ \frac{D^6}{L(D+3.6)} \right\}^{\frac{1}{2}}$
FOR FLOW OF STEAM
BY D.E. FOSTER

actly. Generally speaking, however, the solution of such a problem will give a size other than standard, in which case we must select either the size above and decrease the pressure loss, or select the size below and increase this loss.

Regarding Mr. Berggren's test it may be said that the use of logarithmic paper would have facilitated the determination of equation five page 254 of the Engineer without the calculation of the constant "K" for the several values of the exponent "n". On page 253 Mr. Berggren has given in tabular form the values of the product "yP" and "W" as deduced from the data on test runs three to eight inclusive. By plotting values of "yP" as abscissae against values of "W" as ordinates on log paper and drawing a straight line averaging all points but the first, we obtain a graph that represents the relation between the two. It will be seen that this is correct, because the exponential equation "$W = K(yP)^n$" becomes one of the first degree when the logarithm of both sides is taken. When plotted in the form "$\log W = \log K - n \log (yP)$", "n" is the slope of the line and "log K" is the "Y" intercept. The slope thus obtained was found to be ".612" and the value of "K" was found to be "15.6." The equation of the line under test therefore becomes "$W = 15.6\ (yP)^{.612}$." When the actual diameter instead of the nominal is substituted in the reciprocal of the function "$\left(\frac{D^6}{L(D-3.6)}\right)^{1/2}$", Mr. Berggren's equation three becomes "$K = \frac{4.37\ W}{(yP)^{1/2}}$" the number 4.37 replacing the number 4.66 given by Mr. Berggren. This correction makes his equation four read "$K = \frac{4.37 \cdot 15.6}{(yP)^{.612}} = 68.4$". The general equation then becomes "$W = 68.4\ (yP)^{.612}\left(\frac{D^6}{L(D-3.6)}\right)^{1/2}$" The error in assuming that "n" is equal to ".625" is so insignificant, however, that Mr. Berggren is justified in using it and the writer has left it thus. This change necessitates the changing of "K" from "68.4" to "67.5" because the "Y" intercept reduces to "15.4" for a slope of ".625."

The foregoing should not be taken as a criticism of Mr. Berggren's work, but merely as a suggestion of another method of arriving at results. Mr. Berggren should be highly commended for his efforts and it is to be hoped that he will at some future time continue the experiment further by increasing the pressure losses up to eight and ten pounds per hundred feet of pipe as these losses are very frequently used where a heating system is supplied with steam from a high pressure boiler. The pipe line in such a case acts to a large extent as a reducing valve and the fact that a much smaller pipe can be used, effects a considerable saving in the first cost of the transmission line. The fact that the efficiency of the line tested does not reach a maximum and drop again indicates that it would be highly desirable to carry the test far enough to discover this maximum if there is any. It is also suggested that in continuing an experiment of this kind that losses of pressure be measured along the pipe at regular intervals between its two extremities in order that the relation between pressure loss and pipe length may be checked. It will be noted that, all other factors being constant, Mr. Berggren's equation assumes that the pressure loss varies as the eight tenths power of the length. It goes without saying of course that it would be desirable to have tests made on pipes of large diameter and equally long.



PLASTER OF PARIS PATTERNS.

W. Chisolm.

University of Wisconsin.

The application of plaster of Paris to pattern work has developed considerably in recent years, particularly in Scotland and England. Plaster of Paris has been used in the past a great deal to facilitate the moulding process in the making of matches, as shown by the hand wheel, figure 4. It is also used considerably for carved work, such as stove patterns.

In determining methods of making a pattern, the pattern-maker should consider whether the pattern is to be used but once, or frequently; plaster of Paris would oftentimes be preferred on account of reduced expense, and if the pattern is of such a form as to make a metal pattern desirable, plaster of Paris will usually be found suitable material for the master pattern.

In preparing the mixture for general pattern work, the plaster of Paris may be stirred into the water to the consistency of cream. The use of lime water is often an advantage because it keeps the plaster from setting too quickly, and at the same time reduces the swelling during the setting process, which otherwise might cause the pattern to lose its shape. In some very thin patterns it is better to use all lime water, but for general use equal parts of lime water and clear water form a good working proportion. In preparing the lime water a piece of rock or quicklime may be slacked in a pan by adding a little water from time to time till the lime is reduced to a powder or a paste. This may be put into a five or ten gallon can of plain water. The can should be kept filled by adding fresh water. This procedure may be continued till the lime is all used up.

One pound of lime will make approximately one thousand pounds of lime water. It would be safer, however, on account of the effect of carbonic acid gas, carried by the water and absorbed on exposure to the air, to count on using about half the amount of water, for then the can might be rinsed out and the contents renewed. Care must be taken when drawing out lime water not to allow any sediment from the can to get into the mixture, because this will prevent setting of the plaster of Paris.

If it appears that the time required to sweep the pattern will be such that the plaster will begin to set before the sweeping operation is completed, smaller quantities of plaster may be mixed by an assistant as required. Working the plaster too much after it begins to set, results in soft and crumbly plaster. It is not advisable to add water in an attempt to keep it at a working consistency after thickening occurs.

Cement may be added to plaster of Paris in quantities up to fifty per cent of the whole, or even more, to make it harder.

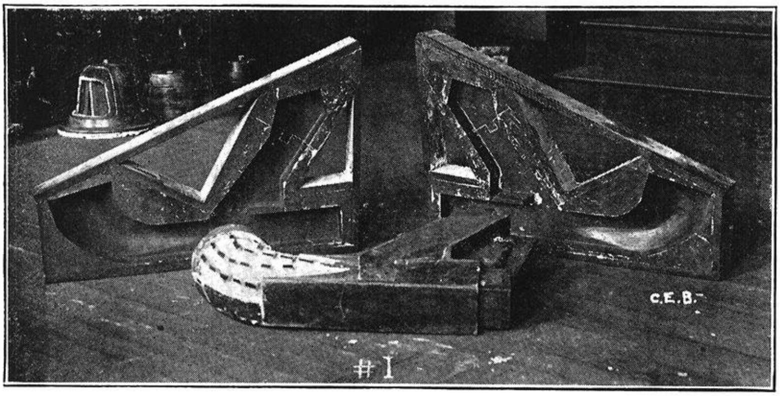


FIGURE 1.

Figure 1 represents a pipe pattern of square section sweeping into an irregular bell shape section.

It would take considerable time and skill to make a core box which would insure equal thickness of metal throughout, but, by the use of plaster of Paris the time and skill required are greatly reduced.

First a full size model of the core was made in wood and plaster of Paris. To do this the square section was made of boards about half inch thick (box construction), the ends being extended far enough each way to form core points. Where the square section was carried through the circular bell mouth section the corners of the box were made tangent to the surface of the circular section, as shown at A, figure 2. Along the center lines of the sides of this part of the rectangular box strips were nailed which were finished tangent to the surface of the circular section, as shown at B, figure 2. Plaster was then filled in between these eight lines to complete the surface of the circular bell mouth section, as shown at X, figure 2. Two coats of shellac completed the model of the core.

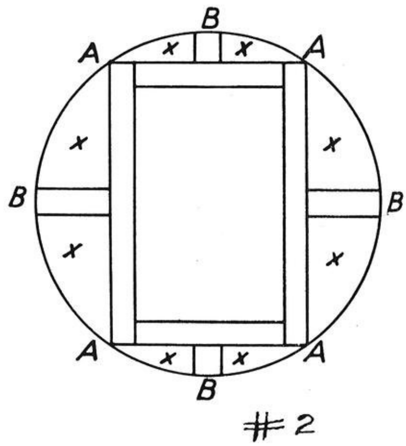


FIGURE 2.

As the model is not symmetrical, two half core boxes are required. To get these, one-half of the model was greased with a mixture of tallow and linseed oil, and then it was bedded half way into moulding sand, with the greased side exposed. A wooden frame was put around it and the model covered over with plaster of Paris to the thickness of one-half inch, the remaining portion of the frame was then filled in flush with plaster and cinders mixed together.

When the plaster had set, the half core box with the model remaining in it, was turned over and the exposed surface of the half core box was schellaced. The all exposed parting surfaces were greased to prevent the other half box from sticking. The frame for the other half box was then placed in position and filled in the same manner. When the plaster of Paris was thoroughly set, the two half core boxes were separated, the model removed, and finished with two or three coats of shellac.

The pattern was then completed by laying out the required length of the pattern on the core model and nailing wood strips of the required thickness of the metal to the rectangular section. Also, as shown in Figure 1, small pieces were nailed on the bell mouth end and plaster of Paris filled in between. As soon as the plaster had set the pattern was finished by sanding and shellacing.

It will be noticed that before the photograph for Figure 1 was taken, the plaster of Paris was cut away so as to show these small pieces of wood exposed.

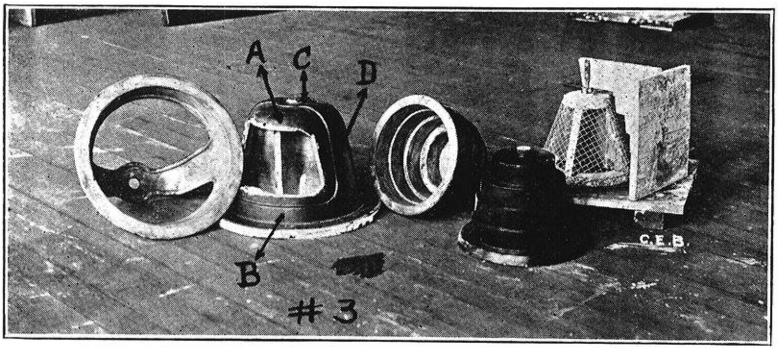


FIGURE 3.

Figure 3 shows an end bracket for a motor, and a step cone pulley, as well as various steps in the production of the cone pulley pattern. At the right is shown the foundation for a block such as is shown completed just in front of it, and the sweep in position for sweeping up the block. At the center of the cut is shown the finished pattern. These blocks are swept by a sweep moving about a vertical axis. The sweep is made of wood, faced with zinc or other thin metal to act as a cutting edge, and provided with a foot to keep it perpendicular as shown in the figure.

In preparing the foundation a post of the required height is fastened to a suitable board by a screw from the underside of the board. In the top of this post a small metal tube about half an inch long is inserted to form a bearing, in which the pin fixed on the sweep works. The moulding block is first swept up to the shape of the inside of the pattern. There is no use in sweeping a solid mass of plaster of Paris for the moulding block, so a drum, or form, of whatever shape the pattern may require can be made from wire netting and fixed to the post so as to clear the sweep by one quarter inch, as shown. After the board is oiled to allow the sweep to slide easily, the plaster of Paris is applied rather thicker than would be used for a pattern, so as to prevent it from running through the mesh of the netting. Some thinner plaster can be swept over the surface of this for finishing.

At the left is shown the motor end bracket, together with the moulding block upon which it was swept. The moulding block is shown open on the sides as it was made, there being no necessity for sweeping up the complete conical surface. The beads for stiffening the casting as shown on the inner surface of the pattern around the openings are produced as follows:

The surface A. was first swept up together with the raised ring B., and the flat circular surface C. The outline for the recessed surface of the arms is laid out on the block so that an extra thickness D. may be swept on to form these recesses, and the sweep is altered to sweep up this surface. To confine this new layer of plaster of Paris to its proper place while being applied in liquid form, strips of leather are tacked on lightly. These strips are thin enough to clear the sweep, and the plaster is applied between them and swept. In a few minutes it is sufficiently set to allow the leather strips to be pulled off; the edges are trimmed, and the whole block shellaced.

The sweep is now altered to form the outside of the pattern. The block is greased, and any marks or lines which may be wanted on the inside of the pattern may be made with an indelible pencil to the block as they will show up perfectly on the inside of the pattern after it is swept. The plaster may be confined to the outline of the finished arms by leather strips, or putty if desired; or if these outlines are laid out on the block with an indelible pencil, the plaster may be quickly pared back to these lines after the pattern is lifted from the block. Plaster of Paris is applied to the surface of the whole block first to prevent air holes on the inside of the pattern; then the rest is added till the pattern is swept to the required thickness. The pattern will be ready for removal from the block in half an hour for trimming and shellacing. In the course of sweeping, weak parts of the pattern can be reinforced with wire netting or hoop iron.

The process involved in sweeping the block and pattern for the step cone pulley is practically the same.

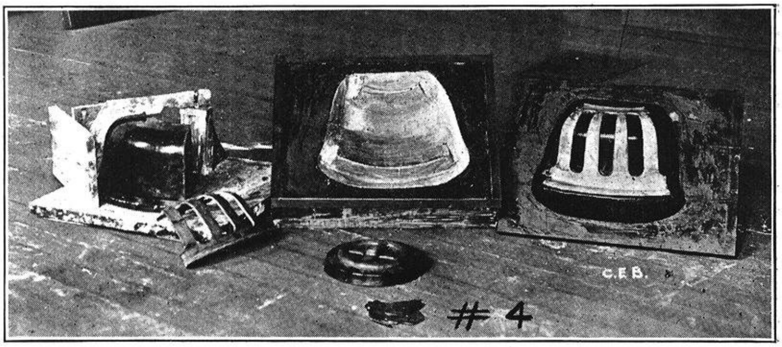


FIGURE 4.

Figure 4 shows the segment pattern for a motor end shield. One view shows the pattern removed and the sweep in position for sweeping the pattern on the block. The other view shows the pattern fixed to a follow board. Before fixing the pattern to the follow board a cast is taken off the follow board in plaster of Paris. This cast is then used as a follow board for making one part of the mould. The two follow boards are usually set up on moulding machines, or, flask pins and guides may be attached for moulding by hand.

The hand wheel is shown placed in a match board. This match board was first swept up for use as a block on which to sweep the pattern.

Figure 5 shows a core box swept by a sweep working about a horizontal axis; the ends of the sweep working in a bearing cut out in each end of the box. The grate pattern of plaster of Paris was cast in a plaster of Paris matrix.

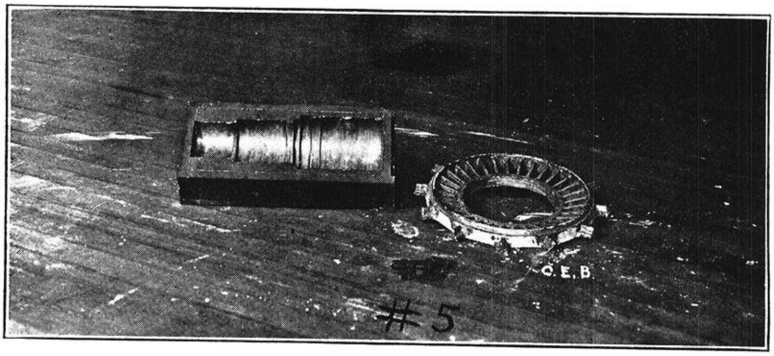


FIGURE 5.

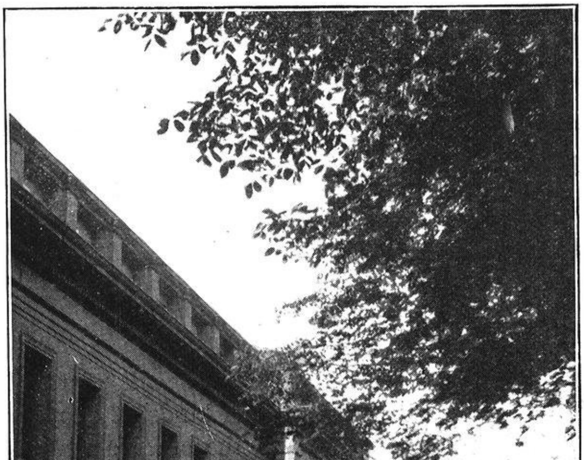
Figure 6 shows what can be done in sweeping irregular surfaces. The figure shows two different kinds of propellors, the one a constant pitch propellor, and the other a variable pitch propellor. The process involved in sweeping is exactly the same as that used in moulding sand. The lower half of the figure shows the swept surfaces with the outline of the blade marked on them, which give the required form to the face side of the completed blades shown in the upper half of the figure.

Plaster of Paris patterns may be used many times if suitable follow boards are provided; if metal patterns are desired, double allowance for shrinkage of the metal may be allowed on the plaster of Paris pattern.

The cost of plaster of Paris by the barrel is about one cent per pound. Its weight is about three times the weight of dry white pine; the cost per cubic foot is about the same as that of white pine.

Generally when the use of plaster of paris would be considered advisable there would be much less waste of plaster of Paris than there would be of wood in making such patterns or core boxes.

The comparison of the labor involved is generally the determining factor in deciding whether plaster of Paris or wood should be used in making a pattern, or a core box. For example: the cone pulley, Figure 3, was made in about one-sixth of the time required to make it in wood; the end bracket, Figure 3, one-twelfth, and, the core box, Figure 5, one-quarter of the time required to make them in wood.



THE TRIP OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS THROUGH GERMANY.

H. J. THORKELSON.

Professor of Steam Engineering, University of Wisconsin.

In response to an invitation of the Verein Deutscher Ingenieure, a party of about 300 members and guests of the American Society of Mechanical Engineers sailed from New York, June 10th, to take part in the 54th annual meeting of the German society at Leiszig, and to spend about three weeks traveling through the industrial cities of Germany.

Every detail of the visit and trip was carefully planned by committees of the two societies, and the opportunities for inspection, and the entertainment given to the party by our German hosts, were of such an unusual character, that a brief account of the trip, together with more detailed articles by Professors Christie and Disque, may be of interest to the readers of the *Wisconsin Engineer.*

The Madison members of the party consisted of: Mr. W. K. Fitch, '13, past president of the Wisconsin student section of the A. S. M. E.; Mr. R. H. Carpenter, '14, member of the same section; Professor R. C. Disque of the Electrical Department, Professor A. G. Christie of the Steam and Gas Engineering Department, Mrs. Thorkelson and the writer.

The party represented the larger part of the sailing list of the Victoria Luise, and abundant entertainment was afforded on board ship for all. A gymnasium, swimming pool, shuffle board tournament, numerous athletic contests, card parties and a well stocked library permitted a variety of diversions during the day, while most of the evenings were devoted to illustrated lectures. Mr. Hess of the Hess-Bright Co., spoke on "German History," Mr. Warner of Warner-Swasey Co., on "German Cities," Prof. Clifford, of Harvard on "German Art and Music," and Prof. Richards of Cooper Institute, on the "German Educational System." Other evenings were devoted to: a reception by the ship's officers, a mock trial, in which Kent's hand book, the "Engineer's bible,'' was used for the swearing in of all witnesses, the celebration of the twenty-fifth anniversary of Emperor William's accession, a Cabaret performance, and two or three dances.

Our ship, after stopping at Plymouth, England, and Cherbourg, France, for a few of the passengers, landed at Cuxhaven, Thursday, June 18th, and after passing through customs, we were taken by special train to Hamburg and assigned to our hotels.

Friday morning we assembled at the ''landing station'' of the harbour, where lunch was served, followed by an illustrated lecture on the Hamburg harbour, and an excursion of about two hours through this marvelous creation of German industry. The greater part of the harbour has been made by dredging the river Elbe and excavating large areas of the surrounding meadows, improvements representing an investment of more than $33,000,000 and affording room for more than 4,500 sea-going ships and about 6,400 large and small river and coasting craft.

Perhaps the most interesting part of this harbour, in addition to the large ship yard, is the ''free harbour,'' which is separated by floating fences and well equipped with cranes, warehouses, etc., permitting the transfer of goods from vessel to vessel without customs, thus bringing a large ocean and coasting trade to this port. An idea of the traffic here may be realized from the statement that in 1912, 3,500,000 tons of merchandise entered the port of Hamburg and as large a quantity sailed from it, while in 1910 the imports aggregated $925,000,000 and goods to the amount of $625,000,000 were received from internal traffic by water and rail.

In the evening, an elaborate reception was given to our party by the ''Senate'' of the city in the ''Town Hall'' or ''Rathous.'' This building, with its 350-foot tower, is one of the landmarks of the city, and is elaborately decorated and richly furnished in a manner wholly foreign to American city halls and seldom seen in our best state buildings. The liveried footmen and pages, the handsome paintings of historical incidents connected with Hamburg and the ''Hanseatic'' cities, and the elaborate banquet in the ''Wine Cellar'' made an impression more lasting than the name of the room might indicate.

The next morning our party visited the recently constructed Elbe tunnel, which connects the manufacturing and harbour district with the main part of the city and is equipped with large American built elevators at each end, for the use of foot passengers, wagons, automobiles, etc., having a capacity at peak load of

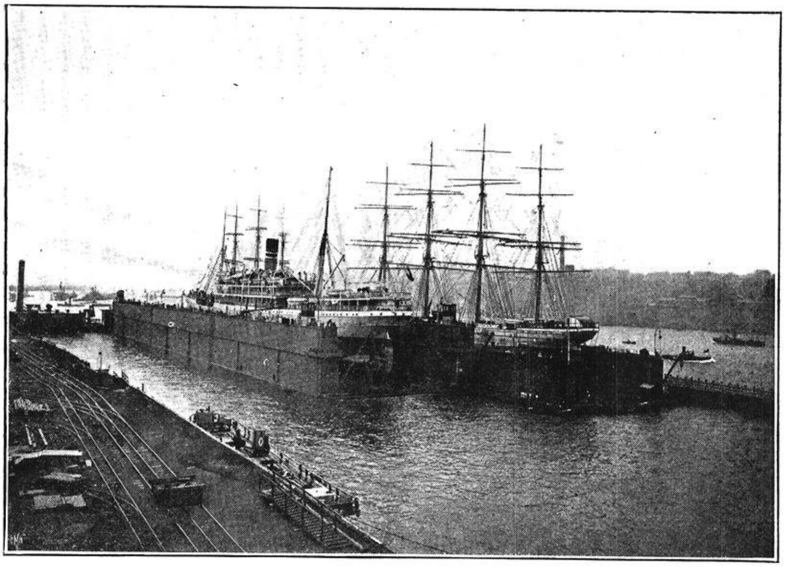


FIGURE 1.

14,000 persons an hour. We then took boat to the large ship building yards of Blohm and Voss, and spent several hours inspecting this mammoth plant, seeing here the largest ship in the world, the "Vaterland," under construction, the largest floating dock and the largest crane in the world. After dinner at the offices of the plant, our party visited the power plant of the Hamburg elevated and underground railway, and Hagenbeck's zoological gardens, with its large collection of wild and trained animals, many of which are kept in comparative freedom on large artificial hills surrounded by deep moats.

We left Leipzig the next morning, arriving late in the afternoon, and in the evening were entertained at an informal luncheon at the Crystal Palace. Here we met the delegates of the

Verein Deutscher Ingenieure, some 1200, strong, and several welcoming addresses and responses were given, followed by a vaudeville performance, which received closer attention from the audience than the more formal part of the program.

The next morning we assembled, with our hosts, at the Central Theater, where a few lectures were given in both English and German and the honorary degree of Doctor of Engineering was conferred on George Westinghouse and the King of Saxony, who was present. After lunch, we were entertained at the "Gewandhous" by a very fine orchestral concert, tendered by the Senate of the city and followed by an elaborate banquet at the Central Theater, during which several musical selections were given by a number of opera singers, and by the world's famous boys' choir from St. Thomas School.

The following morning the ladies of our party were taken in automobiles about the city, while the men were supposed to attend the meetings of the Verein, but instead, many took this opportunity to visit the very interesting Industrial Exhibition of Architecture and Allied Arts, the University buildings and the large monument of the Battle of the Nations, just about completed.

FIGURE 2.

Our last evening in Leipzig was devoted to a banquet in the Palm Garden, with music, a dance, and the illumination of the grounds and fireworks in celebration of the "Solstice."

Leipzig is a very interesting city, although not visited by Americans as much as other cities of Germany. It has one of the largest passenger depots in Europe, the main building being about 1,000 feet long and the train sheds enclosing twenty-four double tracks and thirteen platforms. The book trade forms the most important industry of Leipzig, there being about 12,000 German and foreign booksellers located here, the largest of whom employ as many as 600 people and carry a stock of over 100,000 books of all kinds and in all languages.

An idea of the interest in music here may be obtained from the statement that there are over seventy singing societies in Leipzig, and with a university of over 6,000 students, celebrating a few years ago its 500th anniversary, and a population of over 600,000 Leipzig can justly claim the position of the largest and most important city in Saxony.

From Leipzig we went to Dresden, where our entertainment consisted of an excursion to the Bastei or German Alps, a pleasure resort on the river Elbe somewhat resembling Devil's Lake, Wisconsin. A climb to the top was followed by a lunch and a tramp down a long path through deep valleys and canons, similar to Witch's Gulch at the Dells. We then took boat down the Elbe, passing many barges floating or being towed down the river, and others being pulled up the river by means of a long chain in the bottom of the river, which was passed over the drum of a hoisting engine on the towing boat.

In the evening, a reception and banquet was given in the town hall, and the next morning most of the party visited the technical high school, whose fame because of the research work of the late Zeuner, is still maintained by the work of Mollier. The ladies spent the morning in visiting the world famous Art Gallery, while most of the men were only able to see the Sistine Madonna and a few of the more famous of the many masterpieces on exhibition here. At noon a dinner was given to our party, and we all left shortly after this for Berlin, arriving in time to attend a reception and dinner at the Palace of the Imperial Diet.

The next morning our company was divided into groups to visit the different industries. Two of our Madison party selected the cable plant of the A. E. G. Co., the German counterpart of the G. E. Co. of this country Here we saw the manufacture of raw copper received from the "States" into electrical parts and appliances of all kinds, and the manufacture of telephone and transmission cables, from the familiar lead sheathed telephone cables to large armoured transmission cables of all sizes.

At the conclusion of this inspection our party was tendered a dinner and automobile ride back to our hotels, where we met the ladies, who had spent the day visiting the palaces, parks and places of interest about the city. In the evening we were tendered a banquet at the Marble Hall of the Zoological Gardens and were here given bronze medals, which had been struck to commemorate our visit.

The next morning no definite program had been arranged, but most of the men visited the Technical High School of Charlottenberg, perhaps the best in Germany, and justly famous for its engineering research work, and of particular interest to us because of the connection of Professor Stumpf, the designer of the "Uniflow engine," and Professor Matchoss, who visited Wisconsin last year, and who endeared himself to our entire party, in his capacity as conductor of our German trip. The afternoon was devoted to a long automobile ride and boat ride to the country home of Siemens, where tea was served on the lawn, while we were entertained by a male chorus of 100 voices, and by a monoplane of the German army, which maneuvered over the grounds.

From Berlin we proceeded to Dusseldorf, the "Pittsburg district of Germany." The first evening we listened to an excellent illustrated lecture in English on the industries of the Westphalian district, and at its conclusion a curtain at the back of the room was drawn, and we turned to see apparently in a forest of pine trees, a band with trumpeters playing and flourishing their trumpets and suspended banners in true military fashion. Entering the room, we were served with a cafeteria lunch, with the food displayed in such an artistic fashion that we had to be urged to stop admiring the display and to help ourselves.

In the morning the ladies visited the welfare work of the Krupp establishments, while the men were separated into groups, the writer joining the party that visited the steel plant of the Krupp concerns, offering an opportunity for a comparison with the steel plants of our own country. The most striking difference noticed was the apparently greater use of manual labor, evidently due to its lower cost, a difference, however, that is becoming less as the wages are gradually increasing. The unusual industry, lower wages and the sales organization of the German concerns are probably some of the important reasons for the wonderful industrial development of the country, since its natural resources are rather poor. The coal in Germany is of comparatively low grade, and large quantities of richer coal are imported from England, while a large part of the iron ore comes from Norway and Sweden, factors which together with the heavy burdens due to the needs of the army and navy, make the commercial growth of Germany seem still more remarkable.

After a lunch at the plant, we joined the other parties and were taken by boat about the harbours of Duisberg and Ruhrort, where we found conditions somewhat similar to those of Hamburg harbour, and a character of commerce resembling that at Duluth and Superior, with the difference that the harbour re-

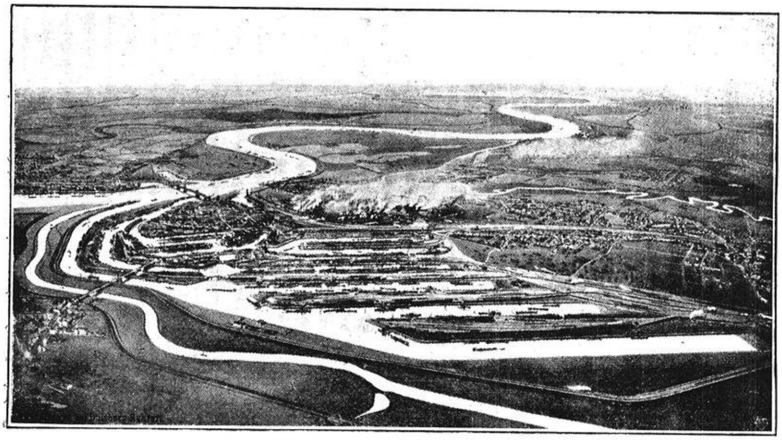


FIGURE 3.

sources of our ports are largely natural, while at Duisberg-Ruhrort a large part of the harbour has been made by dredging the river and a constant dredging is necessary to keep this in shape.

In the evening an especially fine banquet was tendered us in the town hall. The tables were loaded with beautiful crimson rambler roses and the large hall was decorated with garlands of crimson and green about the pillars and with Persian rugs and flags about the walls and balcony. The most striking part of this entertainment was an allegorical play, in which a German actor typifying Labor recited a long poem, while fire sprites danced about a full-sized billet of steel, which gradually became brighter and brighter. An actress representing America also appeared and took part in the play, while the steel billet was put under a steam hammer and flattened; the hammer kept time with the music and produced a very realistic effect. At the climax of the play, the flattened billet was removed by a crane, revealing the emblems of the German and American societies welded together by a chain. Bronze souvenirs showing these emblems and America were then distributed to the ladies.

Other excursions were made the next morning to various industries, but for obvious reasons, the writer was unable to make this nine o'clock and spent the time with Mrs. Thorkelson seeing the city with its beautiful parks and fountains and joining the party in the afternoon to take train for Cologne, where we were entertained in the evening at the Zoological Gardens, a very fine musical program being provided during the dinner. Here we had the pleasure of meeting Mr. Johnson, the German representative of the Gisholt Machine Co. of Madison, Wis. The next morning our party was again divided into groups, most of the Madison party visiting the large Deutz gas engine works, where we were shown their "museum" with the original Langley and Otto gas engines, together with the different improved types produced by this company up to the present day, and were taken about the factory. We were all impressed here with the great use of American built machine tools, a characteristic of many of the industries visited.

The sale of such tools, however, is now meeting the competition of similarly built German tools, but in spite of this, is quite successful due to the improvements constantly being made in American tools and to the practice of furnishing experts to assist in utilizing the American tools to the best advantage. As our party passed through the foundry of the Deutz plant, a large mould was being cast and when finished, a sheet iron plate was removed revealing in red hot iron the words "Welcome A. S. M. E." The courtesy of this company in showing us every detail of their business was characteristic of all the industries visited and indicated a most wholesome and refreshing spirit of growing fraternity among the engineers of all nations.

In the afternoon we had an opportunity of inspecting the famous Cologne Cathedral and its treasures, and in the evening attended a banquet given by the city, in the Gurzenich, a building of rather plain exterior, but beautifully decorated interior, erected in the fifteenth century and used for the commercial and social needs of the city.

The next morning we took train to Coblenz, and proceeded from there by boat, up the river Rhine, passing the Lorelei, the vine covered hills, the many interesting ruins of old castles, the Niederwald monument and seeing the interesting traffic of the river. From Rudesheim we took train to Frankfort-on-Main and in the evening attended a reception at the Palm Garden, one of the most beautiful and complete botanical gardens of Europe. At the entrance to the park our attention was called to large floral beds, representing the pins of the German and American societies. After the dinner the grove was beautifully illuminated revealing figures of the statue of Liberty and the Niederwald monument, before which colored lights were burned.

A reception was given next morning by the municipality in the Romer, the old interesting hall in which imperial elections and coronations took place in the middle ages. After a banquet here, a portion of our party visited some of the industries of the city, while most of us were conducted about the "old town," with its many quaint, ancient buildings, its Goethe house and the magnificent old cathedral. In the evening we all took the suburban train to Homburg to celebrate the Fourth of July with the American colony, and entertain our hosts at a dinner, with illumination, fire works and speeches appropriate to the occasion.

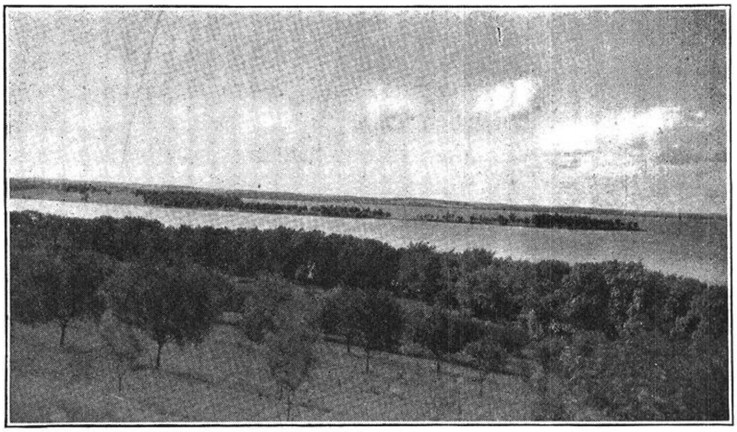
We took train the next morning for Mannheim, were entertained at lunch, and then again divided into groups to visit different industries. The writer joined the party visiting the plant of Brown, Boveri Co. and here saw their large steam turbine and electrical manufacture, with machines so assembled and erected that an opportunity was afforded to see every detail of manufacture and construction. In the evening we were given a reception and dinner by the city in the large hall of the Rose garden and the next day visited Heidelberg.

The entertainment here was partly marred by unpleasant weather but we were afforded an opportunity of seeing this famous old town with its university and students, the ancient castle with its famous wine cask and its "blown down tower," as well as the restored part, interesting, but lacking the charm of the untouched ruins. After supper at the "Molkenkur" we marched down the hill, following the band to the river, and embarking on a large barge, we floated down the river Neckar. As we approached the castle, a signal was given and immediately the grand old towers and walls stood out in a blaze of red fire. The effect was magnificent and was followed by a large display of fire works as we floated beyond the bridge, passing illuminated boats of all descriptions. Our party then took train to Mannheim, just escaping a heavy downpour of rain.

The next day we went to Munich, and in the evening attended a reception at the "Royal Court Brewery," being given here a dinner of Bavarian dishes and an entertainment provided by singers and Tyrolean peasants. The following day we visited the new Munich industrial museum, one of the best in the world, and one which, though only ten years old, has outgrown its present quarters, and is soon to be housed in a magnificent new building. A long article could be written about this interesting museum, with its very complete coal mine in the basement, its models of mechanical appliances and industries of all kinds from the rooms illustrating the development of boilers and engines to its complete collection of air ships, etc., etc.

In the afternoon we enjoyed a trip on Lake Starnberg, a lake somewhat similar to Lake Geneva. The Prince Regent of Bavaria came on board to meet the party during this excursion. In the evening we attended the closing banquet given by the city in the Old Town Hall, a building in use when Columbus discovered America. Here, as at other places, we were reminded of the comparative youth of our own country, but, as one of our speakers said, it is not surprising that in many respects we are behind Germany, particularly in municipal work, for they have 1,000 years the start. Still it must not be forgotten that although this is true the industrial development and remarkable growth of cities in the two countries have been contemporaneous, and there is much that we may learn from Germany, in studying its cities, industry, progress and growth, for above all things else, Germany is a progressive country, and has accomplished wonders from small beginnings, with natural resources less than ours and with taxation burdens far greater.

The next day our party began to separate. Those who remained visited the art galleries in the morning and in the afternoon were entertained at tea at the house of Professor Diesel of gas engine fame. Many returned home after this, but the Madison members spent the rest of the summer in visiting Switzerland, France, Holland, England and Scotland.



STUDENT SECTION.

I. A. Bickelhaupt.

This year we break into the limelight again with our Engineers' Minstrels. It is a big job devolving mostly on the Seniors. We all remember the last one—its success and notoriety—and how glad we were to admit, as we climbed out of our four-bit seats in the coop, after the show, that we were Engineers. Well, we were Freshmen and Sophomores then—now we are Juniors and Seniors. Instead of watching the show, we've got to give it. Let's make it a good one.

* * *

Don't assimilate "roughneckism" because you are an Engineer. Adopt your customs of speech, manner and dress to suit your work, rather than to advertise your profession.

* * *

And as we look over our little desk pad, we see written in livid letters: "Nov. 15.—Engineers' Trip." Say, bo, that's going to be some vacation, and when we say some, we mean quite a bit. Professor Christie remarked in our hearing that the last year's crew was the best ever for spirit and fellowship. Watch us, Christie, watch US! We're rarin' and prayin' to go. Although weak on the adjectives we are strong on the action. With a special car, a quartette, a special reporter, four "real" Profs and thirty grimy Seniors, we cannot help but predict a loud noise in the eastern side of these United States.

*Extra—Dad Hinkley and Cornel Little will not take their wives.

* * *

We notice that Professor Thorkelson's fond dream of Campus Lighting is to be realized. Of course the S. G. A. has triumphed again, but we don't seem to see how it will effect the Engineers.

* * *

After all there is a fascination about Engineering, or is it merely a sort of egotism prompted by the knowledge and ability to understand and work with the silent and powerful phenomena of nature. A machine is a relentless thing. The Engineer deals with material things—conducive to material and rock-bottom views of life. But the thinking Engineer sees beyond this—he gets a prospective of life and men that is logical, clean-cut, and true.

* * *

The following was found in an old 1902 edition of the Sphinx. It was written by Hod Winslow, now well-known in editorial circles, and although exaggerated, is good:

THE BOLD ENGINEER.

You've all heard of wise men like Moses and such,
And heroes by hundreds, Russ, English and Jew,
Greek, Saxon and Roman, French, Spanish and Dutch,
But I sing of the mightiest one of the crew.
Do listen, my children, and then you shall hear
The tale of his talents—the bold Engineer!

He's easy to pick, by his "I am it" air,
By his general manner of owning the place,
By the tilt of his hat and the way he can swear,
By his prize fighter's walk and the pipe in his face,
Whenever a mortal like this doth appear,
You can bet your sweet life its the bold Engineer!

If he chances to talk to a girl who has "Aims,"
He knows how to hint of his "Higher Ideals."
Yet he knows how to jolly the jolliest dames.
He suits to all tempers the "Josh" he unreels,
So the feminine judges all vote him a "dear"
This fickle deceiver—this bold Engineer.

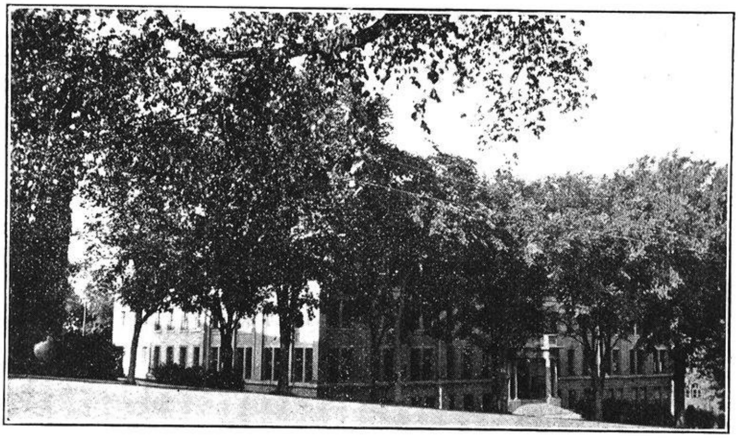
He runs the class meetings, athletics, the "Prom,"
He gets all the plums on the Varsity tree,
He carries the laundry for Harry, Dick, Tom.
He goes to all functions and wiggles in free.
"What's the use of a pull if I don't use it here
I shan't let it lapse," says the bold Engineer.

He can row, he can skate, he can run, he can swim,
Or manage the Badger and act in a play.
He can even brave "John" as he stands in the Gym.
He's the cock of the walk and the King of the day.
But he'll find the great world just as hard work I fear
As the rest of us mortals,—the bold Engineer.

He's a peach and a whale, he's a wonder, a star.
He can bluff out a flush with an ace and a deuce,
He can stand all the drinks that are mixed at the bar,
But when drunk he is Hades and Satan broke loose.
He can throw down the cocktail and guzzle the beer
By quarts and by gallons—this bold Engineer.

Are you short for the crew? He can row like a dream.
Would you win a debate? He can spout by the hour,
He plays in the Haresfoot or plays on the team,
And in either position his strength is a tower.
And when some one is wanted to work or to cheer,
The man that they seek, is the bold Engineer.

He can measure the power of rivers and seas,
He can figure how often to cut without harm,
He can measure the atom or figure his fees,
Or measure a fair co-ed's waist with his arm,
He can stab like a dago or buck like a steer;
There's nothing can rattle the bold Engineer.



GAS PRODUCER ENGINES IN A NEW FIELD.

Self-Propelled Barges for Southern Coal Trade Equipped with Gas Producers and Gas Engines.

A fleet of large self-propelled barges, fifteen in number, to ply between New Orleans and the coal fields of northern Alabama is of peculiar interest in that they are the first craft of their kind in America to be propelled by Producer Gas Engines. They are also the first craft to bring coal from the Alabama fields to New Orleans wharves by water. Alabama coal has heretofore been shipped to New Orleans by rail. A glance at a map of the Gulf States shows these barges follow almost as direct a route. Starting from the coal fields they will proceed down the Black Warrior, Warrior and Tombigbee rivers, across Mobile Bay and proceed to New Orleans by way of Mississippi Sound, Lake Borgne, Lake Borgne Canal and the Mississippi River, a total distance of a little over 500 miles.

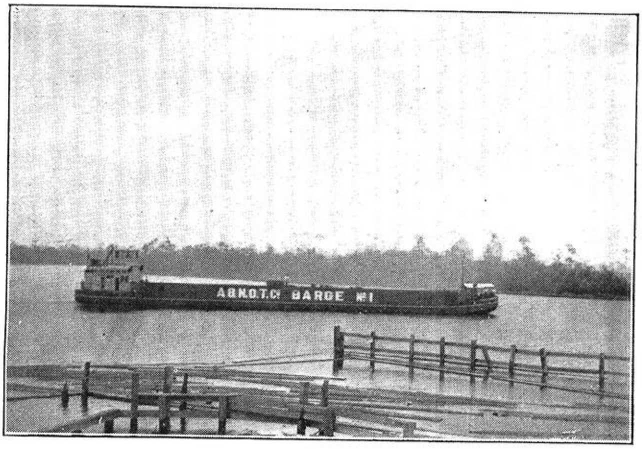


FIGURE 1.

The first barge of a fleet of fifteen being built by the Alabama & New Orleans Transportation Company for transporting coal from Northern Alabama Coal Regions to New Orleans.

The barges are of steel construction, and are similar in design to those in use on the canals of Holland. Their measurements are as follows: Length, 240 ft., width on deck, 32 ft., width at bottom, 28 ft., depth, sides, 8 ft., depth, center, 8½ ft. Their capacity is 1,000 tons. Draft, when fully loaded, 7 ft. They are propelled by twin screws driven by twin engines and have a speed of approximately seven miles an hour when fully loaded. The weight of each barge and equipment is close to 240 tons.

The screws are driven at 300 R. P. M. by two seventy-five H. P. Vertical Producer Gas Engines. Gas for the engine is furnished by a 150 H. P. Producer. The fuel used for the Producer is what has heretofore been a waste coke from the ovens of the Birmingham District and which consequently is secured at a very low price. This coke is practically pea size. It has a calorific value of about 11,000 B. T. U. and the consumption is approximately one pound per horse power hour. Bunkers are provided to hold about fifteen tons of fuel. Each producer is equipped with scrubber, gas tank, tar extractor and is fitted with water bottom.

While the main power plant is of primal interest the auxiliary power equipment of the barge also merits mention. This consists of a nine H. P. gasoline engine, which drives a centrifugal pump handling the ballast and bilge water, a blower, an air compressor and a five and one-half K. W. direct current generator. Current is used for electric lights throughout the boat, fans in cabins and engine room, a 3,200 candle-power search light and a five H. P. motor. The arc light is mounted on the roof of pilot house and galley, which are immediately over the engine room. The motor is for operating an anchor winch. The generator is so mounted that when the large engines are running it may be belt driven from one of them. A second four-inch centrifugal pump is also installed to be driven by one of the large engines through friction wheel contact.

A decided advantage of the self-propelled barge for use in these waters is that they can negotiate the numerous locks on the Warriors and Tombigbee Rivers in much less time than if towed. Each lock can be passed in twenty minutes by these vessels, whereas more than an hour would be consumed by the towed fleet system.

The barges will make the trip from the mine region to New Orleans in seventy-two hours and with all fifteen vessels in service it is estimated that coal will be moved into New Orleans at the rate of 50,000 tons a month. Added revenue will be derived by the barges carrying freight on the return trip to the coal field.

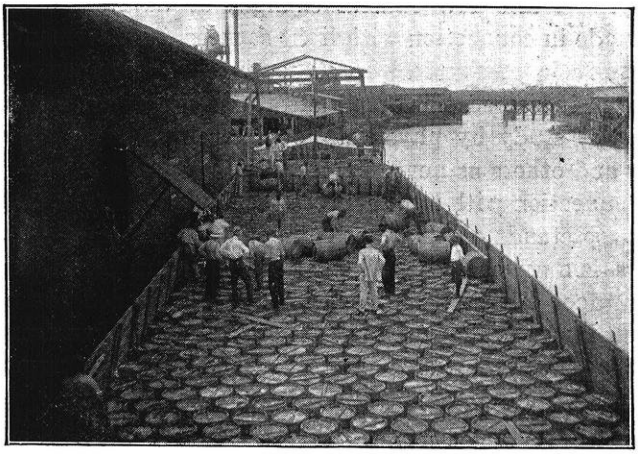


FIGURE 2.

Loading naval stores.

The Alabama & New Orleans Transportation Company, of which John H. Bernhard is vice-president and general manager, control the Lake Borgne Canal which is the key to the route traversed by these barges, and it is to them that the new departure in Alabama coal transportation is due. All the barges are being built at the company's own ship yard, located at a point about twelve miles below New Orleans, where the canal empties into the Mississippi. The first barge was launched June 4th, and it together with one launched in July, are now in commission. A third boat has now been launched—it being the company's plan to construct one a month until the fleet numbers fifteen vessels. All the power equipment for the barges—engines, gas producers, motors, generators, pumps, air compressors, etc., was designed and furnished by Fairbanks, Morse & Co.

RECENT INCANDESCENT LAMP DEVELOPMENT.*

During the past year the science of illumination has probably made greater progress than at any other similar period of its history. While few radical changes or developments have been made in connection with light sources, improvements have been made in mechanical construction of present systems, resulting in increased efficiency; and illumination has become the subject of study by physicists, oculists, architects, legislative bodies and others as never before.

In connection with light sources the development of the tungsten lamp stands out most prominently. This, in high candlepowers, is a serious competitor of the arc lamp both for indoor and outdoor lighting, and has largely superseded the carbon filament lamp, as shown by the following table taken from a recently published article, and giving the relative number of lamps sold.

Type	Per cent. 1907	Per cent. 1908	Per cent. 1909	Per cent. 1910	Per cent. 1911	Per cent. 1912
Carbon	93.27	84.12	68.98	63.08	52.90	25.47
Gem	5.88	8.58	15.07	14.88	19.00	33.59
Tantalum ..	0.75	1.78	2.12	3.57	2.74	1.00
Tungsten ...	0.10	5.52	13.83	18.47	25.30	39.94
Total	100.00	100.00	100.00	100.00	99.94	100.00

It is extremely probable that more recent figures will show that the tungsten lamp, aided by greatly reduced price, its high efficiency and the fact that electric companies are beginning to make free renewals of tungsten lamps as they did of the carbon filament, is destined to make the carbon filament lamp a vanishing quantity. In this connection it is interesting to note that the United States government has issued an order through the office of the supervising architect of the Treasury Depart-

* EDITOR'S NOTE.—The above article is briefed from several papers which were read before the Illuminating Engineering Society in September. We take this opportunity to thank them for the privilege of reprinting.

ment that carbon and metallized-carbon filament lamps are not to be used in any of the government buildings, and any such lamps in use at the time of the receipt of the order must be removed and 25-watt tungsten lamps substituted.

Possibly the most startling development in the tungsten lamp is the announcement of one giving an efficiency of 0.5 watt per candle. A specially shaped tungsten filament is used in a bulb containing an inert gas, as nitrogen, at a pressure of about one atmosphere. The types to be developed first are adapted to high current consumption, say 6 amperes and over.

Since 1908 the strength of the tungsten filament has been increased more than 300%. This is due to the perfection reached in the manufacturing process which has given a more uniform and homogeneous filament. Lamps may now be operated at a far higher efficiency than before, with no decrease in total life.

The increase in the strength of the filament has caused great changes in the lighting equipment of railroads and street railways. Tungsten lamps on cars are now a familiar sight. The tremendous saving on a street railway system of 1,000 cars is well shown by the following example:

LIGHTING COSTS, WITH THE NEW AND OLD SYSTEMS.

	Carbon lamps	Tungsten lamps	
Car-hours of lighting per year.....	1,500,000	1,500,000	
[1] Average number of lamps per car.	22.38	5-94 watt	4.48-23 watt
Lamp hours of lighting per year....	33,600,000	7,500,000	6,730,000
Average life of lamp in hours......	1,800	2,000	2,000
Yearly number of lamp renewals...	18,650	3,750	3,365
Net cost of lamps (on $2,500 contract)	$2,238.00	$2,396.25	$955.65
		$3,352.00	
Yearly cost of power for lighting...	$35,500.00	14,150.00	
[2] Estimated expense of shade equipment	—	2,000.00	
Final total yearly cost.........	$37,738.00	$19,502.00	

The saving is approximately $18,000 or $18 per car per year. Besides this the amount of light is increased by 85% and the quality of the illumination far above that of the old system.

Aside from bettering the life performance of the tungsten-filament lamp, much time and effort have been directed toward decreasing the cost of the product and broadening its application. The cost of manufacturing and handling the lamps varies almost directly with the bulb size, and the cost of reflectors and similar accessories increases in an even greater ratio; hence, from the standpoint of economy, a substantial decrease in bulb size is equivalent to a considerable increase in life performance or efficiency.

Owing to the use of chemical in the new 60-watt lamp, it will give as long a useful life as the older type at a decrease of 25% in renewal cost. The new lamp can also be used in many locations where the size and appearance of the older type rendered it inapplicable. The demand for a 60-watt tungsten-filament lamp in a smaller bulb was probably more pronounced than in the case of any other size, inasmuch as this is the highest wattage which would be used to replace the ordinary carbon lamp unit for unit. At the same time, however, there is a well-marked tendency toward a decrease in size for all lamp bulbs.

Perhaps the most far-reaching of the improvements which have taken place during the past year is the general introduction of the coil filament type of tungsten lamp. It is well known that after the voltage, wattage and efficiency of an incandescent lamp have been determined, all of the filament dimensions are fixed. For example, the old pressed-filament 110-volt, 40-watt lamp when designed to operate at 1.25 watts per candle had a filament diameter of 1.605 mils and a length of 21.25 inches (53.975 cm.). The lamp bulb and filament supports were necessarily of such size and shape as to take care of this length of filament. It was not possible to obtain a concentrated filament lamp, neither could one having a single line of light be manufactured unless the latter were placed in a bulb 22 inches (55.88 cm.) long. Recently it has been found that drawn wire filaments of all sizes can be coiled into the shape of a helical spring; this greatly reduces their overall length and makes practicable a lamp of almost any form desired. This process was first developed in connection with the low-voltage, high-current auto headlight lamps, and later was found practical for even the smallest filament. The diameter of the helical coil is ordinarily not more than seven times the diameter of the filament itself and, therefore, the difference in potential between successive turns is very small, usually about one-tenth of a volt. At this low voltage there is practically no tendency for the current to short-circuit its regular path, even when the coils appear to touch each other.

In addition to the above, it has been found that coiled filament lamps are much stronger than those of the standard type, quite as strong, in fact, as the old carbon lamps. This is due in part to the greater ability of the coiled filament to absorb shock and partly because tungsten wire seems to be increased in strength by stressing beyond its elastic limit.

During the past year the use of concentrated filament tungsten lamps has enormously increased. At the present time a very large proportion of the automobiles now being sold in this country are equipped with these lamps. Concentrated filament lamps are also being used for stereopticon work, for trolley car head-lights and for theatre stage lighting in place of arc lamps and Nernst lamps.

While every effort is being made to get the very newest things in the matter of lamp production, it is reasonable to say that the coming year will not see such an advance as has been made during the past year. It is impossible for manufacturers to install new machinery, and new equipment as rapidly as the changes would demand, and we must wait upon capital until the results to be obtained are sure enough, and of enough value to warrant such extensive changes.

EFFECT OF SUBMERGENCE UPON THE EFFICIENCY OF A WATER TURBINE.

E. Dow Gilman.

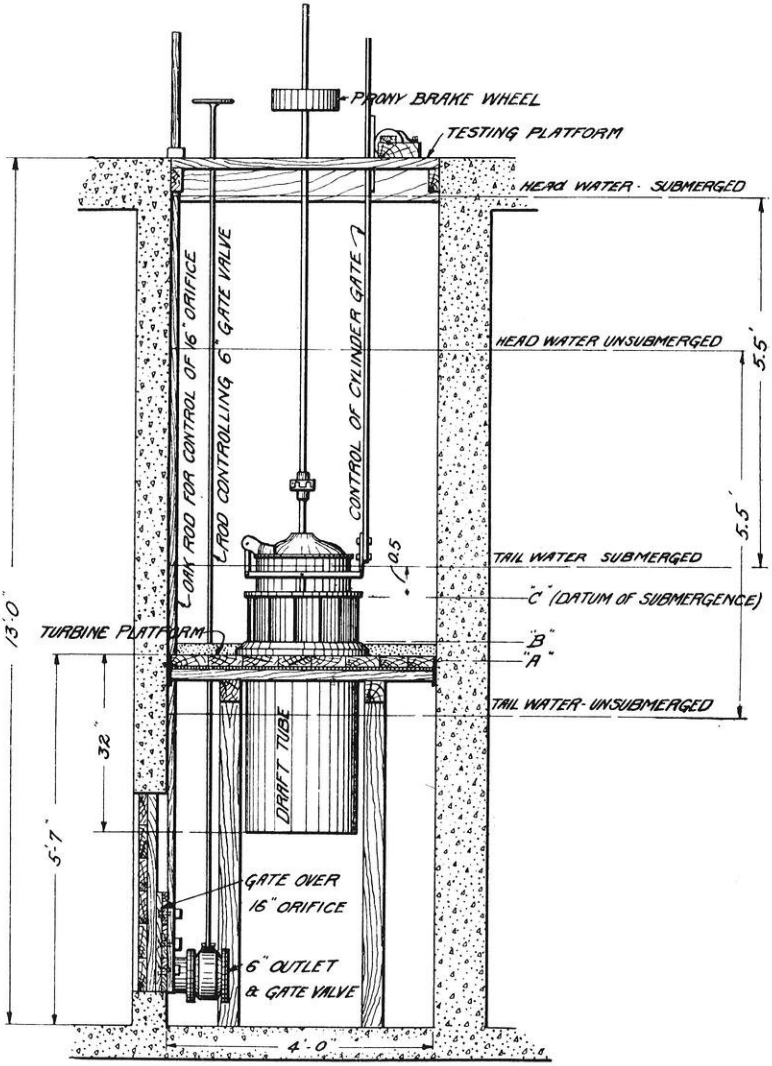
In the development of the American water turbine theoretical considerations have played but a small part. Practically all of the questions involving operations have been decided by actual experiment. A practical condition met in certain installations is that commonly known as submergence, that is, a condition in which the turbine is placed below the level of the tail water. The question has arisen—What is the effect on the efficiency of the turbine of such a condition of installation? Evidently it is important to know the answer. Because the condition is comparatively rare in practice the subject has in the past been neglected; but since in some installations submergence is unavoidable, its effect on the efficiency should be ascertained.

The subject comes up in actual practice in several different cases. First, in the condition met in the greatest number of distinct cases, floods raise the water of the tail race above the level of the turbine which is normally unsubmerged. Second, when low head wheels of large capacity are used, they must be placed low to prevent the forming of vortices at the entrance. Third, when several turbines are placed vertically on the same shaft, the lower wheel is usually placed quite low in the water, in order that the upper wheel may get the entire benefit of the draft tube, and may not be subjected to vortex action.

It has been the unsubstantiated opinion of many hydraulic engineers that turbines should never be placed below the tail water. They have held that this submergence causes a decrease in efficiency of from four to eight per cent, a loss which would sometimes mean the success or failure of a large plant. Others have supposed that at small gate openings submergence might increase the efficiency of the turbine. This idea they based upon the belief that the inflow, under submerged condition at small gate opening, was changed from the impinging action of unsubmerged condition to a flow similar to that of the reaction type of turbine, with its resultant higher efficiency.

Investigations to test these opposing hypotheses have been made at the Hydraulic Laboratory of the University of Wisconsin. In the spring of 1912 W. E. Jessup and O. J. Schieber made tests on a twelve-inch Victor turbine equipped with a register gate. No change of setting was used to obtain submergence and the loss of efficiency was determined to be but a trifle over one per cent. In the summer of the same year tests were made by M. F. Rather, C. D. Vaughn, and E. C. Noyes upon a twelve-inch Smith-McCormick turbine equipped with a cylindrical gate. The conditions of operation were made as nearly like those of the former test as possible. The effects of submergence upon the efficiency of the turbine were so at variance under different gate openings and loads, that the investigators could draw no definite conclusions in regard to this phase of the work, though they believed that submergence decreased the efficiency. Further investigations were made upon the Smith-McCormick turbine by E. D. Gilman and M. C. Sjoblom during the year 1912–13. The purpose of this article is to show the methods used in conducting the last investigation, and to present the conclusions arrived at after a study of the data of this and of the previous tests.

The wheel used was an inward flow Smith-McCormick turbine, with a twelve-inch diameter runner, a draft tube 3.2 ft. long, and equipped with a cylindrical gate. A pit 4x5 ft. in plan and 13 ft. deep, located in the southwest corner of the Hydraulic Laboratory of the University of Wisconsin was utilized as a testing pit. The turbine was placed upon a platform 5.7 ft. above the bottom of the pit, with the draft tube extending into the space below. This platform gave a solid base for the machine and was made water tight by grouting, caulking, and sealing with neat cement.



12" Smith-McCormick Turbine

Section Showing Setting and Water Levels

FIGURE 1.

Water from Lake Mendota was supplied by two eight-inch centrifugal pumps, with a combined capacity of eight cubic feet per second. In addition to the pumps a four-inch pipe from the university water system delivered into the channel leading to the turbine. The quantity of water supplied by the pumps was controlled by means of a gate valve in the discharge pipes to the channel, and by throttling the engines. This served as a rough adjustment for the elevation of the head water. The final adjustment was made by means of a valve in the four-inch pipe.

The discharge from the pit below the turbine was regulated by gates over two circular orifices leading into the weir channel. The larger orifice, sixteen inches in diameter, covered by a sliding wooden gate, was used to make the rough adjustment. The smaller, fitted with a six-inch gate valve, served as a means of final adjustment. To control these gates, rods were extended from them up through the turbine platform to the testing platform, thirteen feet above the bottom of the pit. A small vent pipe also extended from near the bottom of the pit to above the level of the testing platform, allowing free passage of air and assuring atmospheric pressure on the surface of the tail water.

The purpose of these tests was to discover the effect of submergence upon the efficiency of the turbine. Accordingly, the purpose of the setting which has been described was to provide a means of running the turbine both submerged and unsubmerged without changing the setting and with the same head of water. The turbine was submerged by decreasing the area of discharge from the tail water pit. This also raised the elevation of the head water. By careful adjustment of head and tail water, the effective head could be made the same for either submergence or non-submergence, without in any way disturbing the operating conditions of the machine. In both runs, all other details of the test were kept as nearly as possible constant, so that any variation in the results might be attributed to submergence alone.

The runner was directly connected to a twelve-inch pulley slightly above the testing platform. The load carried was measured by the usual prony brake method. The cylindrical gate controlling the quantity of water passing into the turbine was operated by a wooden rod extending through the testing platform and controlled by a rack and pinion. A graduated scale was provided for determining the amount of gate opening. The various details of the setting as enumerated are shown on Plate I.

After discharging through the orifices in the tail water pit the water was measured over a 3.0 ft. weir. The head on the crest was measured to one-one-thousandths of a foot by means of a hook gage and vernier in a still water basin connected to the weir channel. The elevations of head and tail water were measured by gages connected to the head and tail water chambers respectively.

In order to obtain a suitable degree of submergence and use the same head as used in the unsubmerged condition the effective head had to be limited to five and one-half feet. This gave a range of two and one-half feet in the elevation of the tail water between the submerged and the unsubmerged conditions. The datum plane of submergence was chosen as that level at which the runner was completely submerged. This plane appeared to offer the best possibilities for comparison with other tests on other types and makes of turbines. The tests under the submerged condition were run with .5 ft. of water above that actually required to completely submerge the runner, and were therefore referred to as having .5 ft. submergence.

Tests were run at 3/8, 1/2, 5/8, 3/4, 7/8, and 8/8 gate openings, under the unsubmerged and the one-half foot submerged conditions. At each gate opening of each condition a series of tests with varying loads was made, ranging from the maximum load that the turbine would carry to the runaway speed. Certain tests were run over to show how closely the work could be made to check, and are an indication of the extent of experimental error under the conditions surrounding the operation of the turbine.

The interpretation of the data secured by these tests was best accomplished by placing the data in graphical form. For the purpose desired the tests were studied by plotting curves with efficiency as ordinates, and the ratio of the peripheral velocity of the runner to the theoretical velocity of a jet of water discharging under the head used, as abscissae. This ratio, a common one in hydraulics, is generally represented by the Greek letter θ, and the curves are referred to as the efficiency-θ curves. Plate II shows the efficiency-θ curves for the 7/8 gate opening. It shows clearly the effect on the efficiency at different speeds. Although this curve is typical of those at the other

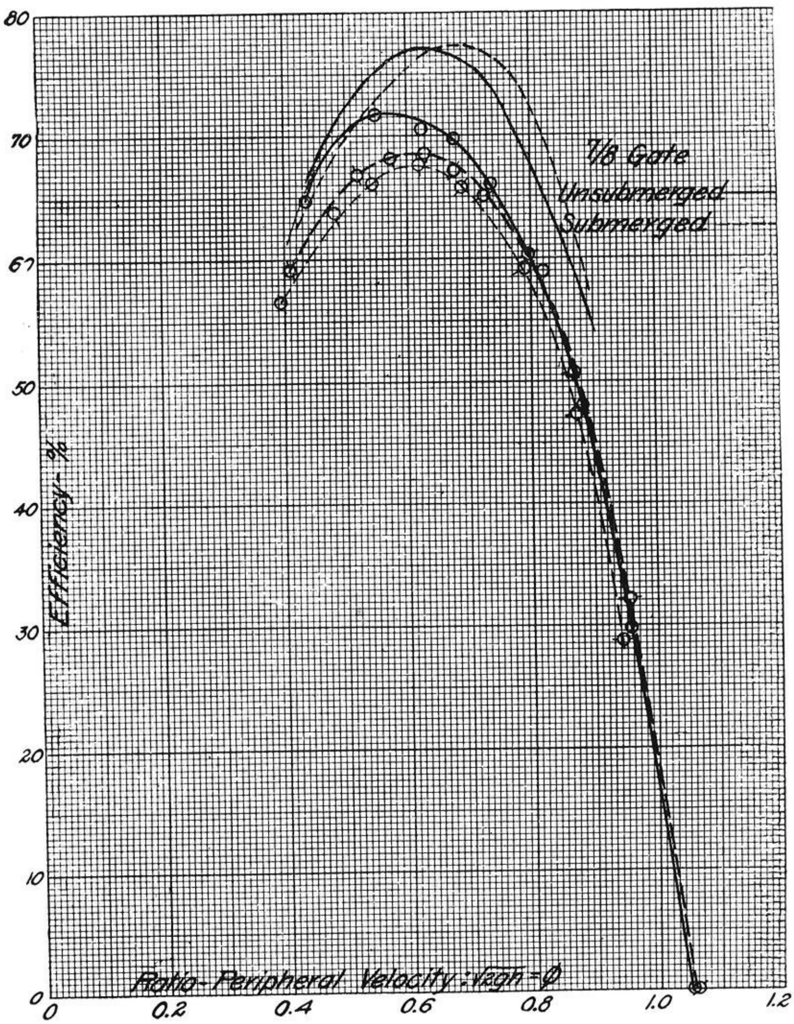


FIGURE 2.

gate openings, variations existed so that at the ⅝ gate opening the curve for the submerged condition was above that for the unsubmerged condition.

Another curve of importance was that with R. P. M. as ordinates and brake load as abscissae. In these experiments, the Vic-

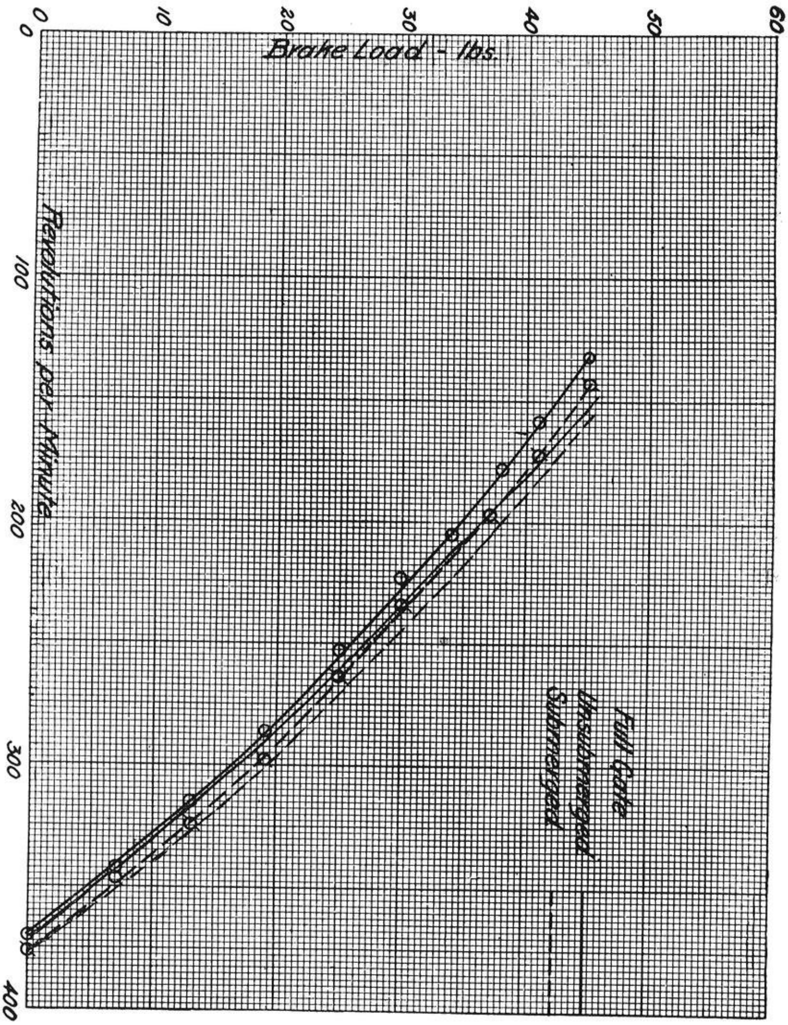


FIGURE 3.

tor turbine at a given speed carried a greater load when unsubmerged. The Smith-McCormick turbine carried a greater load when submerged, as shown by the curves on Plate III. This fact was true for all gate openings except the smallest, and the curves shown are typical of the others.

Curves were also plotted for both conditions showing the maximum efficiency at the different gate openings, the relation between the discharge and θ, and the relation between input and output. The results of all the tests were consistent in indicating that there is a greater discharge with the turbine submerged than with it unsubmerged for a given value of θ or for a given load. The cause of this is extremely uncertain. As the efficiencies under both conditions are practically the same, it follows that for a given θ or for a given load the power developed is greater under the submerged than under the unsubmerged condition. The fact is shown by a study of the input-output curves.

The work done by W. E. Jessup and O. J. Schieber in 1911–12, and by M. F. Rather, C. D. Vaughn, and E. C. Noyes in the summer of 1912, led them to believe that the efficiency of the turbine was decreased when it was placed in a submerged condition. This belief was based upon a study of their efficiency-θ curves, which showed certain strange inconsistencies, the submerged condition giving sometimes a higher and sometimes a lower efficiency than the unsubmerged condition. A like variation was found in the set of experiments under discussion. It is true, however, that the lower efficiency predominated for the submerged condition.

The writer believes that the effect of submergence was less than the experimental error of the conditions under which the tests were run. The conditions of operation, the small head and necessarily small loads used in conducting the tests, were such that it is highly probable that the experimental error affected the results to a greater extent than did the submergence. In order to determine how great the variation due to experimental error might be, duplicate tests were made at the same gate openings and the same loads. The second test was made twenty-four hours after the first, during which time the apparatus remained undisturbed. The result (Plate IV) showed a variation in efficiency of seven-tenths per cent. These two tests were made with the purpose of duplicating as closely as possible and would represent a probable minimum of experimental error. It may easily be assumed that the variation from this cause might be from 1.0 to 1.5 per cent. It is impossible, therefore, from the three studies made to advance any definite idea as to the effect of sub-

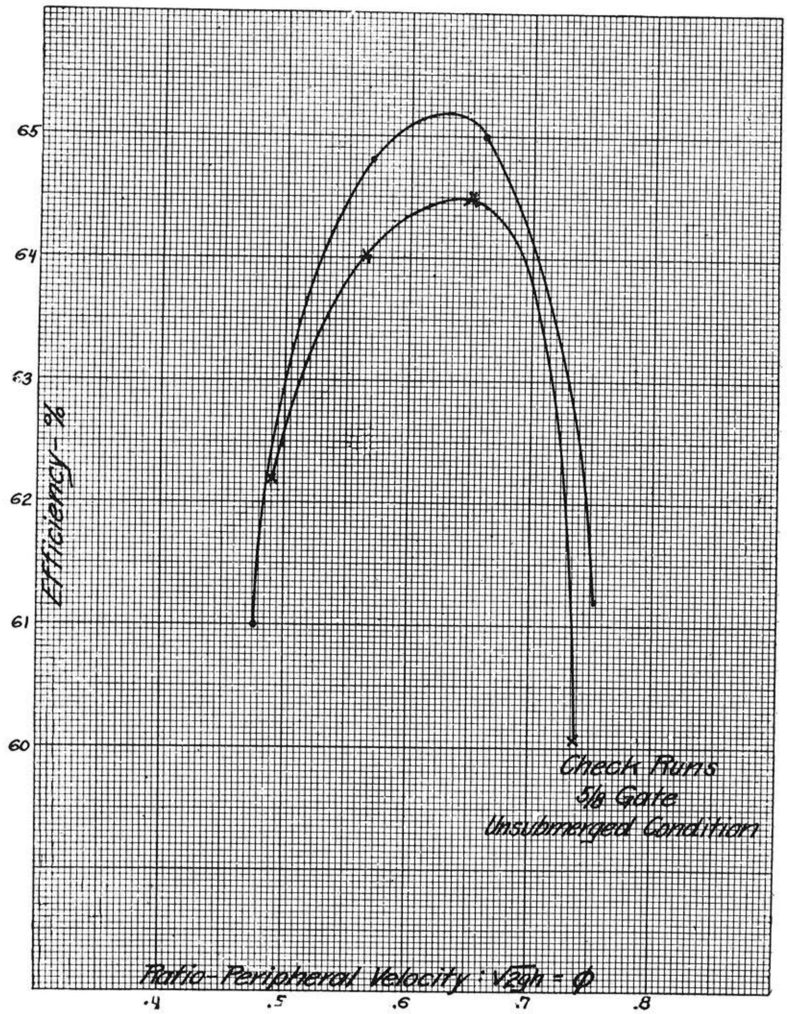


FIGURE 4.

mergence other than to say that any such effect is small, and is within the limits of the experimental error, i. e., less than 1.5 per cent. Evidently, then, it cannot be said that submergence either decreases or increases the efficiency as small an amount as one per cent. Any further study along this line must be with an apparatus which will measure very small quantities. A larger head capable of carrying greater loads must be used and an apparatus so sensitive that experimental error is but a very small per cent of the total load.

The practical conclusion arrived at from this study is that the effect of submergence upon the efficiency of the wheel is so small that the convenience of placing the turbine so that it might act submerged part of the time would be the determining factor in its installation. The installation at the new water power plant at Keokuk, Iowa, consists of low head turbines of large capacity placed within three feet of normal tail water elevation. In showing the writer over the plant this past summer, the chief engineer stated that submergence was probable, but had not been considered in the design because he believed that its effect would be negligible. In the light of these experiments his opinion seems justified. The mammoth plant at Keokuk, however, is a practical illustration of a case in which the effect of possible submergence on the efficiency of the wheels is worthy of study.

The Wisconsin Engineer.

EDITORIAL.

We know a man who today has most of the qualities that make for success. Time was when he had but two of these, but they were so well nurtured that today his personality combines a wealth of good qualities.

The two with which he started were willingness to work and self-confidence in his ability. His ideas were not always good, his manner of presenting them not always agreeable, so naturally he made many mistakes. But he always carried his ideas through to completion in spite of opposition, and he seldom made the same mistake twice.

With increased experience his ideas became more rational, and since he made fewer mistakes, he was able to accomplish more. His readiness to attempt anything which he thought right and his growing number of successes won him the respect of others and he became a leader. When he faced a difficult proposition and his ability was questioned, he overwhelmed doubt with his sincerity and the record of his past achievements.

The attainment of his aims and of the qualities leading to success was not an easy matter. His life was at first a succession of unequal struggles, in which experience, natural enthusiasm and confidence gradually overcame the odds against him, until finally his position was assured. When his name is mentioned, it is said "He had the stuff."

We knew a freshman with two talents,—fair intellect and self-confidence. Because he failed to properly use these assets, he did not acquire more, while his liabilities increased until he became a scholastic bankrupt. The faculty took over the receivership and sent him home.

Engineering moral. You can put 100 pounds of air into a tank that held but fifty pounds; but it takes energy and a force pump.

Most people read the editorial columns of a paper before they read the articles, and for that reason we want to call your attention to some of the articles we are printing this month.

Prof. Thorkelson has written a mighty interesting article about the recent trip of the A. S. M. E. to Europe. It is a fine chance for you to find out just what they did over there, where they went, and what they saw.

Mr. Chisolm has given us some brand new dope on the use of Plaster of Paris in making patterns. Mr. Chisolm has only been in the United States for a few years, but his success with this method in England and Scotland should make you anxious to learn about it. We believe that we are safe in predicting that this article will attract more attention than any we have printed this year.

What would be the effect upon a power-house if the water below the dam backed up and flooded the tail-race? Would the turbines work? We have an article by Gilman that in its results will surprise you. Look it over carefully.

Last spring we published an article by Berggren about the Flow of Steam in Pipes. Prof. Foster of Washington has written an article for us, and given us a brand new solution for Berggren's equation.

Next issue we start with some more new material from Karapetoff. The subject will be treated in sections, and will be published in three numbers of the magazine.

ADVERTISER'S NEWS DEPARTMENT.

The work on the Spaulding Dam, in Nevada County, California, which dam, by the way, is to be the largest dam in the world, is progressing rapidly. During the month of August the Pacific Gas & Electric Company broke the world's record for pouring concrete. During that time they mixed and placed 40,485 yards of concrete with four No. 14 Smith Mixers. This information was furnished us by Mr. F. G. Baum, Chief Engineer of the Pacific Gas & Electric Company. This record broke the previous world's record which was held by the Medina Valley Irrigation Company Dam near San Antonio, Texas, whose best record was 40,303 cubic yards with five Smith Mixers.

"The Allis-Chalmers Manufacturing Company announces the removal of the Sales and Engineering Offices of their MINING MACHINERY DEPARTMENT from Chicago, Ill., to the Milwaukee Works at West Allis.

The Chicago shops will also be removed to Milwaukee in the near future.

The advantages to be gained by concentrating all Departments, both commercial and manufacturing, at one plant are the reasons for this move."

We are in receipt of "The Concrete House and its Construction," published by the Association of American Portland Cement Manufacturers, and we wish to say that it is the best book that has ever come to our desk. The arrangement of the material, the taste shown in the selection of material, the clearness of the descriptions, the paper, press-work, and half-tones are above criticism.

Not to be outdone by the Commonwealth Edison Co. of Chicago, which has recently purchased an enormous English-built Parsons Turbine, the Interborough Rapid Transit Co. of New York has awarded a contract to the Westinghouse Machine Co. for a horizontal turbine of 30,000 KW capacity. We hope to publish more detailed accounts of the two above mentioned installations, in the near future. Neither of the turbines are in place as yet.

Mr. Broders, the staff photographer, is going on the Eastern trip with the Engineers, and we expect some good live snap-shots of the places the men will visit. Watch for them in the December issue. Some more of that special feature service that we are giving you this year.

ALUMNI NOTES.

For a number of years the University Y. M. C. A. conducted a student employment bureau, through the medium of which needy students could obtain work to aid them in self-support, and prospective employers could find help.

This year the Board of Regents made an appropriation to maintain a graduate and student employment bureau in connection with the Alumni Association office. When this was done, the Y. M. C. A. immediately gave over its bureau and patronage to the Alumni office.

Chas. J. Belsky, '10, is instructor in Electrical Engineering at the University of Pennsylvania.

E. E. Sands, '00, is City Engineer of Houston, Texas.

John C. Potter, B. S., '04, and E. E., '09, is pursuing graduate work at the Massachusetts Institute of Technology.

J. R. Iackisch, '10, is in the U. S. Reclamation Service, with headquarters at Powell, Wyoming.

R. D. Lewis, '09, has a position as Assistant Mechanical Engineer with the Robinson, Cary & Sands Co., of St. Paul.

A. B. Whitney, '08, is Assistant to the Manager of the Chicago, Milwaukee and St. Paul Railway in Chicago.

B. L. Milliren, '09, is General Manager of the Brandon Gas and Power Co, Brandon, Manitoba, Canada.

L. L. Hebberd, '12, is Mechanical Engineer with Vaughn, Meyer and Sweet, Consulting Engineers, of Milwaukee.

H. G. Hislingbury, '08, is with the Hoden, Pyl, Hardie Co., Operators, with offices in the Dime Savings Bank Bldg., Detroit.

H. Gardner, '05, is Instructor of Mechanics at the University of Illinois.

F. W. Braasch, '12, is Efficiency Engineer with the Sheboygan Chair Co., at Sheboygan, Wis.

F. P. Hutchinson, '11, has been transferred from the Milwaukee to the Chicago branch of the Cutler-Hammer Mfg. Co., located in the People's Gas Bldg.

E. C. Noyes, '13, is in the Waterloo office of the Dunphy-Fridstein Co.

F. W. Ives, '09, in addition to instructional work in the College of Engineering of Ohio State University, has a commercial practice in general engineering and patents.

John Berg, '05, is with Ralph Modjeski, Consulting Engineer, in Chicago.

Harold D. Wile, '12, is manager of the inspection department of Wile, Loeb and Gutman, Insurance Exchange, in Chicago.

We have the announcement of the marriage, on June 16th last, at Salt Lake City, of Robert F. Ewald, '05, and Miss Pearl Olsen. They have been at home since July 15th at Alcoa, Tenn.

Ernest J. Springer, '09, and Miss Mary Donavin were married in New York City, Sept. 13th. They are at home after October 15th at 203 Underhill Ave., Brooklyn.

Practically all of the graduates from the Chemical Engineering Department in the class of 1913 are located. Mr. A. H. Frost is with the North Shore Gas Company at Waukegan. C. K. Textor is with the Wood Pulp Grinding Laboratory of the Forest Service at Wausau. K. W. Erickson is in the Forest Products Laboratory at Madison. D. B. Becker is with the Coal Products Company, Aurora, Ill. W. H. Steinberg is with the Cutler-Hammer Company, Milwaukee. A. S. Wahl was married on September 1st to Miss Elizabeth Kreis of Wheaton, Ill.

We clip the following from the ELECTRICAL REVIEW, published in London, England:

> *Hundreds of pounds spent on training for a position in a central station is sheer waste, when electrical courses can be had now so reasonably. Engineers should be good practical all-round men, those who have worked up through several stations, from the boiler house upwards; and this is found in a good ambitious engineman with technical training.*

To you fellows that are spending four years here at Wisconsin, getting nothing but a technical education, this clipping ought to have a mighty serious meaning.

The Engineer is here to do you a real service, and we are going to keep after this subject of a broader education for Engineers until you begin to take it to heart. There are a great many men on the faculty that are fighting for the same thing, and we look to them for co-operation.

It means a lot to most of us,—when we come here for four years, at no little expense, when we find out about our senior year that we have missed half the good in college. The ability to talk about something besides Engineering, to see the other side of life once in a while, to realize the conditions that other people are working under,—all these things that come from an understanding of economic life, and politics, are of the utmost importance to the man that hopes to some day advise others,—the Engineer.

At this point we want to bring another question to your attention. How many times have you wanted advice about your studies, or your future prospects, and haven't been able to get it? Wouldn't it be a fine thing if we had a Dean of Men, or some one in that line that could help us make up our minds once in a while when we were in trouble, or doubtful about the right course to pursue.

We're going after that proposition next. At Illinois they have a Dean of Men that knows every fellow in school by his first name.