The Wisconsin engineer. Volume 10, Number 2 February 1906

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

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

Volume 10 *The* Number 2

WISCONSIN ENGINEER

Published Four Times a Year by the University of Wisconsin Engineering Journal Association

MADISON, WIS. FEBRUARY, 1906

CONTENTS

Entered in the Post Office at Madison as Matter of the Second Class.

GOULD STORAGE BATTERY CO.

New York Chicago Boston

STORAGE BATTERIES

ADAPTED FOR

EVERY REQUIREMENT

E. R. CURTISS,

Photographer

MADISON, WIS.

Vilas Block **Elevator**

THE HUB

A Favorite with the....

YOUNG MAN

Because we aim to reduce the matter of merchandising, so far as **Clothes snd Shoes** are concerned, to a science.

Stein-Bloch Clothes Stacy-Adams Shoes

are the products of the highest priced "engineering" skill—in their respective fields. : : :

---

50 YEARS' EXPERIENCE

PATENTS

TRADE MARKS
DESIGNS
COPYRIGHTS &c.

Anyone sending a sketch and description may quickly ascertain our opinion free whether an invention is probably patentable. Communications strictly confidential. HANDBOOK on Patents sent free. Oldest agency for securing patents.

Patents taken through Munn & Co. receive *special notice*, without charge, in the

Scientific American.

A handsomely illustrated weekly. Largest circulation of any scientific journal. Terms, $3 a year; four months, $1. Sold by all newsdealers.

MUNN & Co. 361 Broadway, **New York**

Branch Office, 625 F St., Washington, D. C.

The Lubricating Oils

in use by the
University of Wisconsin
are the Exclusive Product
of the.....

Viscosity Oil Co.

1522 Manhatten Bldg.

Branches—	**Chicago, Ill.**	**Branches—**
Duluth	—	Colnmbus
St. Paul		Indianapolis
Milwaukee	**L. D. Phone**	Pittsburg
Grand Rapids	**Harrison 536**	Boston

READ

HOW TO BUILD A ONE KILOWATT DIRECT CURRENT DYNAMO or ONE HORSE POWER MOTOR. By A. E. Watson, Author of "Electricians' Handy Book" and the Watson Poplar Hand Books on Dynamo and Motor Building, etc., in

Bubier's Popular Electrician

The only Amateur Electrical Paper Published. In simple languague, so all can understand. Two electrical engineers on our Board of Editors. All questions answered by experts. **50 CENTS PER YEAR. 3 YEARS $1.00. WATSON'S BOOKS, How to Build 1/4, 1/2 and 1 H. P., 50c Each.**

BUBIER PUB. CO. Dept. W. Lynn, Mass.

Eng.—2

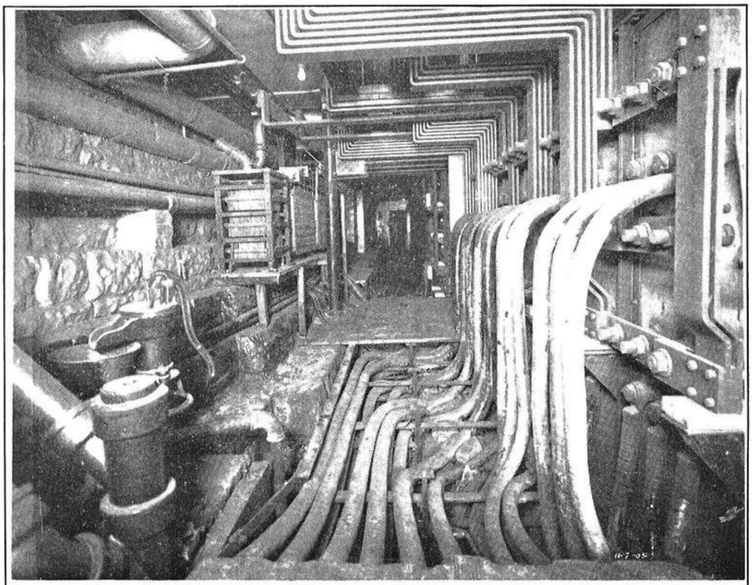


FIG. 1.

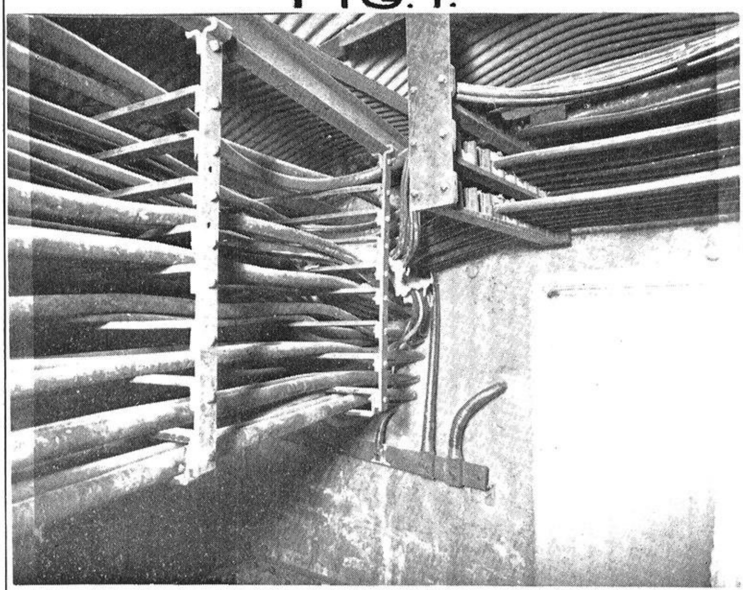


FIG. 2.

THE WISCONSIN ENGINEER

VOL. 10 FEBRUARY, 1905 NO. 2

DEVELOPMENT IN DESIGN AND CONSTRUCTION OF SWITCHBOARDS AND CABLE RUNS FOR LARGE DIRECT CURRENT INSTALLATIONS.

BY EDW. SCHILDHAUER, U. W. '97.

The object of this paper is to show the development in switchboard design and construction of cable runs during the period in which the central light and power station itself was transformed from a direct current station, situated at the center of the load, to one of alternating current, generating at a high potential and located at a point where the price of real estate, coal and water facilities, etc., are the determining factors.

The main credit for this change should be given to the rotary converter, for it has allowed the distributing systems of established companies to remain unchanged, as Edison Three Wire, 110, 220 volt direct current, as well as influenced the new central station companies to adopt direct current as the kind of energy to distribute, due to its superior advantages in the business districts of large cities, and has allowed the engineer much greater freedom in the location of the generating plant. Necessarily accompanying this change, the sub-stations or converting station was developed. Within these sub-stations, as well as in the generating stations, the development illustrated by the accompanying figures took place.

From even a casual glance over the various illustrations, it may be seen that the enormous electrical progress in other lines has not surpassed the development in the station switching and distributing equipment. Carrying this point still further, we might refer to the development in the indi-

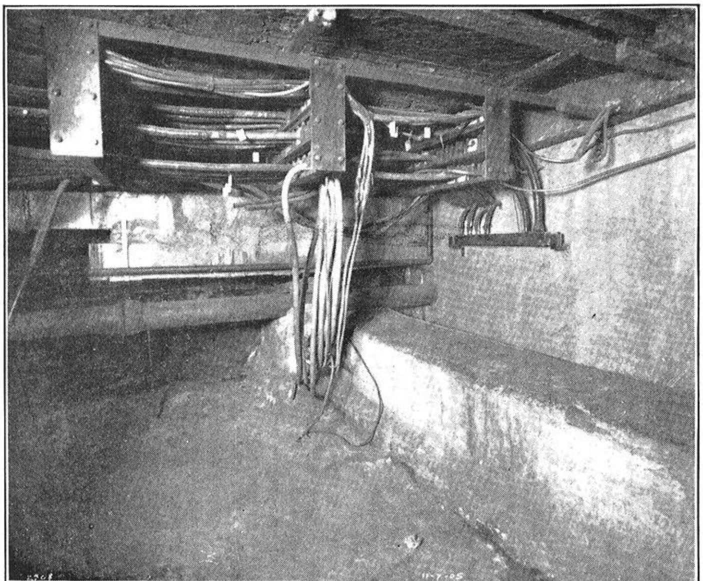


FIG. 3.

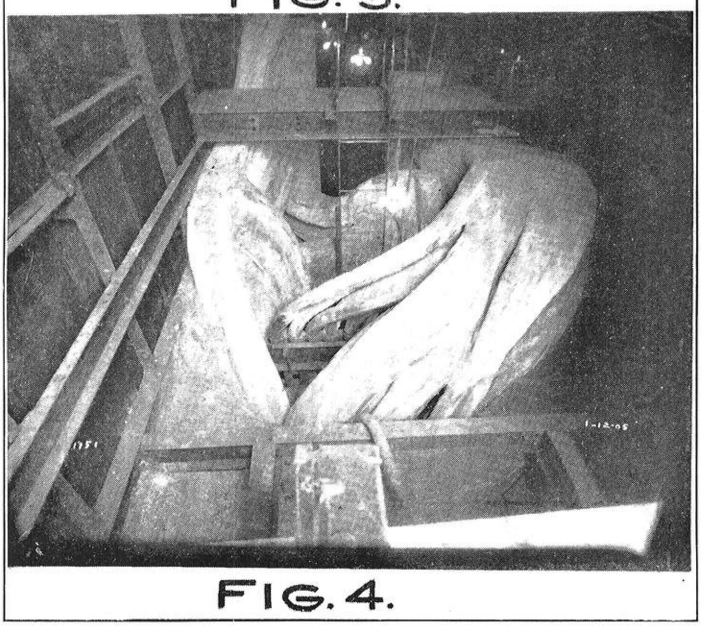


FIG. 4.

vidual switches which are mounted on these various boards. Even though the switches used in the primitive stations which were erected at the beginning of this period were undoubtedly as serviceable as those of the present day, still the appearance and the finish of those of the present are far superior. Before going into the detail of switchboard construction let us first consider the installation of cables.

In 1890, when the Edison Three Wire, 110, 220 volt systems were small compared to the present systems, feeders were likewise small in cross-section as compared to the feeders of to-day. The feeders being few in number, it was comparatively easy to isolate them sufficiently in the station so that the spacing in cable racks could be made ample for all practical purposes. Where the growth of the station, however, was beyond the conception of the designing engineer it generally brought about such a condition that the spacing which was originally allowed between cables had to be decreased in order to get additional feeders in the space alloted to them. Later, with the introduction of the clay tile for conduit work in the streets, it naturally suggested itself that this same material be used to separate the cables in stations, and in a great many instances the cables which were installed before this improvement have now been covered with clay tile. A mechanic with a little practice can score the sides of clay tile so that the same will split in a comparatively straight line. Then placing them around the cable in a position so that the cracks will match, and binding the two halves of the tile with wire, the whole length can be cemented so that a neat appearance is obtained.

The application of tile has to be tempered with good judgment. Figure No. 1 shows a cable run composed of cables varying in size from 1,000,000 to 2,000,000 c. m., there being in all about 60,000,000 c. m. cross-section. In the original installation the clay tile stopped at a point shown in the lower portion of the figure. From this point to the switches, the cables, which are lead covered, were supported on iron racks, the intervening air space being relied upon to give

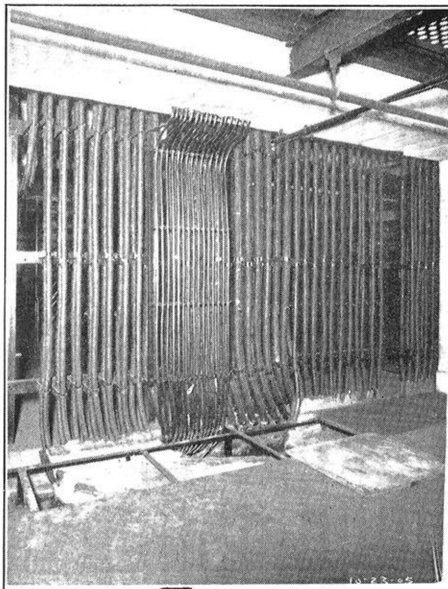


FIG. 5.

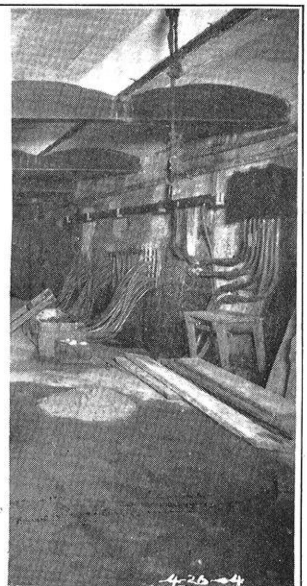


FIG. 6.

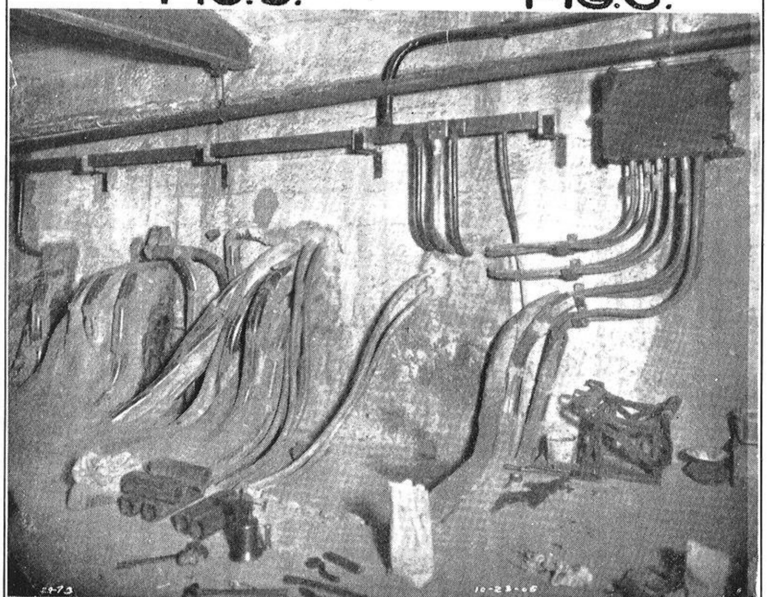


FIG. 7.

sufficient protection. Later the tile was extended, thereby making a continuous conduit run from a point near the switches out into the street. Figure No. 2 shows cable leaving a station through a curb wall. Since the practice of Edison Three Wire, 110, 220 volt systems is to burn off short circuits, it is evident that if a short circuit should start anywhere near this point the chances are that it would not stop until all of the cables were involved. This is an installation where comparatively few cables of small cross-section were used at first but more were added from time to time until a congested and dangerous condition resulted. Even if only a small number of the cables become involved in a burn out, it would be a difficult place to repair the damage. Hence, since it has proven in practice that enclosing cables in clay tile will prevent injury to adjacent cables, and since the cost of enclosing cables referred to would be comparatively small, this place, as well as others of this kind found in a system, should be protected by this means.

A still different condition is illustrated by Figure No. 3, which shows a view where cables have partially been enclosed with clay tile. The tile should have been continued from the floor line up to and including the first cable rack where the cables are separated sufficiently so that they could not readily injure adjacent cables. This construction would also prevent any one from moving the cables and thereby injuring same at the short bends.

Another difficult place to provide protection for cables where they were unprotected, is at the head of a tunnel as shown in Figure No. 4. This particular case was, however, more congested than that shown in Figure No. 2. Although the finished installation is not pleasing in appearance, nevertheless, the desired protection is secured. Cable runs in tunnels built more recently have been laid out in such a manner that all cables are drawn in, in clay tile conduit, so that the cables are enclosed from tunnel head to tunnel head. When the cable layout is made with the view of protecting same with clay tile, a neat and flexible arrangement can be

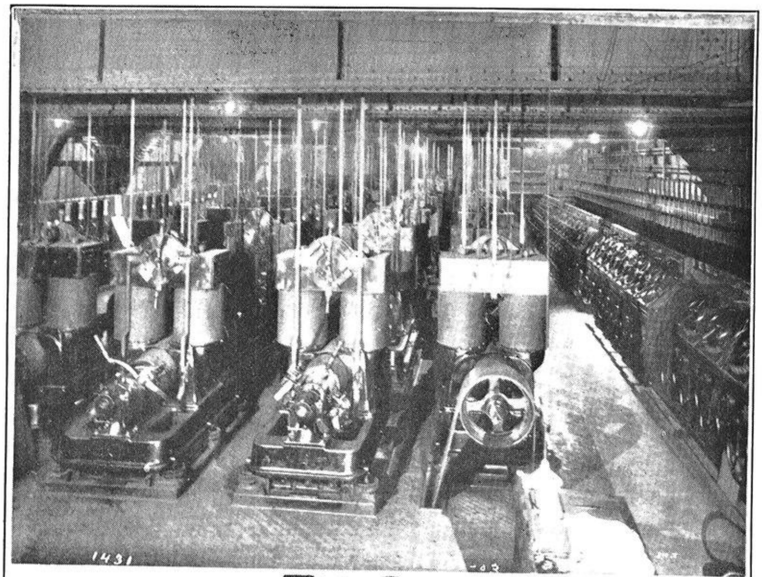


FIG. 8.

FIG. 9.

secured. The tile used for this purpose can be bought in any lengths up to eighteen inches, and for any degree curve.

Where the room is available it is good practice to separate the cables as in Figure No. 5, and in order to secure further protection, to wrap them with several layers of asbestos tape. This figure shows cables from the floor of a station to a duct line beneath the basement floor. In Figure No 6 we have a number of cables leaving a station in a manner that shows that the location of feeders, in ducts, from switchboard to junction box in manholes, has not been properly considered. It is evident if new cables are added that a still more unsatisfactory condition will result. All of the cables shown in this figure have now been enclosed with clay tile as will be seen by glancing at Figure No. 7. This particular photograph also shows a neutral bus and a standard underground junction box at the upper right hand. Conditions such as shown in Figure No. 7 can be avoided if a careful investigation of the requirements is made and each feeder located in the proper ducts from switchboard to junction box. This same method of using tile to isolate cables should be applied in manholes through which a considerable number of cables pass.

Experience shows that a burn out may cause other burn outs in an entirely different location by the lead sheaths of cables coming in contact with iron racks, pipes, or adjacent cables. The clay tile generally interposes enough insulation so that the current passing is not sufficient to injure the lead sheath at such a time. Having briefly considered the growth of cable work during a period of nearly fifteen years, let us consider the development in design and construction of switchboards.

The large direct current systems of to-day had a very small beginning. This will be seen in Figure No. 8, which shows an installation, typical of about 1890, of a large number of small machines operating on the Edison Three Wire system where but a few sets were originally installed. The number increased till all the available space was occupied by

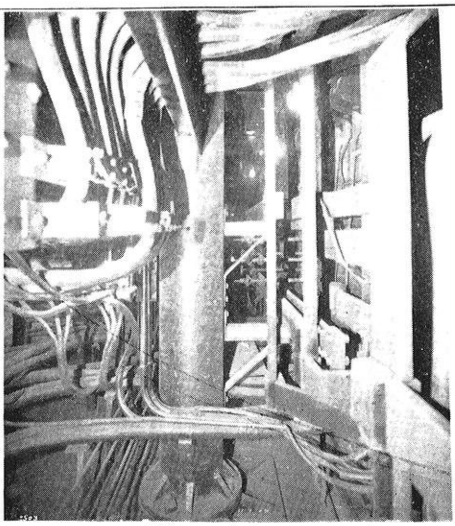


FIG. 10.

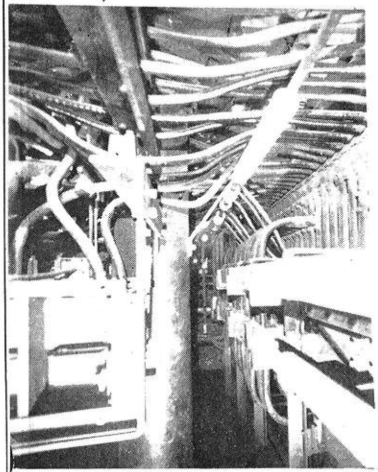


FIG. 11.

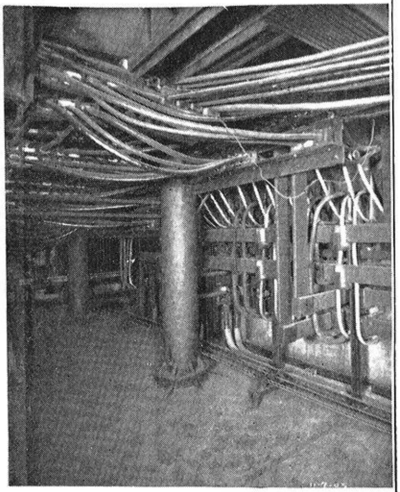


FIG. 12.

boilers, engines, shafting, belting, generators and switchboard. The feeders installed at this time were of the "Edison Tube" type, varying in size from 250,000 c. m. to 450,000 c. m. In order to take care of the rapid growth a new station with larger direct connected units was soon erected and this particular station abandoned.

Since there were about twenty feeders already emanating from this point of the system, it was decided that this location should remain a distributing center. A new switchboard was built in the basement of the building as shown in Figure No. 9, and connected by means of trunk lines to the new generating station. This installation consisted of the row of ammeters shown and the upper row of switches, the feeders being all connected to a single bus. Each feeder had a positive, negative and neutral switch located side by side. As the system became larger it was necessary to increase the capacity of the main bus. Still later a storage battery was installed as this was the main distributing center of the system. The panels for the storage batteries, which are now three in number, having an aggregate output of 18,000 ampere hours per side at the one hour rate, are shown at the further end of the switchboards. In fifteen years the number of feeders has increased from twenty to forty-eight. The average maximum load per feeder increased from 180 amperes to 560 amperes a side.

Having now a fair idea of the growth of the system and bearing in mind the front views of the switchboards, let us consider what had to be done in the rear of the switchboard during this period. Figure No. 10 shows the connections between the battery board, which is of a later design, and the main feeder board at the left of Figure No. 9. From the number of bends in the copper bus work it is evident that the installation was a difficult task, due to the number of feeders that were already installed, and the additional leads from the battery. The growth of the system, however, was such that this was the best method at the time to take care of the particular installation.

Having installed the battery and in order to utilize the feeder copper already connected to the best advantage, it was advisable to install an auxiliary bus so that all the feeders could be utilized at the maximum ampere output. The auxiliary bus is plainly shown in Figure No. 11. Since the design of the original feeder switches was such that they could not be remodeled readily for double throw switches,

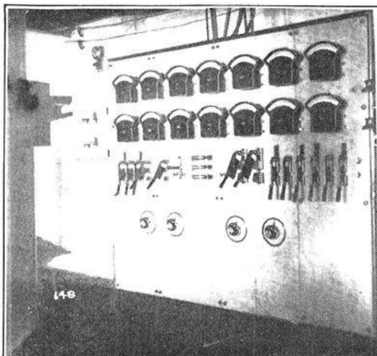


FIG. 13.

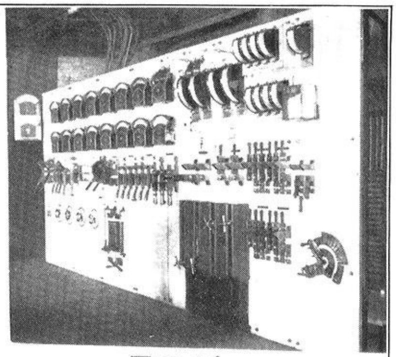


FIG. 14.

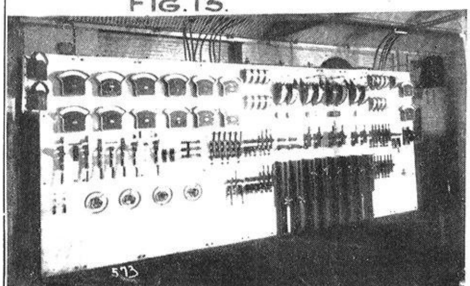


FIG. 15.

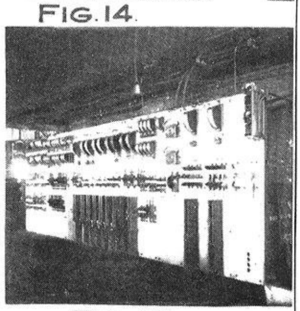


FIG. 16.

additional single throw switches had to be installed for the auxiliary bus connections. This necessitated cable connections from the feeder side of the original switches to the bottom stud of the auxiliary switches. The blades of the auxiliary switches, which are the lower switches of Figure No. 9, are connected to the auxiliary bus. With this connection it is possible to tie the main and auxiliary bus together through the feeder switches. This, together with the fact that the manipulation of the switches is slower than double throw type, makes this construction undesirable.

Another view, Figure No. 12, shows a section of the rear of the right hand switchboard. It is obvious from a glance at this figure that the basement of this building was not originally designed with a view of installing switchboards. Consequently the location and design of switchboard and feeder layouts was largely governed by the building construction.

In order to show more clearly how the growth of the system affected the design of switchboards we will follow the development of another station. Figure No. 13 shows a switchboard for two 80 KW and two 100 KW generators, on which are mounted a tie switch and three feeders, with complement of instruments. At the time this was considered a large and handsome installation, a viewpoint which changed when an increase of four 200 KW, 125 volt generators and five more feeders were ordered and completed, as shown in Figure No. 14. Here it is evident that the method of mounting generator switches has changed. The panel for the two 200 KW generators is narrower than the panel occupied by two 80 KW generators. The new additional feeder panel, the second from the right, also shows four three wire feeders having fuse extension switches, as before, but with edgewise ammeters. These four feeders occupy less lateral space than the previous installation. The last panel to the right is for a 60 KW, 250-volt motor driving a 500-volt generator, supplying a district not readily reached at this time by the Edison Three Wire System.

Figure No. 15 shows this switchboard still further remodeled and extended, there now being a total of twelve 125 volt generators, having an aggregate normal output of 1,960 KW. In order to keep the equipment for the larger generators on adjacent panels the feeder panels were rearranged. This modification sufficed for a period of one year, at which time another change, as shown by Figure No. 16, was made. Leaving the eight 200 KW generator panels as they were previously installed, a 1,000 KW, 250 volt generator panel was erected immediately to the left. At the right there were installed two 400 KW, 250 volt generator panels, and a 750

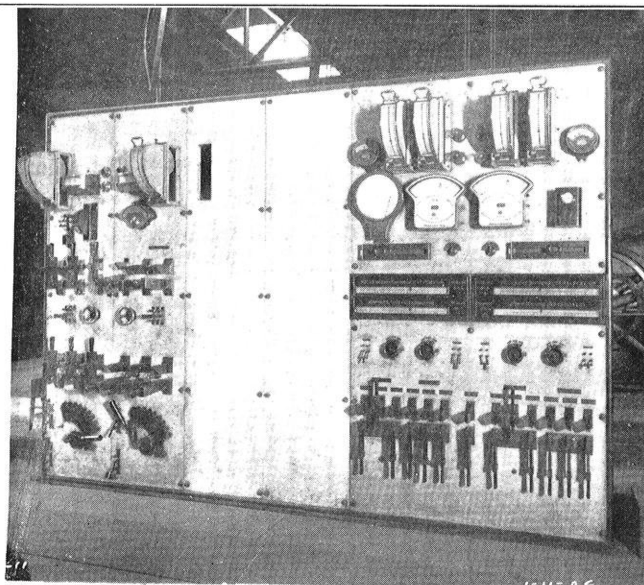


FIG. 17.

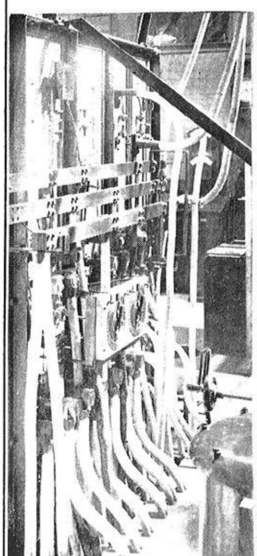


FIG. 18.

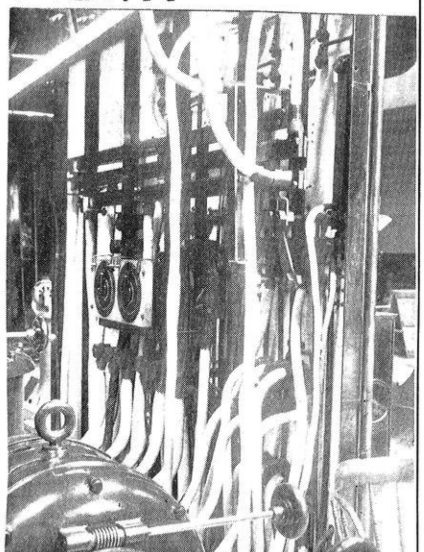


FIG. 19.

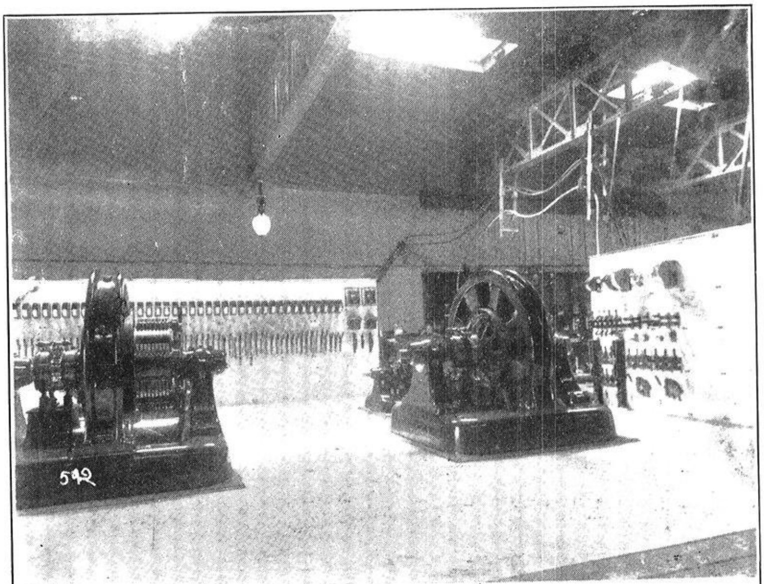


FIG. 20.

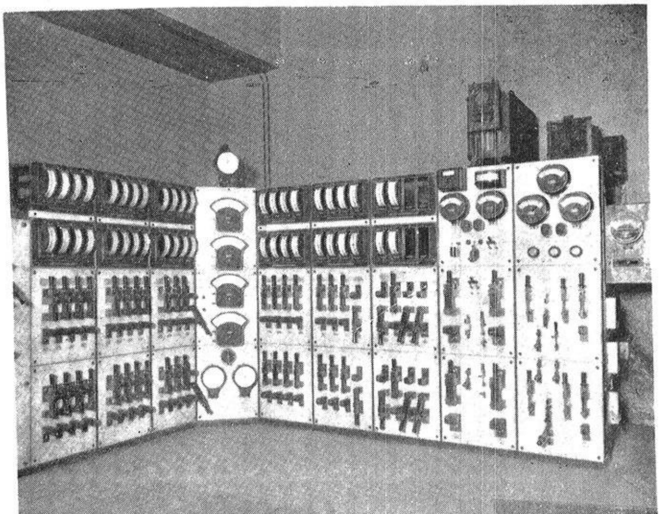


FIG. 21.

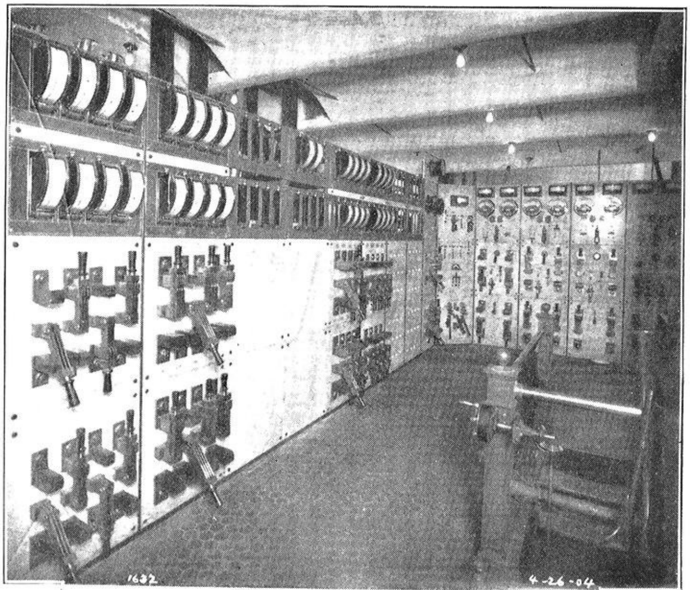


FIG. 22.

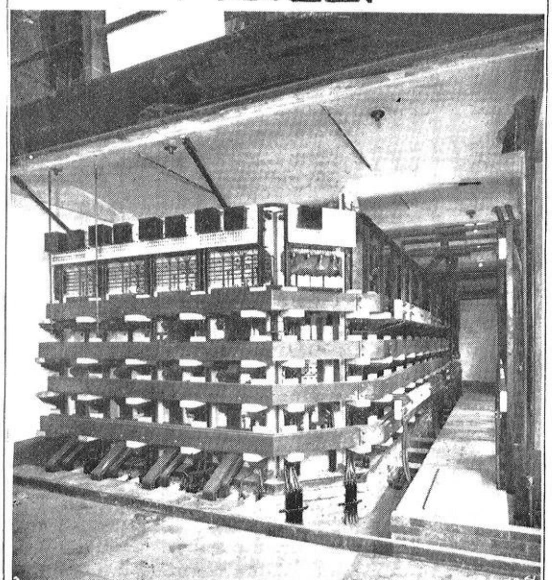


FIG. 23.

KW, 250 volt generator panel as shown in course of erection, while the two 80 KW and the two 100 KW generators were abandoned and the feeders rearranged, as shown at the left. Still later an additional 400 KW generator panel was installed to the right of this switchboard. The station where this evolution took place was originally a series arc and alternating current station, the machines being driven by means of jack shafts. The series arc lamps were gradually cut over to the Edison Three Wire System, and as the load was thus cut down on the series arc machinery the engines were equipped with direct connected generators. We have here, then, a station, the engines of which were first used for driving machines on jack shafts and later remodeled to direct connected units. Thus from an original capacity of 360 KW in direct current feeding an Edison 110 volt, 220 volt three wire system was increased step by step to 4,550 KW in a period of ten years. Bearing this in mind, it is easily conceived that the bus bar work on the rear of the board was not the best obtainable.

The cable shafts were also originally designed for series arc and alternating current work, therefore making it difficult to install low tension feeders requiring more space than the original installation. This station is now used only about two months in the fall for the "Peak" load, and since a sub-station was erected in an adjacent building all of the feeders have been transferred to this point, where a simpler design of generator panel was adopted and erected adjacent to the sub-station switchboard.

With the advent of the rotary converter in 1897 switchboard design was materially changed. One of the first switchboards erected in this country for rotary converters is shown in Figure No. 17, in which there are two 200 KW, 125 volt rotary converter panels at the left and a storage battery panel at the right. Figures No. 18 and 19 show a portion of the rear of this switchboard. The two rotary converters were fed from one set of three transformers, making it necessary to synchronize each rotary converter sepa-

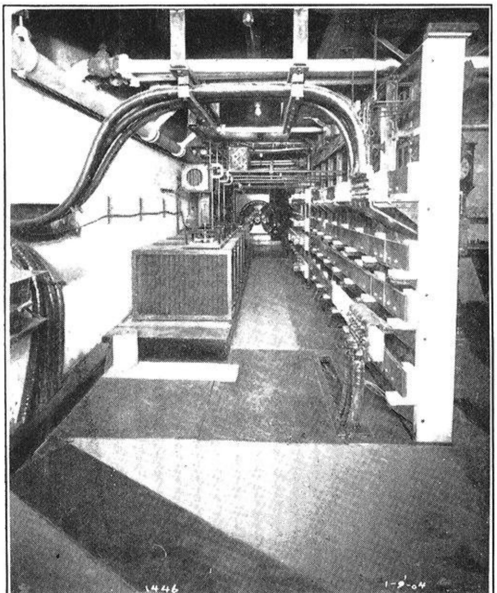


FIG. 24.

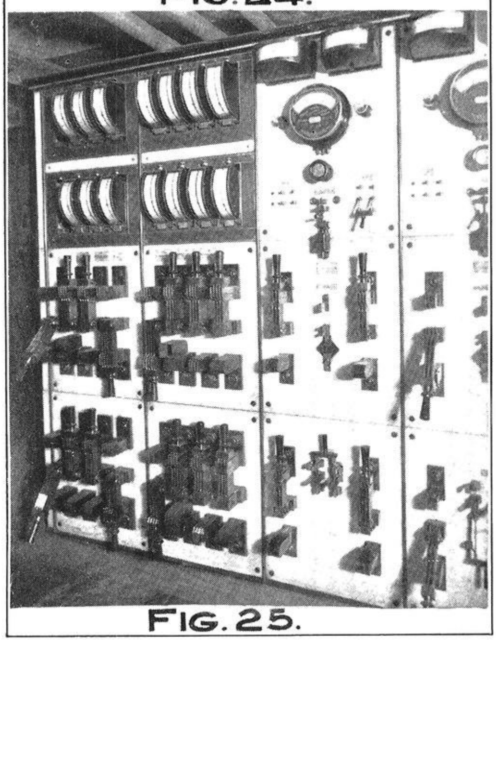


FIG. 25.

rately on the low tension side. In this installation the alternating current leads were brought to the same panel occupied by the direct current leads, a construction which brings about a crowded condition on the panels and is not at all suitable for rotary converter work of large capacity. Figure No. 20 shows the above mentioned rotary converter panels at the right and a portion of the three-wire feeder switchboard at the left. In this installation two 24-inch panels were required for the 200 KW rotary converters, whereas in Figure No. 21, which shows the remodeled switchboard, the equipment for the two rotary converters was installed on one 24-inch panel. In order to avoid complex cable runs, a double pole, single throw switch was installed for each machine near the collector rings for synchronizing on the low tension side. The direct current starting switch for each rotary converter was also mounted on the machine base. The neutrals of the two machines were connected together without switches direct to the neutral bus. The positive lead of the positive machine and the negative lead of the negative machine were connected direct to the switches on the switchboard panels, while the old feeder switchboard, a portion of which is shown in Figure No. 20, was replaced by the panels shown in Figure No. 21. In the old construction each feeder occupied fifteen inches of lateral space while in the new construction this has been reduced to six inches per feeder.

Figure No. 22 shows another rotary converter sub-station switchboard. The four panels controlling four 1000 KW rotary converters are set at right angles to the feeder board. This was done on account of the space available not permitting the panels all being in line. It is to be noted that all feeder and rotary converter switches are double throw. The positive feeders are at the top and the negative feeders at the bottom, while the neutral feeders are not brought to the switchboard but terminate without the use of switches near the curb wall where the neutral bus is located. Figure No. 23 shows the rear of this switchboard, the panels at the left being for the four rotary converters and the panels at the right for the feeders leaving the sub-station. The bus bars as shown occupy a considerable amount of space vertically, making it difficult to inspect and overhaul the nuts and studs of switches and various other connections. The location of the switchboard as well as the sub-station design, is such that the rheostats for the rotary converters were placed on a gallery above the switchboard.

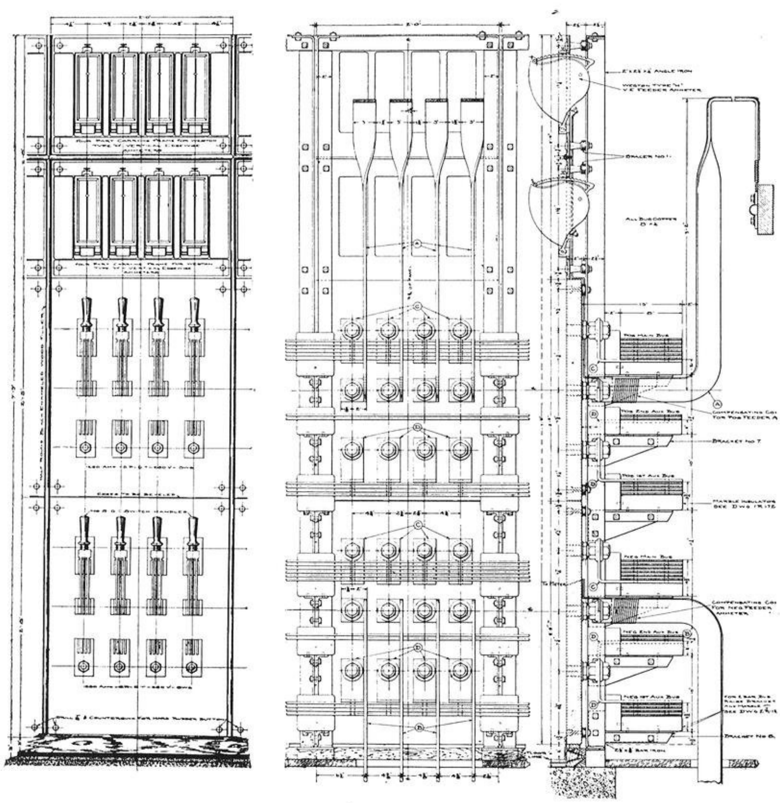


Fig. 26

In 1902 a switchboard of similar design was erected in the basement of an office building as shown in Figure No. 24. The bus bars are arranged similar to Figure No. 23 and are from top to bottom: positive main, positive auxiliary, negative main, negative auxiliary. The field rheostats for the rotary converters and the starting boxes are placed directly behind the panels, leaving sufficient room between the rheostats and the bus bars for extension as the number of units increased. It is to be noted that no alloy shunts are installed, the shunts for the ammeter being obtained by using about eight feet of the cable with a compensating coil

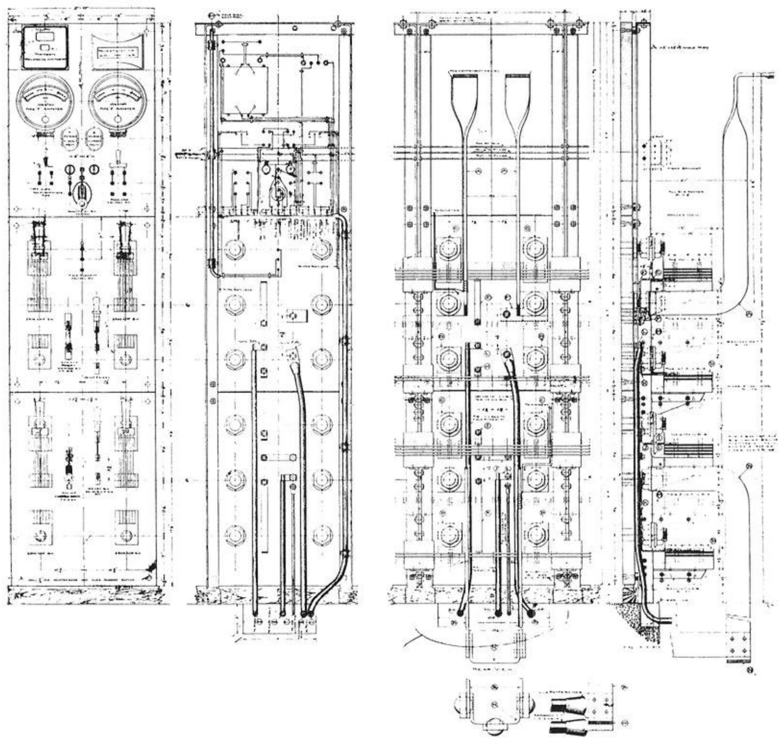


Fig. 27

to correct any temperature errors of the cable. Figure No. 25 shows a front view of a portion of this switchboard, the two panels at the left being equipped with 2,000 ampere switches for eight 2,000,000 c. m. feeders. The panel next to the feeders is equipped for a 500 KW, 250 volt rotary converter, connected on the double delta principle and requiring, therefore, only one ammeter to measure the total direct current ampere output. The location of the bus bars and the particular construction adopted would make it difficult to install more than one auxiliary bus, and even if this is accomplished as in similar installations, it would be a difficult and hazardous task to change the feeder connections from the first auxiliary to the second auxiliary bus or vice versa.

Up to within a year it has been the practice to place the bus bars in a vertical position, parallel to the front of the marble panel. In the latest design, however, to secure the

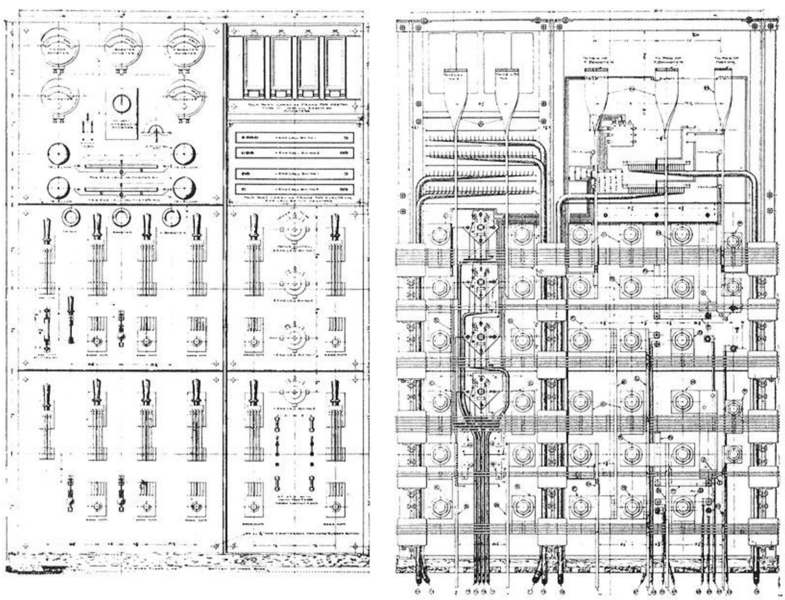


Fig. 28

best separation of potentials and at the same time have the rear of the switchboard as accessible as possible, the bus bars are placed horizontally as shown in the following figures. A front, rear and side elevation of feeder panel is shown in Figure No. 26. The appearance in the front of elevation has not been altered from that shown in Figure No. 24, but the copper work in the rear of the board has undergone a radical change. In the previous construction, as illustrated in Figures No. 22 to No. 25 inclusive, the bus bar copper is placed vertically, this necessitating two bends in the copper,

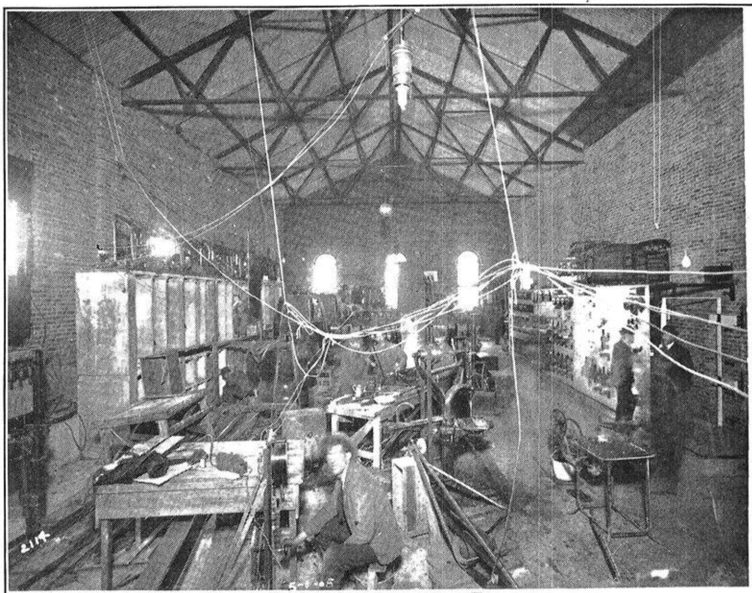


FIG. 29.

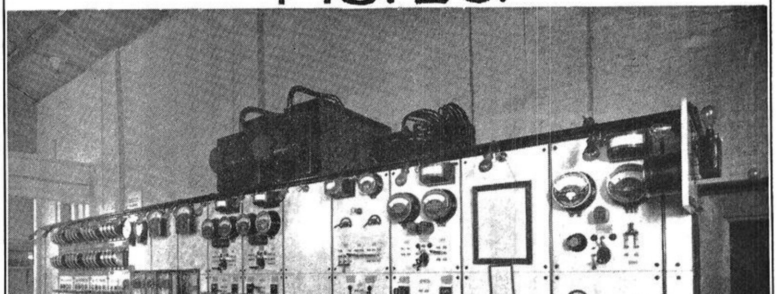


FIG. 30.

from switch stud to bus bar. It also required the difficult bending of copper from the center stud of the double throw switch, which is connected directly to feeder, as shown plainly in Figure No. 24.

In general the cross-section of bus bars is a matter which cannot be calculated accurately, and knowledge obtained by experience has to be applied. It is, therefore, essential that the bus construction should be such that the cross-section may be increased as the growth of business demands. Good practice dictates the installation of more copper in the switchboard when erected than the immediate needs demand, because the interest on the money invested in copper and labor on the first installation, when everything is "dead," is small in comparison with the cost of labor of increasing the cross-section of the bus bars when this has to be done on "alive" switchboards. Work of this kind can only be trusted to mechanics of long experience and, therefore, only the best construction men are available. In the old design where the bus bars were placed vertically, the ventilation is better than in the new where the flow of air must be horizontal in order to dissipate the loss of the middle bars. However, since the cross-section of copper should always be liberal the heat to be dissipated is small and, therefore, the difference in loss, due to ventilation, can be neglected.

In the new construction there is but one bend in the copper from switch stud to bus bars. The same tie from the first auxiliary to switch stud will also fit the second auxiliary connection, so, that in order to change a feeder from first auxiliary to second, or vice versa, it is only necessary to remove the bolts securing the tie to bus and one nut from the switch stud. The tie can then be readily removed and reversed. Although the cost of labor for making the long copper bar from center stud of switch to fuse panel is more in this construction, it is balanced by the necessary cable racks and training of feeder cables as shown in Figure No. 24. This same bar can generally be made of sufficient length to use for the ammeter shunt by applying a compensating coil for

FIG. 31.

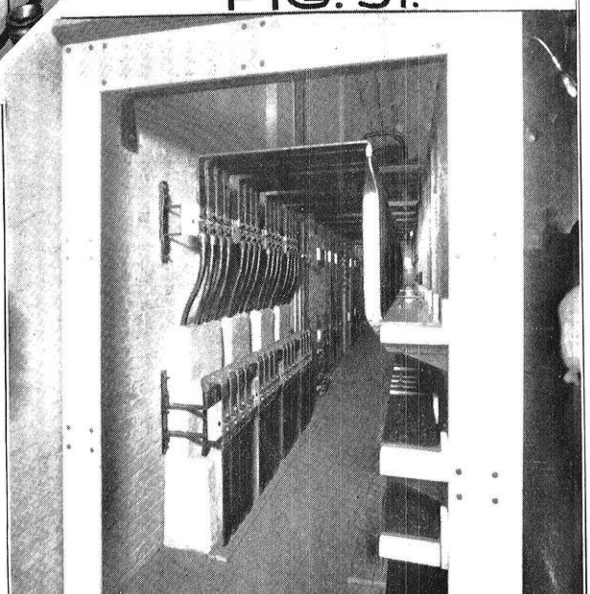


FIG. 32.

temperature corrections. The foregoing advantages are only incidental, the principal advantage is that all studs, nuts and bolts are readily accessible. With a socket wrench, having insulated stem and handle, a mechanic can tighten any bolt on the panel.

Figure No. 27 shows the front, rear with copper removed, rear showing copper, and side elevation of rotary converter panel for units of 1,000 KW capacity. This panel is designed for diametrically connected rotary converter with the common point of the transformer connected through a switch to the neutral of the Edison Three Wire system, therefore, requiring two ammeters to measure the total output of the rotary converter. For rotary converters above 1,000 KW capacity, the knife switches become cumbersome, and remote controlled switches are advocated. Figure No. 28 shows a combined arrangement for battery and booster-balancer panels, which occupied a width of eight feet in the earlier switchboards but now reduced to five feet. It will be seen that the studs, nuts and bolts are as accessible in these as in the feeder and rotary converter panels. The following figures show at once the advantages of the design just described.

Figure No. 29 shows the condition where a sub-station had to be erected and in operation by a definite date and where the electrical construction was delayed by building operations. Two 1000 KW rotary converters were installed and ready for service thirty-five days after the first electrical material was delivered. Figure No. 30 shows a switchboard built according to the latest design. In this sub-station the current is sold at the switchboard and for this reason integrating watt meters are installed between the rotary converter and feeder panels. This switchboard will accommodate five 1000 KW rotary converters and twenty feeders, but can be readily extended by adding more panels. Figure No. 31 shows this sub-station with three 1000 KW rotary converters, installed complete. Figure No. 32 shows a side view of the switchboard from the feeder end in which the bus location from top to bottom is as follows: positive main, positive auxiliary, negative main, negative auxiliary. The positive feeders are all brought out from the switch up and over to the wall, where, in this case, the fuse panel is located, while the negative leads are brought out from the switch down below the floor line and up to the negative fuse panel. One inch removable slate, which serves as the floor, protects this negative copper. The positive cables enter through the wall directly under the floor and are completely enclosed in tile up to a point near the fuse and a sufficient distance above negative cables to insure effective isolation. Similarly the negative cables are brought up in tile to a point near their terminals. The neutrals of the feeders terminate at the neutral bus located in the basement. This construction is believed to meet the requirements or the most exacting conditions.

THE HOLBROOK SPIRAL CURVE.*

PROF. W. D. TAYLOR.

The following account of the properties of this curve and of its use is compiled from various sources:

Let R = radius of the central circular curve.

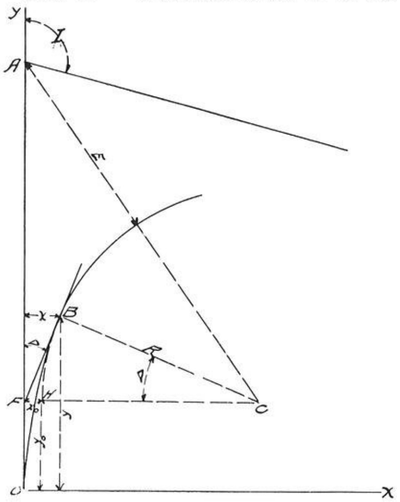
Let Δ = total angle turned on the spiral from the tangent to any point B on the curve.

Let d = deflection angle at O to turn from tangent O A to any point on O B distant L ft. from O.

Let (x, y) = co-ordinates (cartesian) of any point on O. B.

Let (x_0, y_0) = co-ordinates of H., P. C. of the central curve.

Let L = distance from O in ft. of any point on O B.



Note: By a "60 ft. spiral" is meant a spiral that increases its rate of curvature one degree per 100 ft. for each 60 foot distance along the spiral.

The equation of the spiral can be written thus:

R L = C

where C is one constant for any one spiral, but a different constant for each particular spiral. Thus: For a 30 ft., 60 ft., and 120 ft. spiral, respectively, taking the radius of a one degree curve to be 5730 ft.

R L = 5730 × 30 = 171900.
R L = 5730 × 60 = 343800.
R L = 5730 × 120 = 687600.

Now to express in minutes of arc the subtended central angle for any length L of the spiral we have:

$$\Delta = \frac{K L^2}{100} \quad \ldots\ldots (1)$$

*Reprinted from the WISCONSIN ENGINEER, December, 1902.

where K is a constant and equals the number 30 divided by the chord length of spiral: Thus for a 60 ft spiral $K = \frac{30}{60} = 0.5$. To express $\triangle$ in circular measure we have:

$$\triangle = \frac{KL^2}{100} \times \frac{1}{60} \times \frac{1}{57.2958} = 0.00000291\ K\ L^2 \ldots\ldots\ldots\ldots (A)$$

Or if we make $c = 0.00000291$ K. we can write:

$$\triangle = c\ L^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (B)$$

Where c has the value shown in table I below for the various spirals.

Applying the calculus we have:

$$\frac{dx}{dL} = \sin \triangle = \sin cL^2, \text{ or}$$

$$dx = \sin cL^2 dL \therefore x \overset{*}{=} \Big|_{o}^{L} \sin cL^2 dL.$$

Expanding the sine in terms of the angle by trigonometry.

$$\sin a = a - \frac{a^3}{\underline{3|}} + \frac{a^5}{\underline{5|}} - \frac{a^7}{\underline{7|}} + \text{etc.}$$

For *a* write cL^2 in value of x and we have:

$$x \overset{*}{=} \Big|_{o}^{L} \left(cL^2 - \frac{c^3L^6}{\underline{3|}} + \frac{c^5L^{10}}{\underline{5|}} - \frac{c^7L^{14}}{\underline{7|}} + \text{etc.}\right) d\ L, \text{ integrating.}$$

$$x = \frac{cL^8}{3} - \frac{c^3L^7}{42} + \frac{c^5L^{11}}{1320} - \frac{c^7L^{15}}{75600} + \text{etc.}$$

$$= \frac{cL^3}{3} - 0.0238c^3L^7 + 0.00076\ c^5\ L^{11} - \text{etc} \ldots\ldots\ldots\ldots (2)$$

Similarly, $\frac{dy}{dL} = \cos \triangle = \cos c\ L^2$.

$$dy = \cos c\ L^2\ d\ L, \text{ and } y \overset{*}{=} \Big|_{o}^{L} \cos c\ L^2\ d\ L.$$

$$\cos a = 1 - \frac{a^2}{\underline{2|}} + \frac{a^4}{\underline{4|}} - \frac{a^6}{\underline{6|}} + \text{etc. Hence:}$$

$$y \overset{*}{=} \Big|_{o}^{L} \left(1 - \frac{c^2L^4}{\underline{2|}} + \frac{c^4L^8}{\underline{4|}} - \frac{c^6L^{12}}{\underline{6|}} + \text{etc.}\right) d\ L.$$

$$= L - \frac{c^2L^5}{10} + \frac{c^4L^9}{216} - \frac{c^6L^{13}}{9360} + \text{etc.}$$

$$= L - 0.1c^2L^5 + 0.00463c^4L^9 - \text{etc} \ldots\ldots\ldots\ldots (3)$$

By inspection of the figure the following formulas are easily derived:

$$y_o = y - R \sin \triangle \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$d = \tan^{-1}\frac{x}{y} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

---

* | denotes integral sign.

In most cases in steam railroad practice it will be near enough for practical purposes to take $x_o = \frac{x}{4}$, and $d = \frac{\Delta}{3}$. But if it is desired to calculate x_o more accurately, as would be the case in short spirals to very sharp curves in street railway work, it can be calulated from the formula

$$x^o = x - R\ (1 - \cos \Delta)$$

Since both (2) and (3) are rapidly converging series a very few terms will express the result with sufficient accuracy. For ease in computation the formulae (1), (2)...... (5) are arranged in order to give the elements in the tables in the (1), (2)...... and 5th columns after the columnns giving L.

To get the distance to measure back from the point of intersection to start the spiral we have:

$A\ O = T = (R + x_o) \tan \frac{1}{2} I + y_o$ ....(C)

To take an example from practical work let I= 36° 36′ and A fall at station 42 + 47.47. Run in the curve with 60 ft. spirals, the central curve being a 6°.

A O = T = (955 + 5.64) 0.3307 + 179.79 = 497.47. Then O, the P. S. falls at 37 + 50. To locate the stations 38, 38+50, 39, 39 + 50, 40, 40 + 50, 41, and 41 + 10, the point B, the P. C. C., turn from the tangent A O the angles 0° 0.42′, 0° 16.7′, 0°37.5′, 1°06.7′, 1°44.2′, 2° 30′, 3° 24.2′ and 3° 36′, respectively, the transit setting at O. To continue the central curve from B, sight back at O with vernier set so that when the angle $O\ B\ F = \frac{2}{3}\ \Delta = 7°\ 12'$ (in this case) is turned the zeros of the instrument shall coincide when the telescope points along the common tangent of the spiral and central curve at B. The central curve is thus to be run in similarly to any other circular curve to the point 43 + 60 which is the P. C. C. of 2nd spiral. Note that 10° 48′ of central angle is turned on each spiral leaving 15° to be turned on the central curve.

In putting in spirals in old track it is often times best to increase the degree of the central curve so as to throw the middle point of the curve toward A and the ends of the old curve toward C, then getting in the spirals with the minimum amount of horizontal shift of the track. If the old track is to true line and located without spirals we have the external distance $E = R$ $(\sec. \frac{1}{2} I - 1) = R.$ Exter. sec. $\frac{1}{2}$ I.

To find the degree of central curve D′, radius R′ with the new external distance E′, and without spirals, we have:

$R' = \dfrac{E}{\text{Exter. sec. } \frac{1}{2} I.}$ from which D' can be determined by interpolation in a table of radii or by the formula $D' = \dfrac{5730}{R'}$.

D'', the degree of curve with spirals and external E', is given by

$$D'' = \frac{E' + x_o \sec. \frac{1}{2} I}{E'} D' \qquad \text{(D)}$$

The formula (D) is perfectly general and by its use E' can be taken $= E$ so that the central part of the present curve need not be disturbed if so desired.

It should be noticed that in the formula (D) x_o is supposed to correspond with D'' and not with D', but knowing x_o for $(D)'$ since x_o changes so slowly with considerable change in D, x_o can usually be estimated on the first, and always on the second, approximation with sufficient accuracy.

TABLE I.

Chord Length of Spiral Used.	Value of K.	Value of $c = 0.00000291$ K.
6 ft.	5	0. 0000145
12 ft.	$\frac{5}{2}$	0. 00000755
18 ft.	$\frac{5}{3}$	0. 0000048
24 ft.	$\frac{5}{4}$	0. 00000364
30 ft.	1	0. 00000291
36 ft.	$\frac{5}{6}$	0. 00000243
48 ft.	$\frac{5}{8}$	0. 00000182
60 ft.	$\frac{1}{2}$	0. 00000145
84 ft.	$\frac{5}{14}$	0. 00000104
108 ft.	$\frac{5}{18}$	0. 00000081
120 ft.	$\frac{1}{4}$	0. 00000073
180 ft.	$\frac{1}{6}$	0. 00000048
240 ft.	$\frac{1}{8}$	0. 00000036

TABLE NO. II.—18 FT. SPIRAL.

Degree of curve.		L. ft.	Δ		x	y	y_o	d	
0°	20	6	0°	0.6	.00	6.00	3.00	0°	0.2
	40	12		2.4	.00	12.00	6.00		0.8
1°	00	18	0°	5.4	.01	18.00	9.00	0°	1.8
	20	24		9.6	.02	24.00	12.00		3.2
	40	30		15.0	.04	30.00	15.00		5.0
2°	00	36	0°	21.6	.08	36.00	18.00	0°	7.2
	20	42		29.4	.12	42.00	21.00		9.8
	40	48		36.1	.18	48.00	24.00		12.1
3°	00	54	0°	48.6	.25	54.00	27.00	0°	16.2
	20	60	1°	00.0	.35	60.00	30.00		20.0
	40	66		12.6	.46	66.00	33.00		24.2
4°	00	72	1°	26.4	.60	72.00	36.00	0°	28.8
	20	78		41.4	.77	77.99	38.99		33.8
	40	84		57.7	.91	83.99	41.99		39.3
5°	00	90	2°	15.0	1.18	89.99	44.99	0.	45.0
	20	96		35.6	.43	95.98	47.98		51.2
	40	102		53.4	.71	101.97	50.97		57.8
6°	00	108	3°	14.4	2.04	107.97	53.97	1°	4.8
	20	114		36.6	.39	113.95	56.96		12.2
	40	120	4°	00.0	.79	119.94	59.95		20.0
7°	00	126	4°	24.6	3.23	125.93	62.94	1°	28.2
	20	132		50.4	.72	131.91	65.93		36.8
	40	138	5°	17.4	4.25	137.88	68.92		45.8
8°	00	144	5°	45.6	4.83	143.85	71.90	1°	55.2

TABLE NO. III.—30 FT. SPIRAL.

Degree of curve.	L. ft	Δ	x	y	y_o	d
0° 20	10	0° 1.0	.00	10.00	5.00	0° 0.3
40	20	4.0	.01	20.00	10.00	1.3
1° 00	30	0° 9.0	.03	30.00	15.00	0° 3.0
20	40	16.0	.06	40.00	20.00	5.3
40	50	25.0	.12	50.00	25.00	8.3
2° 00	60	0° 36.0	.21	60.00	30.00	0° 12.0
20	70	49.0	.33	70.00	34.98	16.3
40	80	1° 4.0	.50	80.00	39.98	21.3
3° 00	90	1° 21.0	.73	90.00	44.98	0° 27.0
20	100	40.0	.97	99.99	49.97	33.3
40	110	2° 1.0	1.29	109.99	54.97	40.3
4° 00	120	2° 24.0	1.68	119.98	59.97	0. 48.0
20	130	49.0	2.14	129.97	64.96	56.3
40	140	3° 16.0	2.66	139.95	69.96	1° 5.3
5° 00	150	3° 45.0	3.27	149.93	74.95	1° 15.0
20	160	4° 16.0	3.97	159.91	79.94	25.3
40	170	49.0	4.77	169.88	84.94	36.3
6° 00	180	5° 24.0	5.65	179.84	89.93	1° 48.0
20	190	6° 1.0	6.64	189.79	94.91	2° 0.3
40	200	40.0	7.75	199.73	99.89	13.3
7° 00	210	7° 21.0	8.96	209.65	104.86	2° 27.0
20	220	8° 4.0	10.30	219.56	108.89	41.3
40	230	49.0	11.77	229.45	114.82	56.3
8° 00	240	9° 36.0	13.38	239.33	119.79	3° 12.0

TABLE IV.—60 FT. SPIRAL.

Degree of curve.	L. ft.	Δ	x	y	y_o	d
0° 10	10	0° 0.6	0.00	10.00	5.00	0° 0.2
20	20	2.1	.00	20.00	10.00	0.7
30	30	4.5	.01	30.00	15.00	1.5
40	40	8.1	.03	40.00	20.00	2.7
50	50	12.6	.06	50.00	25.00	4.2
1° 00	60	0° 18.0	0.10	60.00	30.00	0° 6.0
10	70	24.6	.17	70.00	35.00	8.2
20	80	32.1	.25	80.00	40.00	10.7
30	90	40.5	.35	90.00	45.00	13.5
40	100	50.1	.48	100.00	50.00	16.7
50	110	1° 0.6	.66	110.00	55.00	20.2
2° 00	120	1° 12.0	0.84	120.00	60.00	0° 24.0
10	130	24.5	1.06	129.99	65.00	28.2
20	140	38.0	1.33	139.99	70.00	32.7
30	150	52.5	1.64	149.98	75.00	37.5
40	160	2° 8.0	1.99	159.98	80.00	42.7
50	170	24.5	2.38	169.97	85.00	48.2
3° 00	180	2° 42.0	2.83	179.96	90.00	54.0
10	190	3° 0.5	3.32	189.95	95.00	1° 0.1
20	200	20.1	3.88	199.93	100.00	6.7
30	210	40.5	4.49	209.91	104.99	13.5
40	220	4° 2.0	5.16	219.89	109.98	20.7
50	230	24.5	5.90	229.86	114.98	28.2
4° 00	240	4° 48.0	6.70	239.83	119.97	1° 36.0
10	250	5° 12.5	7.57	249.79	124.97	44.2
20	260	38.0	8.51	259.75	129.96	52.7
30	270	6° 4.5	9.53	269.70	134.95	2° 1.5
40	280	32.0	10.63	279.64	139.95	10.7
50	290	7° 0.5	11.81	289.57	144.93	20.1
5°	300	7° 30.0	13.07	299.49	149.91	2° 30.0
10	310	8° 0.5	14.42	309.40	154.91	40,2
20	320	32.0	15.86	319.29	159.89	50.1
30	330	9° 4.5	17.34	329.17	164.86	3° 1.5
40	340	38.0	19.02	339.04	169.85	12.7
50	350	10° 12.5	20.74	348.89	174.82	24.2
6° 00	360	10° 48.0	22.56	358.72	179.79	3° 36.0
10	370	11° 24.5	24.49	368.54	184.76	48.2
20	380	12° 2.5	26.52	378.33	189.72	4° 0.7
30	390	40.5	28.66	388.09	194.68	13.5
40	400	13° 2.0	30.91	397.84	199.64	26.7

TABLE V.—90 FT. SPIRAL.

Degree of curve.	L. ft.	Δ	x	y	y_0	d
0° 10	15	0° 0.75	0.00	15.0	7.50	0° 0.2
0 20	30	0 3.0	0.00	30.0	15.00	0 1.0
0 30	45	0 6.75	0.02	45.0	22.50	0 3.2
0 40	60	0 12.0	0.07	60.0	30.00	0 4.0
0 50	75	0 18.75	0.13	75.0	37.50	0 6.2
1° 00	90	0° 27.0	0.23	90.0	45.00	0° 9.0
1 10	105	0 36.75	0.37	105.0	52.50	0 12.2
1 20	120	0 48.0	0.58	120.0	60.15	0 16.0
1 30	135	1 6.75	0.79	135.0	71.11	0 20.2
1 40	150	1 15.0	1.09	150.0	75.00	0 25.0
1 50	165	1 30.75	1.44	164.99	77.51	0 30.2
2° 00	180	1° 48.0	1.88	179.98	90.01	0 36.0
2 10	195	2 6.75	2.36	194.98	97.70	0 42.2
2 20	210	2 27.0	2.99	209.97	105.03	0 49.0
2 30	225	2 48.75	3.68	224.95	112.34	0 56.2
2 40	240	3 12.0	4.47	239.93	120.02	1° 4.0
2 50	255	3 36.75	5.36	254.90	127.80	1 12.2
3° 00	270	4° 3.0	6.29	269.87	134.97	1 21.0
3 10	285	4 30.75	7.40	284.83	142.43	1 30.2
3 20	300	5 0.0	8.64	299.78	148.96	1 40.0
3 30	315	5 30.75	10.00	314.71	157.47	1 50.2
3 40	330	6 3.0	11.50	329.64	164.91	2 1.0
3 50	345	6 36.75	13.14	344.55	172.40	2 12.2
4° 00	360	7° 12.0	14.93	359.43	179.42	2° 24.0
4 10	375	7 48.75	16.87	374.31	187.40	2 36.2
4 20	390	8 27.0	18.95	389.16	194.75	2 49.0
4 30	405	9 6.75	21.23	403.98	202.21	3 2.2
4 40	420	9 48.0	23.66	418.78	209.47	3 16.0
4 50	435	10 30.75	26.28	433.54	217.33	3 30.2
5° 00	450	11° 15.0	29.08	448.27	224.69	3° 45.0
5 10	465	12 0.75	32.07	462.96	232.15	4 0.2
5 20	480	12 48.0	35.27	477.61	239.45	4 16.0
5 30	495	13 36.75	38.66	492.21	246.64	4 32.2
5 40	510	14 27.0	41.03	506.91	254.38	4 49.0
5 50	525	15 18.75	46.08	521.27	261.69	5 6.2
6° 00	540	16° 12.0	50.10	535.69	269.26	5 24.0
6 10	555	17 6.75	54.35	550.07	276.42	5 42.2
6 20	570	18 3.0	58.76	564.46	284.05	6 1.0
6 30	585	19 0.75	63.57	578.59	291.27	6 20.2
6 40	600	20 0.0	68.52	592.73	298.60	6 40.0

THE CHEMICAL ENGINEERING BUILDING.

JUDSON C. DICKERMAN,*
Assistant Professor of Chemical Engineering.

For a number of years the College of Engineering has recognized the desirability of establishing a Course of Chemical Engineering, and plans were made to organize such a course as soon as facilities could be provided. The construction of the new Chemistry building in 1905 and the consequent vacating of the old Chemical building provided the necessary space for the new department. The old Chemical building, henceforth to be known officially as the Chemical Engineering building, has been extensively remodelled during the fall and early winter, the basement and first story for the use of the Department of Chemical Engineering, the the second and third stories for work in Electrical Testing and in Physiological Chemistry.

The Course in Applied Electrochemistry, with its extensive facilities for electrolysis and electric furnace work, as given for several years under the direction of Prof. Chas. F. Burgess, has been merged with this new department. In fact the successful inauguration of this department is due to the persistent and energetic efforts of Prof. Burgess, who becomes the head of the Department of Chemical Engineering.

The demand for men to enter the industries requiring chemical engineers has been increasingly insistent for a number of years. This demand has been filled in part by graduates of the Department of Chemistry on the one hand, and of the College of Engineering on the other hand. A training embracing fundamental and practical courses in both chem-

---

* Prof. Dickerman is a graduate of the Chemical Engineering Course of the Massachusetts Institue of Technology, class of 1895. Previous to coming to the University, he has had a varied and extensive experience with the Merrimac Chemical Company.—ED.

istry and engineering became a necessity which the University of Wisconsin is now prepared to provide. The rapidly expanding producer gas industry requires the services of engineers who have a working knowledge of chemistry and its applications, in other words, a chemical engineer. The Fire Insurance companies find that a chemical engineering training makes an especially well qualified inspector. The numerous illuminating gas works of our cities and larger towns, the beet sugar industry, the metallurgical industries, railroad companies, the paper and leather industries, all demand men with the training of a chemical engineer. Even the more strictly chemioal industries, like the manufacture of mineral acids, alums, fertilizers, etc., depend largely for their advancement on the chemical engineer, the man who can plan great works involving the cheap handling of hundreds of tons of material a day, and still keep the chemical reaction working successfully.

In the Chemical Engineering building, beside offices and lecture room, there are four large and six small rooms provided and equipped for laboratory purposes. There are also storage rooms, a storage battery room, grinding and polishing room, work shop, and photographic dark room. In the third story, under the charge of the instructors in Electrical Testing, are well equipped photometric rooms, available for use by the students in Chemical Engineering.

At the north end of the basement will be located the Laboratory of Manufacturing Chemistry. Here the equipment consists of practical working models of the apparatus and machinery used in chemical manufacture. Among some of the apparatus now or soon to be provided, may be mentioned —centrifugal machine, steam jacketted kettle, vacuum pan, still and condensers, filter presses, gravity aud suction filters, tanks with and without agitators, hot air and vacuum dryers, rotating, reverberatory, and gas furnaces, vacuum and compression pumps, hydraulic press, and a multiple effect evaporator. With this equipment and working with quantities of 2 or 3 lbs. of the raw materials of chemical manufacture, as bauxite, sulphate of soda, acetate of lime, zinc dross, etc., the student will be directed to prepare products, constantly bearing in mind the cost items as well as the chemical reactions involved. Based upon the results and observations of his experiment, he will design a plant to produce a given quantity of product per day, figuring the sizes of the necessary tanks, bins, and other apparatus required. He will have impressed upon him that every step in a process represents *cost*, and that he must adopt the cheapest efficient device possible.

Another room in the basement will be equipped with crushing, grinding and polishing machinery, including roll crusher, disc grinders, disintegrator, mechanical mixer, ball mill, a sand blast apparatus, and polishing wheels. These will be used in preparing the various raw materials for, and in furnishing the products of, the various experiments in applied electrochemistry aud manufacturing chemistry.

A course of lectures in Chemical Technology is offered, covering all the important industries working on chemical principles, in which a comprehensive description of each process will be given, and its chief points of interest to Chemical Engineers discussed. Whenever possible, experts in particular industries will be invited to discuss the features of their specialties.

Two rooms on the first floor will be devoted to the important course in technical gas, fuel and oil analysis. The methods and apparatus used for these purposes will be discussed and practice given in the laboratory in the analysis of chimney, producer, illuminating, metallurgical, and mine gases, and in gas analysis for control of chemical processes; also the determination of the heating values of coal, oil and gas, both by analysis and by direct determination, with several types of combustion calorimeters. The lighting values of oils and gases can be determined in the photometric rooms in the third story. The results of the above work will be interpreted as regards their application to chemical engineering practice.

All the technical chemical work of the department requires previous qualification in qualitative and quantitative chemical analysis.

Another room on the first floor is equipped with apparatus for microscopic examination of metals and micro-photographic work. The largest laboratory room is devoted to electrochemistry, under the direction of Mr. Oliver W. Brown,* who, previous to coming to this university, occupied the chair of Assistant Professor of Electrochemistry in the Indiana State University, and there are several small rooms for research work. The research work upon iron, now being done by Dr. Oliver P. Watts, under a grant from the Carnegie Institute, will be carried on in this department.

The equipment is designed and the instruction arranged to give the student a good foundation in the principals of chemistry and engineering, with experience in practical experimentation in the application of these principles along those lines in which he becomes most interested.

---

*Under the direction of Mr. Oliver W. Brown, who, previous to coming to this University, occupied the chair of Assistant Professor of Electro-chemistry in the Indiana State University.

THE UNIVERSITY AND MINING.

BY C. K. LEITH,
Professor of Geology, University of Wisconsin.

The unprecedented expansion of the mining industry in recent years, the tendency toward concentration of control, and the accompanying changes in methods of mining, extraction and transportation of the ores have required a differentiation and specialization of the technical help necessary for such operations. The versatile mining engineer who, when called upon, will open up a mine, install machinery, run a concentrating plant or smelter, build a railway, or make a geological report, with excursions into other technical branches, is as ubiquitous as ever, but his activities are becoming less diversified, and a part of his work is passing into the hands of specialists in one or more of these several lines of work, such as the civil engineer, the mechanical engineer, the metallurgist and the economic geologist. These specialists may or may not know some of the other branches necessary to mining. It is highly desirable that they do know them. But their essential qualification must be thorough training in the fundamentals of their particular lines; the application of these principles to mining can, if necessary, be largely acquired in the local field of work. On the other hand, the man who has acquired a knowledge of the applications of his specialty to mining without a thorough grounding in the principles can scarcely supply this deficiency in later years, and is permanently handicapped in the development of new methods to meet the constantly changing conditions. Managers of some of the largest mining enterprises are beginning to insist on thorough fundamental training in their technical help even to the point of taking men whose training in applied mining and allied subjects has been trivial. They reason that experience will soon give them enough of the applied branches to meet their immediate needs, while experience will not give them the fundamentals.

The tendency toward specialization thus opens a field to graduates of universities or colleges in which this fundamental training in engineering, geology or chemistry is emphasized rather than their applications to mining. The mining school has excellent courses in the fundamentals, but the necessity of crowding in so much applied work in the four years makes it necessary to encroach upon these subjects to an extent not necessary in a university or college. On the other hand some of the universities or colleges may give instruction in applied mining subjects equal to that of the mining schools, though as a whole the mining school is better adapted to give this work. It would follow from these remarks that in the training of men for the mining industry in its newer phases, both the mining school and the university may play an important part,—the university in the basal training of engineering or geology or chemistry, the mining school in the applications of these subjects to mining. There seems to be little need of duplication of their work. It would seem especially undesirable for the university to attempt to introduce courses in applied mining and metallurgy into a four years' course at the expense of the subjects of the present courses. If introduced, as they doubtless will be, to a small extent, they may well be a part of a five or six years course. Instead of competing at a disadvantage, perhaps temporary, in the mining school's field, the university has its own special opportunity.

The University of Wisconsin is especially well fitted to meet the requirements of the new mining conditions above outlined. The student who wishes to go into mining may follow one of several courses of study: (1) He may take a straight general engineering, civil engineering, mechanical engineering, electrical engineering, or chemical engineering course, perhaps supplemmenting the course with a small amount of mine surveying and geology where these are not included in his regular course. The graduate of any of the engineering courses has little difficulty in finding employment in the larger mining companies, with opportunies and salaries not less than those offered mining school graduates, and in some cases more. If the engineering student can in addition put in one or two years at a mining school, he secures a survey of the mining field and the technique of the mining industry which will serve him well in his subsequent career. In the last two years the demand for Wisconsin engineering graduates for mining work, even without mining school training, has been greater than the supply. (2) The engineering student may supplement his engineering training by taking geological courses, either in the "mining group of electives" in the four year general engineering courses or in the special five year combination engineering and geological courses now offered, and prepare himself to understand in some degree the geological problems which so largely control his mining work. Again, supplementary study at a mining school is desirable. (3) By taking, in addition, a considerable amount of graduate work in geology, the engineering student or other student properly prepared may make himself competent to solve the geological problems so fundamental to mining. While this means a number of years of graduate study, and such a course may therefore seem too long to men anxious to begin "practical" work, the financial returns, to say nothing of scientific results, justifies the longer time spent in preparation. Some of the highest salaried men connected with mining operations are the men who determine the geological structure upon which mining operations and explorations are based, such as the probable extensions of the ores into adjacent areas, their depth, altitude, and related features. Their conclusions are the basis for large expenditures, and the salaries paid are commensurate with the magnitude of the interests involved.

The University of Wisconsin is near the great iron and copper districts of Lake Superior on one hand, and the lead and zinc districts of the Mississippi valley on the other. Members of the instructional force and Wisconsin graduates have been prominent in the geological mapping of these districts and the study of the ores for the United States, Wisconsin, and Missouri Surveys and for commercial organizations. Wisconsin graduates are now actively engaged in mining and exploration in these districts. The best openings for Wisconsin graduates are thus likely to be in this field. But this field is sufficiently large and important to offer opportunities to Wisconsin graduates for some time to come, for the value of its output nearly equals that of all other metal-producing districts of the United States combined, not excepting the great gold and silver districts of the West and Alaska.

The Wisconsin Engineer.

Published Quarterly by the Students of the College of Engineering, University of Wisconsin.

Vol. 10. Madison, Wis., December, 1905. No. 1.

TERMS:

$1.00 if paid before February 1st; after that date, $1.25. Single copies, 35c.
Entered in the postoffice at Madison as matter of the second class.

EDITORIALS.

The students, and especially the civil engineering students have heard with regret of the resignation of Prof. Taylor and his withdrawal from the University to accept the position of chief engineer of the Chicago & Alton Railway. Prof. Taylor came here in the fall of 1901, as Professor of Railway Engineering, having previously been in charge of track elevation in Chicago for the same road he now returns to. During his four and one-half years at the University he has been one of the most popular professors in the Civil Engineering

Course, and in taking up his new work, he carries with him the congratulations of the students upon his success and their best wishes. He enters upon his new duties at the close of this semester and his headquarters will be in Chicago.

Prof. Taylor has been associated with the technical side of engineering to a large extent. He graduated from the Civil Engineering Course at the Alabama Polytechnic Institute in 1881, and later took post graduate work in Mathematics and Mechanics at Johns Hopkins for a year. He has also done considerable work in the laboratories of Cornell University and the University of Chicago. From 1891 to 1898 he was Professor of Civil Engineering at the University of Louisiana.

Soon after graduation in 1881, Prof. Taylor went to Mexico where he worked for two years on the construction of the Tampico Branch of the Mexican Central Railway, being successively topographer, instrument man and division engineer. Upon his return to the United States he was engineer of construction for the Montgomery & Florida Railway, now a part of the Atlantic Coast Line, and for a number of mineral lines of the Louisville & Nashville Railway. In 1898 he became chief engineer of the St. Louis, Peoria & Northern Railway, and when this road was bought up by the Alton, he went to the same road, being for several years in charge of important works, including the reconstruction of the bridge across the Missouri River at Glasgow, Mo., and the track elevation in Chicago.

From the Alton, Prof. Taylor came to Wisconsin. Since coming here he has been especially prominent in appraisal work, and has carried on a number of important investigations. In 1901 he made an appraisal of the physical properties of the Duluth & Iron Range, and Duluth, Mesaba & Northern Railways, for the Minnesota Railroad & Warehouse Commission. Since June, 1903 he has been engineer expert for the State Tax Commission of Wisconsin in charge of the appraisal of all Wisconsin railways. Last winter he made an extended report for the U. S. Census Bureau on the value and condition of all railroads in Minnesota and Texas, and during the past summer he made an examination of a railroad route through the Cascade Mountains in Washington for J. G. White & Co.

Last summer Prof. Taylor was tendered the position of chief civil engineer for J. G. White & Co., of New York City, and it was only after mature deliberation that he decided to decline the offer and remain at the University. Of late years he has made an especial study of the subject of railway economics, and it was due to the desire to continue this work that he remained in Madison last summer.

At a recent meeting of the faculty several changes were made in the rules governing the annual inspection trips. Heretofore it has been customary for those students who desired to go to make an inspection trip early in the Senior year. The trips were not compulsory, but if a majority of the students went all regular classes were abandoned during their absence. It has been customary for several years for the electrical and mechanical students to go east, visiting the various large industries at Buffalo, Pittsburg and surrounding places, while the civil engineers spent a week at or near Chicago. The new rules, which go into effect at once, provide for a trip for all Junior engineering students, this trip to be taken during the Easter recess. All Juniors will be required to go unless excused by the committee in charge, these students so excused being required to present a written report at the opening of the Senior year on some certain industries, selected by the class officer, which may be visited during vacation periods. The students taking the trip must also present a written report on the same. As before, several members of the faculty will accompany the students, and will be in general charge. The trip will probably consist of a visit to the leading industrial plants at Chicago and Milwaukee, although there may also be an eastern trip. The estimated expense of the Chicago-Milwaukee trip is $23, while that of the eastern trip will be approximately $52.

On Friday, December 8th, Mr. J. N. Faithorn, president of the Chicago Terminal Railway Company, delivered a very interesting and instructive lecture upon "The Regulation of Railway Freight Rates." The subject was one of very general interest now, especially to Wisconsin people, and Mr. Faithorn is especially well fitted to speak upon this subject as, being a traffic man himself, he has made a study of this question.

The speaker traced the development of rates and showed how they were the result of a complex adjustment of distance, cost of handling the traffic, competition, etc. He also discussed the subject of rebates saying: "Excepting perhaps in isolated instances, the rebate system never has been used by the railroads for the purpose of giving one shipper an unfair advantage over another. The purpose has been to secure traffic for the railroad."

Mr. Faithorn said the ideal regulation of railway rates "would be such that would by its workings seize upon the improprieties or irregularities that exist in an otherwise reasonably well adjusted whole and eradicate them, leaving the rate structure otherwise intact." As a remedy he advocated the creation by law of two tribunals; one to pass originally upon the question presented, but whose findings shall not become operative, if appealed from by either side, until reviewed by the second tribunal which shall be a higher court.

On Friday, Jan. 12, Mr. Bernhard A. Behrend, Chief Engineer of the Bullock Electrical Manufacturing Co., of Cincinnati, Ohio, gave a lecture upon "High Speed in Modern Engineering." Mr. Behrend is an interesting speaker, and delivered a very instructive talk upon the high speeds attained now in the modern engines and machinery. He dwelt especially upon the rapid development of this new class of machinery, and gave several instances of the replacement of engines installed but a few years ago by the modern turbines and other high speed engines of to-day.

The complete list of lectures which are yet to be delivered is given below. As will be seen, we are to have the opportunity to hear some of the best men in the country in their respective lines, and their lectures will prove very instructive, as have those already given. The lecturers and dates are as follows:

Jan. 26—Mr. S. Weyer, Consulting Engineer of Columbus, Ohio.

Feb. 23—Mr. L. R. Clausen, U. W., '97, Chief Signal Engineer, C., M. & St. P. Ry., Milwaukee, Wis.

March 2—Mr. Andrews Allen, U. W., '91, of Chicago, on some phase of "Engineering Contracting."

March 9—Mr. Ralph Modjeska, Consulting Bridge Engineer of Chicago, on "The Thebes Bridge."

March 23—Mr. Arthur B. Wheeler, President of the Chicago Telephone Company.

April 6—Mr. L. P. Breckenridge, Professor of Mechanical Engineering at the University of Illinois, on "The Use of Bituminous Coal in Boiler Furnaces."

In addition Mr. Frank Skinner, Associate Editor of the *Engineering Record*, will probably deliver a series of lectures, designed especially for civil engineers, on the erection of large structures and on deep foundation work. These lectures will be given in the spring, and will be very practical in their nature.

As announced in the last ENGINEER, through the generosity of Mr. Fred B. Wheeler, a sum of $50 is to be awarded at the coming commencement for the best two baccalaureate engineering theses.

The first prize is to consist of the sum of $30, and the second prize of $20.

The theses which will be considered in competition are those presented this year by seniors in the mechanical, electrical and chemical engineering courses.

A committee appointed by the faculty of the College of Engineering will select the theses for which the awards will be made, limiting the choice to those theses which are recommended by the various instructors as possessing special merit.

The qualities which will be considered in making the choice are originality, completeness as a piece of technical investigation, and literary merit. Theses representing the work of two or more students will be included in the competition, but such theses must represent a correspondingly greater amount of work than those prepared by individuals.

A condition placed upon the recipients of the awards is that a copy of each of the successful theses be furnished to Mr. Wheeler.

The minstrel show is progressing nicely and is now an assured thing. An abundance of talent has been found in the class, and the various men selected are now working on their stunts. According to present plans, the event will take place early in March. The committee has effected the following organization:

Business Manager—O. Eskuche.

Stage Carpenter—B. K. Read.

Electrician—C. C. Thwing.

Property Man—C. Beye.

Stage Manager—D. H. Keyes.

Along this line it might not be out of place for THE ENGINEER to offer a suggestion to seniors and underclassmen alike, and this is, to make the minstrel show an engineering ministrel show throughout. Let the audience be strictly an engineering audience, and limit the admission to engineers and their lady friends. To do this, the financial aid necessary must be subscribed by the underclassmen. In former years the expenses have been met by subscriptions to the Social Fund. This year there is no Social Committee, so the seniors must rely upon a ticket sale. Let the tickets be offered only to engineers, and we believe all will be sold readily, for we believe the underclassmen are more than willing to help make the show an exclusively engineering one.

The committee promises an entertainment second to none given by preceding classes, and those of us who have attended former ones know that they were among the best events of the year.

In short, let us have an *Engineers' Minstrel Show* for *Engineers*, and follow the custom established by two preceding classes.

The following is the menu for the Thanksgiving dinner in the camp of the engineers of the U. S. R. S., who are working on the Fort Buford Project, with headquarters at Glendive, Mont. In the party were E. C. Bebb, '96, who is division engineer of the first division, and Mr. Burchart, ex. '04, who is division engineer in charge of the third division on the same project. The menu is so thoroughly an engineering one that one might suppose that the cooks were also engineers:

THANKSGIVING—1905.

LA MESA.

MENU.

Giblet-Rice.
For the alimentary canal and laterals.
Baked Salmon.
From the "Cost and Apologetic Survey."
Braised Brisket of Beef–Brown Gravy.
Are you insured in the U. S. R. S. M. Ins. Co.?
Roast Turkey–Oyster Dressing. *Cranberry Sauce in saucers.*
"The keen essence of how came you so."
Potato Salad. *Apple Briquettes.*
a la "Theological Survey." Tensile strength 150 lbs.
Potatoes au gratin. *Mashed Potatoes.*
Escalloped Corn. *String Beans.*
"Recreation Service" style. Pelham's best.
Old English Plumb Pudding.
"plumb gentle."
Fruit Cake a la Mesa. *Fruit Syllabub.*
Concrete Mince Pie. *Plane Apple Pie.*
Reinforced Punch.
Coffee. *Milk.* *Tea.* *Cocoa.*
Investigated Fruits. *Hexagonal Nuts.*

At the annual meeting of the Western Society of Engineers, in Chicago, on January 2d, Mr. Andrews Allen, '91, and Prof. D. C. Jackson, were elected vice-presidents. Prof. Jackson also read a paper on "The Development of University Trained Engineers."

On Friday evening, Dec. 15, the Senior Engineers held a smoker to get the men in the various sections together in a social gathering, and to give the minstrel show a good start. About ninety of the men were out, and all report a good time.

THE SOCIETIES.

The U. W. Engineers' Club.

The loss of last year's sixteen seniors created a vacancy which has proven hard to fill. There has, however, been a decided increase in the interest taken in literary societies by the engineering undergraduates, and this has brought several upperclassmen into the club. Besides nearly enough freshmen and sophomores have joined to make up the full quota. Up to the present time the club has had but one outside speaker, Professor Thorkelson, who gave a well attended lecture on "Refrigerating Machinery." It is the intention of the present program committee to bring in more outside speakers, especially members of the faculty and graduates of the club. Musical numbers will also be a regular feature of the program. A recent discussion in the club brought out the fact that short and numerous papers were preferred to long ones. A change from the old custom will give a greater number of members an opportunity to appear on the program. After the Christmas recess, President Sorem, Vice-President Cade, Secretary Birkett, Censor Egelhoff, and Assistant Censor Wilber, were succeeded by Biersach, Balsom, Mumm, Sorem and Birkett. Lately the following men were elected to the club: W. O. Krahn, '09; G. A. Wickstrom, '09; R. J. Hardacker, '06; F. M. Warner, '07; O. Scheunemann, '09; J. H. Solke, '08; F. J. Murray, '09; W. J. Kutchers,' 09; J. C. Wied, '07, and B. Berssenbrugge, '09.

The N. O. Whitney Association.

The N. O. Whitney Society has been in good healthy condition all fall. The meetings have been well attended by the members, and the programs have been good ones. Debating has not been made a feature of the programs this year, but in its place the members have been asked to present some topic without use of notes. This plan has worked well. It is still the policy of the society to have members of the faculty address the society upon some topic either of the choosing of the person or the society.

At the recent election, the following men were elected:

President—E. E. Parker, '07—C. E.

Vice-President—L. B. Robertson, '06—M. E.

Secretary and Treasurer—O. O. Kuentz, '08—M. E.

Censor—O. L. Kowalke, '06—Ch. E.

The Civil Engineers' Society.

Although the youngest of the three engineering societies by several years, the Civil Engineers' Society is now one of the strongest. One of the recent changes which has strengthened the society has been the admission of sophomore civils as full members and freshmen as associate members. The membership is limited to those in the civil engineering course, and the programs consist largely of lectures by various professional men and members of the faculty.

The society is not a debating society, leaving that part of the field to the other societies, but attempts are made to give the members a wider range of subjects than one can secure in the class room. Of late the attendance has ranged about 60. Among those who have talked before the society recently are Professor C. K. Leith, on "The Opportunities for a Wisconsin Man in Mining Work;" Professor Taylor, on "Experiences on Mexican Railway Construction;" Professor Comstock, "The Non-Professional Assets of An Engineer;" Professor Slichter, on "The Garden City, Kansas Project;" Mr. Willis, of the Carnegie Institute, on "Engineering Notes of a Traveler," and Professor Smith, on "The Mexican Boundary Survey."

An effort is being made to increase the membership, and to this end all civil engineering students are urged to join the society. The meetings are held each Friday evening in room 207.

ALUMNI NOTES AND PERSONALS.

The friends of Prof. H. S. Webb, '98, of Orino, Maine, will regret to learn of his death, which occurred June 12, 1905. Prof. Webb died of tuberculosis following a run of typhoid fever. He was Professor of Electrical Engineering at the University of Maine.

C. H. Stevens, '02, has been promoted to Assistant Engineer, and has been transferred from Chicago, Ill., to Arapahoe Agency, Wyo., on the Casper-Lander extension of the C. & N. W. Ry.

L. A. Terven, '02, has located with L. K. Comstock & Co., of New York City. Mr. Terven was formerly with the Nernst Lamp Co.

E. B. True, '96, is now Shop Foreman of the Peoria Gas & Elect. Co., and may be addressed at 701 Jackson St., of that city.

R. G. Walter, '05, who was formerly employed as timekeeper on the Great Northern, is now with Ward Baldwin, Consulting Engineer of Cincinnati, Ohio.

C. T. Watson, '04, is with the Wisconsin Central Ry. as Assistant Engineer.

F. C. Weber, '03, has accepted the position of Manager of the Plattsmouth, Neb., Electric Light Co.

C. I. Zimmerman, '03, is now with the Carborundum Co., at Buffalo, N. Y.

J. M. Gilman, '04, is now in the B. and B. Dept. of the C. M. & St. P. Ry., with headquarters at Chicago, Ill.

J. F. Hahn, '03, has removed from Walkersville, Ontario, to St. Louis, Mo. Mr. Hahn is now in the employ of the St. Louis Expanded Metal Co.

C. Hinrichs, '90, who was formerly with the Stirling Boiler Company at Barberton, O., is now with the U. S. Shipbuilding Co. at Camden, N. J.

J. T. Hurd, '01, who was Engineer with the Chicago Junction Ry., is now Inspector of Tunnels for the City of Chicago.

J. A. McKim, '91, is now Secy.-Treas. of the Westlake Construction Co., of St. Louis, Mo.

F. A. Chamberlain, '04, has left the Madison Gas & Electric Co., and accepted a position with Henry L. Doherty, of Brooklyn, N. Y.

Mr. Walter Richards, '93, formerly Assistant Chief Engineer of the National Electric Co., of Milwaukee, Wis., is now with the Engineering Department of the Bullock Electric Manufacturing Co., at Cincinnati, Ohio.

F. J. Short, '97, has become Professor of Civil and Mechanical Engineering at the Grove City College, Grove City, Pa.

S. Schattschneider, '05, is now on the U. S. Schooner "Matchless," as aid on the U. S. Coast and Geodetic Survey.

L. B. Moorhouse, '04, is employed on the design and construction of the new plant for the San Antonio (Texas) Gas Co.

I. B. Hosig, '05, who is employed with the U. S. R. S. on the Lake Basin Project with headquarters at Billings, Mont., is back at the university on "leave of absence," until Feb. 1st.

E. J. Fisher, '04, is at present located at Billings, Mont., on the Clark's Fork Project of the U. S. R. S.

Joe Bingham, '04, is located on the Huntley Project at Huntley, Mont., and L. R. Balch, '05, is on the same Project.

T. E. Van Meter, ex. '06, is instrument man on the Iowa division of the C. & N. W. Ry., with headquarters at Boone, Iowa.

W. S. Lacher, ex. '06, is with the Chicago & Alton Ry., being located at Slater, Mo.

Ira Wilson, ex. '06, spent a portion of the holidays in Madison. Mr. Wilson is now an electrician in the light house service of the U. S. government.

E. J. Hawley, ex. '06, is an instrument man on the construction of the Casper-Lander extension of the C. & N. W. Ry.

W. C. McNown, '03, is an Instructor in Civil Engineering at Cornell University.

E. A. Ekern, '03, formerly with the Niagara Construction Co., has also a position as Instructor at Cornell University.

It has been suggested that THE ENGINEER add a matrimonial editor to its staff. As before the work of reporting the marriages of alumni falls to the alumni editor, but of late this portion of his work has become quite voluminous. Below are given a few of the notes which we have been able to gather. These are far from complete, but many marriages have been reported of which no details have been available. From present indications this column will be will sustained. The congratulations of THE ENGINEER are extended to our alumni who may be mentioned in this column, and we desire to receive their support in making it as complete as possible.

Norman Lee, '04, was married on October 26th, 1905, in Paris, to a talented young English lady. His address is 59 Rue de Paris, St. Denis, Seine, France.

C. A. Hansen, '05, was married recently to Miss Bessie Suttle, of Lancaster, Wis.

During the past summer Vincent McMullen, '05, and Miss Edith Perkins, of Dodgeville, Wis., were married. They are now living in Evansville, Wis., where Mr. McMullen is a draftsman with the Baker Manufacturing Company.

A. T. Stewart, '04, was married Nov. 21, '05, to Miss Gertrude A. Smith, of Pasadena, Cal. They are at home at Elyria, Ohio.

C. M. Larsen, '05, was married in Madison during the holidays to Miss Mabel Davenport. Mr. Larsen is in charge of the construction of a branch of the Mexican National Railway near Vera Cruz, and returned with his wife about the first of the year. His address now is Cordoba, Vera Cruz, Mexico, No. 21 Apartado.

H. M. Olson, '05, was married on July 29, '05, to Miss Julia Palmer, of Madison. Mr. Olson was formerly working with the Stanley Electrical Manufacturing Co., of Pittsfield, Mass., but has recently moved to Milwaukee.

D. McArthur, '04, was married recently at St. Louis, where he is working with the La Clede Gas Co.

E. C. Bebb, '96, was married January 3d, at Washington, D. C.

R. G. Griswold, '04, and Miss Mary Cox, of Onalaska, were married September 6th, and now reside at 411 W. 6th Ave., Denver, Colo. Mr. Griswold is with the gas department of the Denver Gas & Electric Co.

A. E. Blossey, '05, was married recently to Miss Ola Ward. Mr. Blossey is in the employ of the La Clede Gas Co., at St. Louis, Mo.

BOOK REVIEWS.

The Lucin Cut-off, by Oscar King Davis, in the January *Century*, is of especial interest to engineers, for it describes a feat which is distinctly an engineering one. The boldness of the undertaking, especially against the advice of leading experts who were called upon to pass upon its feasibility, has caused a great deal of comment all over the country. The article traces this recent feat of engineering from its inception during the construction of the old Central Pacific Railroad, in the early sixties, by Mr. Hood, now chief engineer of the Southern Pacific Ry., down to its completion in 1904. The old line of the Southern Pacific ran from Ogden around the north end of Salt Lake and then southwest into Nevada and abounded in heavy grades and curves, this section being very difficult to operate. The new cut-off runs west from Ogden directly across Salt Lake to Lucin, where it connects with the old line. The important feature of this cut-off is the section across Salt Lake, thirty-two miles in length, there being twelve miles of trestles and twenty miles of heavy fill. The sinking of the fills almost as rapidly as they were made, and the filling of the apparently bottomless hole, together with the persistence of those in charge of the work, are very interestingly described. The article is well illustrated by a map of the territory adjacent to the cut-off, and by several views of the work during the construction period and after the completion.

THE ENGINEER is in receipt of an interesting book entitled "Industrial Opportunities not yet Utilized in Massachusetts," which is published by the Commonwealth of Massachusetts. It is the report of a special committee which had for its object the increasing of the permanent prosperity of the state. Complete investigations were carried on, the land and power available, transportation facilities, most suitable industries, etc., all being noted and recommendations offered for over two hundred small towns in various parts of the state. The report is interesting to one in the west as showing the efforts the New England states are making to keep their manufacturing interests from decreasing.

The United States Geological Survey has just published two papers by Professor Slichter, entitled "Field Measurements of the Rate of Movement of Underground Waters" and "Observations on the Ground Waters of Rio Grande Valley." They are listed as Water Supply and Irrigation Papers, Nos. 140 and 141. They treat of his work in the southwest, describing the methods used and the results obtained in this work.

ALUMNI DIRECTORY.

The alumni directory, given below, has received a large number of corrections and additions since its last publication, and is as near correct and complete as we have been able to make it with the information obtainable. Any one knowing of further corrections is requested to send them to the alumni editor. We wish to thank all alumni, professors and students, who have helped us in this work. Addresses of which we are uncertain are preceded by an asterisk (*).

Abbott, Clarence E., B. S. M. E., '01, C. E., 05, Hazel Green, Wis., Mine Supt.

Adams, W. K., B. S. E. E., '03, S. Milwaukee, Wis., M. of W. Dept., C. & N. W. Ry.

Adams, B. C., B. S. E. E., '03, 1010 Grant St., Madison, Wis., Madison Gas and Electric Co.

Adams, B. F. B. S. M. E., '02, 37th and Rockwell Sts., Chicago. Ill., Art Bedstead Co.

Adamson, Wm. H., B. S. C. E., '86, 927 24th Ave., S. Seattle, Wash., Draftsman.

Ahara, Edwin H., B. S. C. E., '92; M. E., '96, Mishawaka, Ind., Supt., Dodge Mfg. Co.

Ahara, George V., B. S. M. E., '95, 1020 Oak St., Beloit, Wis., Asst. Supt. Testing Dept., Fairbanks, Morse & Co.

Ahara, Theo. H., B. S. M. E., '00, Williamsport, Pa., Draftsman, Williamsport Staple Co.

Albers, John F., B. S. C. E., '77; C. E., '78, Antigo, Wis.

Alexander, Walter B., B. S. M. E., '97, Milwaukee, Wis., Asst. Mast. Mech., C. M. & St. P. Ry.

Allen, Andrew B., B. S. C. E., '91; C. E., '97, 5535 Washington Ave., Chicago, Ill., 1127 Monadnock Bldg., Contracting Engineer, Wis. Bridge & Iron Co.

Allen, John S., B. S. E. E., '97, Beloit, Wis., Mgr., Beloit Electric Light Co.

Almond, Fred C., B. S. E. E., '04, Clear Lake, S. D.

Alverson, Harry B., B. S. E. E., '93, 40 Court St., Buffalo, N. Y., Supt., Cataract Power & Conduit Co.

Anderson, A. E., B. S. M. E., '03, Janesville, Wis.

Anderson, Gustav A., B. S. M. E., '02, 367 Jackson Blvd., Chicago, Ill., Draftsman, McCormick Works, Int. Harvester Co.

Andrews, A. W., B. S. C. E., '05, Chicago, Ill., Field Draftsman, C. B. & Q. Ry.

Anger, B. F., B. S. M. E., '05, 330 20th St., Milwaukee, Wis.
Arms, Richard M., B. S. E. E., '94, Seattle, Wash., Asst. Mgr., Seattle Elect. Light and Power Co.
Aston, James B., B. S. E. E., '98, 1042 National Ave., Milwaukee, Wis., with Thomas Aston & Son, Founders.
Austin, W. A., B. S. M. E., '99, 430 Board of Trade Bldg., Boston, Mass., Erecting Engineer, Under-Feed Stoker Co. of America.
Bachelder, C. H., B. S. M. E., '01, Milwaukee, Wis.
Baehr, Wm. A., B. S. C. E., '94, St. Louis, Mo., Engr. La Clede Gas Co.
Bailey, H. E., B. S. E. E., '03, 318 73d St., Brooklyn, N. Y., Brooklyn Rapid Transit Co.
Balch, L. R., B. S. C. E., '05, Washington, D. C., U. S. R. S.
Baldwin, Geo. W., B. S. C. E., '85, Crete, Neb., Lumber Dealer.
Bamford, F. E., B. S. M. E., '87, Manila, P. I., Capt. 28th Infantry, U. S. A.
Barber, Edw. L., B. S. E. E., '04, 506 W. 20th St., Kansas City, Mo., Metropolitan St. Ry.
*Barnes, Chas. B., B. S. M. E., '00, Milwaukee, Wis., Engr., Pfister & Vogel Leather Co.
Barr, J. M., B. S. M. E., '99, 260 Shady Ave., Pittsburg, Pa., Engineering Dept., Westinghouse Elec. Co.
Bassett, Henry S., C. E., '71, Preston, Minn., Lawyer.
Baus, Richard E., B. S. M. E., '00, Pittsburg, Pa., Engr., Westinghouse Elec. Co.
Barkhausen, Louis H., B. S. M. E., '01, Racine, Wis., Asst. foreman, J. I. Case T. M. Co.
Bebb, E. C., B. S. C. E., '96, Washington, D. C., Asst. Engr., U. S. R. S.
Beebe, M. C., B. S. E. E., '97, Madison, Wis., Associate Prof. of Elec. Engr. U. of W.
Belling, J. W., B. S. E. E., '03, Schenectady, N. Y., General Electric Co.
Benedict, W. J., B. S. M. E., '04, Joliet, Ill., American McKenna Process Co.
Bennett, C. W., B. S. M. E., '92, Elwood, Ind., Dist. Mrg., Am. Tin Plate Co.
Benson, F. H., B. S. C. E., '91, New Insurance Bldg., Milwaukee, Wis.
Bently, F. W., B. S. M. E., '98, 153 La Salle St., Chicago, Ill., Prin., Manual Training Dept., Association College.
Berg, John, B. S. C. E., '05, Ames, Iowa, Inst. Civil Engr. Iowa State College.
Bergenthal, V. W., B. S. E. E., '97, 3963 McPherson Ave., St. Louis, Mo., Sales Mgr., Wagner Elec. Mfg. Co., 2017 Locust St.
Bertke, W. J., B. S. E. E., '03, Kansas City, Mo., Asst. Mgr. Union Gas Imp. Co.
Bertrand, P. A., B. S. E. E., '95, 533 So. Campbell St., Springfield, Mo., Mgr., Springfield Gas & Elec. Co.
Berry, Claude, B. S. C. E., '01, 2854 Minnehaha Ave., Minneapolis, Minn., Struct. Engr. Minn. Steel and Mch. Co.
Biefield, P. A., B. S. E. E., '94, Hildberghausen, Germany, Prof. of Physics, Hildberghausen School of Technology.

Biegler, P. S., B. S. E. E., '05, Chicago, Ill., Draftsman, Chic. Edison Co.

Bingham, J. L., B. S. S. E., '04, Bismarck, So. Dak., U. S. R. S.

Bird, H. S., B. S. C. E., '94, New York City, N. Y., Lawyer.

Blaine, J. R. S., B. S. M. E., '05, Milwaukee, Wis., Draftsman, with Pawling & Harnishfeger.

Bleser, A. J., B. S. G. E., '04, Cripple Creek, Colo., Mining.

Bliss, W. S., B. S. M. E., '80, 558 Main St., Fond du Lac, Wis.

Blood, F. H., B. S. E. E., '05, Kenosha, Wis.

Blossey, A. F., B. S. M. E., '05, St. Louis. Mo., with La Clede Gas Light Co.

Boardman, H. B., B. S. E. E., '93, Chicago, Ill., with System Magazine.

Boardman, H. P., B. S. C. E., '94, Chicago, Ill., with Fitz Simmons & Connell Co., Contractors.

Bohan, W. J., B. S. E. E., '95, St. Paul, Minn., Elect. Engr., General Offices, N. P. Ry.

Boldenweck, F. W., B. S. M. E., '02, 27 Stratford Pl., Chicago, Ill., Engr. Dept., Western Elec. Co.

Boley, C. U., B. S. C. E., '83; C. E., '90, Sheboygan, Wis., City Engr. and Chairman Board of Public Works.

Bolles, E. J., B. S. E. E., '05, Milwaukee, Wis., with Wisconsin Tel. Co.

Boone, Chas., B. S. E. E., '05, Warren, Ill.

Boorse, J. M., B. S. E. E., '95, Milwaukee, Wis., Electrician, with Schlitz Brewing Co.

Borchert, Ernst, Jr., B. S. G. E., '05, Milwaukee, Wis.

Bossert, C. P., B. S. M. E., '88, 179 36th St., Milwaukee, Wis., Pfister & Vogel Leather Co.

Boynton, C. W., B. S. M. E., '98, Sedro-Woolley, Skagit Co., Wash.

Boynton, J. E., B. S. M. E., '05, Madison, Wis., Inst. in Mech. Drawing, U. of W.

Brace, J. H., B. S. C. E., '92, 125 W. 33rd St., New York City, Engr. of Alignment, Penn. N. Y. & L. I. Ry.

Bradford, William, B. S. E. E., '04, 1435 N St., Lincoln, Neb., Exp. Dept., Lincoln G. & E. Co.

Bradish, G. P., B. S. C. E., '76; C. E., '78, 717 Cass St., La Crosse, Wis., Civil Engr.

Bradley, W. H., B. S. C. E., '78, Fort Henry Club, Wheeling, W. Va., Engr., Nat. Tube Co., U. S. Steel Corp.

Brandt, H. W., B. S. C. E., '03, Madison, Wis., Asst. Engr., State Board of Assessment.

Brennan, B. C., B. S. C. E., '05, 876 Federal Bldg., Chicago, Ill., U. S. G. S.

Brennan, W. M., B. S. C. E., '94, Cato, Wis., Asst. Engr., Wis. Cent. Ry.

Brenton, C. E., B. S. E. E., '05, St Louis, Mo., Union Light & Power Co.

Brobst, J. E., B. S. E. E., '03, Schenectady, N. Y., Gen. Elec. Co.

Broenniman, A. E., B. S. C. E., '97, Watertown, Wis., Civil Engr.

Brown, G. W., B. S. C. E., '86; C. E., '90, Dry Tortugas, Fla., Supt. of Improvements, U. S. Navy Coaling Sta.

Brown, L. R., B. S. E. E., '03, Schenectady, N. Y., Gen. Elec. Co.
Brown, P. F., B. S. C. E., '97, Oakland, Cal., City Engr.
Brown, S. L., B. S. M. E., '89, Oil Ex. Bldg., Bakersfield, Cal., Supt., Pacific Smelting Co.
Brown, T. R., B. S. C. E., '95, Box L. N. Milwaukee, Wis., Wis. Bridge & Iron Co.
Brown, Wm. E., B. S. C. E., '05, 4 Toledo Ave., Elmhurst, Long Island City, N. Y., Rodman, E. River Tunnell, P., N. Y. & L. I. Ry.
Buerstatte, F. W., B. S. M. E., '01, 1440 Park Ave., Chicago, Ill., Special Apprentice, C. & N. W. Ry.
Buckley, W. J., B. S. E. E., '99, Milwaukee, Wis., Smith Concrete Mixer Co.
Bull, E. H., B. S. G. E., '05, Brooklyn, N. Y., with Johns-Manville Co.
Bump, M. R., B. S. E. E., '02, Denver, Col., Denver Gas & Elec. Co.
Burdick, W. C., B. S. C. E., '03, So. Chicago, Ill., with Morden Frog Works.
Burgess, C. F., B. S. E. E., '95, Madison, Wis., Prof. of Applied Electro Chemistry.
Burgess, G. H., B. S. C. E., '95, Jersey City, N. J. In charge of Terminal Improvements, Erie Ry., 21 Courtland St., N. Y.
Burke, T. J., B. S. C. E., '05, Buffalo, N. Y., M. of W. Dept., Erie Ry.
Burkholder, C. I., B. S. E. E., '96, Schenectady, N. Y., Gen. Elec. Co.
Burns, J. P., B. S. C. E., '04, 35 Gotham St., Watertown, N. Y., Draftsman, Erie Canal Imp.
Burns, L. A., B. S. C. E., '05, Bostable Bldg., Syracuse, N. Y., Leveler, State Barge Canal.
Burling, L. D., B. S. G. E., '05, Madison, Wis., U. S. G. S.
Burnet, E. S., B. S. M. E., '05, Madison, Wis., Grad. Scholar.
Burton, W. C., B. S. E. E., '93, 22 A, College Hill, Cannon St., London, Eng., Elec. Engr., J. G. White & Co., Ltd.
Buttles, B. E., B. S. E. E., '00, Mansfield, Ohio, Ohio Brass Works.
Cadby, J. N., B. S. E. E., '03, 451 Broadway, Milwaukee, Wis., Chief Draftsman, T. M. E. R. & L. Co.
Cahoon, O. B., B. S. M. E., '04, La Crosse, Wis., Supt. Wis. Light & Power Co.
Campbell, B., B. S. C. E., '98, Center, Col., Irrigation Engr.
Carey, J. L., B. S. M. E., '88, Home Telephone Building, Dayton, Ohio. Mech. Engr., American Straw Board Co.
Carlsen, C. J., B. S. M. E., '96, 279 Keystone Ave., River Forest, Ill., Elect. Engr., Chicago Telephone Co.
Carpenter, C. G., B. S. C. E., '82, City Hall, Milwaukee, Wis., Landscape Architect and Supt. of Parks.
Carter, B. B., B. S. M. E., '83, 1644 Monadnock Bldg., Chicago, Ill., Consulting Engr.
Carter, C. E., B. S. E. E., '04, Madison, Wis., Madison Gas & Electric Co.
Carter, P. J., B. S. C. E., '04, Beaumont, Tex., Engr. Dept., Atchison, Topeka & Santa Fe Ry.

Casserley, J. F., B. S. E. E., '05, Milwaukee, Wis., Wis. Tel. Co.
Caverno, X., B. S. M. E., '90, Kewaunee, Ill., Pres. and Gen. Mgr., Kewaunee Light & Power Co.
Chamberlain, F. A., B. S. E. E., '04, 77 Willow St., Brooklyn, N. Y., Engr., with Henry L. Doherty, 60 Wall St., New York city.
Cheney, S. W., B. S. M. E., '04, 1608 9th St., Denver, Col., Exp. Dept., Denver Gas & Elec. Co.
Clausen, Leon R., B. S. E. E., '97, Milwaukee, Wis., Chief Signal Engr., C. M. & St. P. Ry.
Cochran, R. B., B. S. M. E., '97, St. James Park, Rochester, N. Y., Vice-President and Supt., Cochrane Bldg. Co.
Cole, C. M., B. S. M. E., '02, Council Bluffs, Iowa.
*Cole, H. W., B. S. M. E., '02, Milwaukee, Wis., Erecting Engr., Allis-Chalmers Co.
Colby, L. W., B. S. C. E., '71, Beatrice, Neb., Lawyer.
Comstock, N., B. S. M. E., '97, Washington, D. C., U. S. Patent Office.
Connor, S. P., B. S. C. E., '99, New York, N. Y., Contractor.
Connolly, P. H., B. S. C. E., '85, Racine, Wis., City Engr.
Conover, A. D., B. S. C. E., '74; C. E., '75; 151 W. Gilman St., Madison, Wis., Member State Board of Control.
Conrad, N. J., B. S. E. E., '05, Chicago, Ill., Operating Dept., Chicago Edison Co.
Conradson, C. M., B. S. M. E., '83; M. E. '85, Warren, Pa., American Turret Lathe Co.
Cook, T. R., B. S. M. E., '00, 421 E. Berry St., Fort Wayne, Ind., Motive Power Inspector, Penn. Lines west of Pittsburg.
Coon, R. J., B. S. C. E., '05, Plainfield, Wis.
Coombs, E. C., B. S. C. E., '97, 93 Dearborn Ave., Chicago, Ill.
Cooper, A. S., B. S. C. E., '81; C. E., '83, Savannah, Ga., U. S. Asst. Engr. in charge Savannah Harbor and River.
Cornish, R. C., B. S. C. E., '97, 182 Wisconsin St., Milwaukee, Wis., Engr., Milwaukee Gas Light Co.
Cowie, H. J., B. S. C. E., '03, Niagara Falls, South Ontario, Canada, Asst. Engr., Ontario Const. Co.
Craigo, R. T., B. S. G. E., '05, St. Joseph, Mo., St. Joseph Gas Co.
Crandall, H. R., B. S. M. E., '98, 180 23d St., Milwaukee, Wis., Hendee-Bamford-Crandall Co.
Crane, E. W., B. S. E. E., '95, Orizaba, Mexico, Supt., Power Transmission Plant.
Cronk, F. B., B. S. C. E., '05, Bovey, Minn., Oliver Mining Co.
Crowell, R., E. E., '96, Sacramento, Cal., Asst. Elec. Engr., Sacramento Gas & Ry. Co.
Crumpton, W. J., B. S. E. E., '04, 724 Foster St., Evanston, Ill., North Shore Elec. Co.
Curtis, N. P., B. S. C. E., '04, 333 West Washington Ave., Madison, Wis.
Davidson, J. A., B. S. E. C., '04, Chicago, Ill., West. Elec. Co.
Dean, C. L., B. S. M. E., '01, 917 South 10th St., Lincoln, Neb., Instructor in Engr., Univ. of Neb.

Dean, G. C., B. S. M. E., '03, Eau Claire, Wis., Phoenix Mfg. Co.
Dean, J. S., B. S. M. E., '03, 4210 Prairie Ave., Chicago, Ill.
De Lay, F. A., B. S. E. E., '02, Houghton, Mich., Instructor, Mich. School of Mines.
Dessert, H. L., B. S. M. E., '04, Mosinee, Wis.
Dixon, F. B., B. S. C. E., '97, Point Loma, Cal., Horticulturist.
Dixon, J. E., B. S. M. E., '00, 10 Epprit St., Orange, N. J., Representasentative, Sales Dept.. Am. Loc. Co., Asst. Mgr., Atlantic Equipment Co.
Dodge, Jos., B. S. M. E., '84, 707 Woman's Temple, Chicago, Ill., Western Agent, J. R. Kein & Co.
Dodge, McClellan, B. S. C. E., '84, Eau Claire, Wis., City Engr.
Dorner, F. H., B. S. M. E., '05, Milwaukee, Wis., Draftsman, Turbine Dept., Allis-Chalmers Co.
Douglass, C. C., B. S. M. E., '03, 1508 Union St., Schenectady, N. Y., General Elec. Co.
Dousman, J. H., B. S. C. E., '84, 73 31st St., Milwaukee, Wis., Civil Engr., General Practice.
Dow, H. W., B. S. M. E., '02, Ames, Iowa, Asst. Prof. of Machine Design, Iowa State College.
Duffy, W. F., B. S. C. E., '84, Montgomery, La., Asst. Engr., S. & R. B. V. Ry.
Dutcher, J. E., B. S. E. E., '97, Chicago, Ill., Electrician, with Chicago Edison Co.
Earle, R. R., B. S. E. E., '02, Monterey, Mex., Monterey Elec. Co.
Earll, C. I., B. S. M. E., '85, 76 Williams St., New York City, Consulting Mech. Engr. and Expert in Patent Cases.
Ehreke, G. W. R., B. S. E. E., '02, 917 State St., Schenectady, N. Y., Testing Dept., Gen. Elec. Co.
Ehrnbeck, A.D., B. S. C. E.,'02, Port Casey, Wash.
Ekern, E. A., B. S. E. E., '03, 125 Quarry St., Ithaca, N. Y., Instructor, Cornell Univ.
Ela, E. S., B. S. C. E., '96, Washington, D. C., Engr., U. S. R. S.
Elliott, H. S., B. S. E. E., '03, Madison, Wis., Instructor in Elec. Engr., U. of W.
Elvis, G. H., B. S. M. E., '04, St. Louis, Mo., LaClede Gas Co.
Emerson, F. M., B. S. C. E., '00, 94 19th St., Milwaukee, Wis., Contracting Salesman, Am. Bridge Co.
Erbach, W. Z., B. S. M. E., '93, Athens, Wis., Supt., Rietbrock Land & Lumber Co.
Erwin, O. R., B. S. E. E.. '04, 256 24th St., Milwaukee, Wis., Erwin & Wheeler.
Evans, E. M., B. S. C. E., '94, Chicago, Ill., Draftsman with Am. Bridge Co.
Eriksen, E. T., B. S. C. E., '89; C. E., '90, 1203 Manhattan Bldg., Chicago, Ill., Asst. Engr., Bates & Rogers Constr. Co.
Ewald, R. F., B. S. C. E., '05, Madison, Wis., Asst. in Civil Engineering, U. of W.

Fairchild, D. L., B. S. C. E., '90, St. Louis Hotel, Duluth, Minn., Consulting Engr.

Falconer, D. P., B. S. C. E., '05, 1113 Union Sta., Pittsburg, Penn., Engr. Dept., Penn. R. R.

Falconer, R. C., B. S. C. E., '95, 50 Park St., Mont Clair, N. J., Asst. Engr., Erie R. R., 408 Havemeyer Bldg.

Farris, J. A., B. S. M. E., '00, Harvey Ill., Draftsman, Whiting Foundry Equipment Co.

Fehr, H., B. S. M. E., '84, 14 Grand Ave., Milwaukee, Wis., Lawyer.

Fisher, E. J., B. S.C. E., '04, Washington, D. C., U. S. R. S.

Fisher, J. J., B. S. C. E., '76, Prescott, Ariz., U. S. Surveyor and Civil Engr.

Fisher, J.R., B. S. C. E., '74; C. E., '80, Beaver Dam, Wis.

Flaig, John, B. S.C. E., '04, St. Paul, Minn., Draftsman.

Foote, F. J., E. E., '02, Cincinnati, Ohio, Bullock Elec. Mfg. Co.

Ford, A. H., B. S. E. E., '95; E. E., '96, Iowa City, Ia., Prof. of Elec. Engr., Iowa State Univ.

Ford, F. H., B. S. E. E., '93, Warren, Ohio., Sales Mgr., Peerless Elec-Co.

Fowle, F. F., B. S. C. E., '93, Wauwatosa, Wis.

*Fowle, H. H., B. S. E. E., '95, Milwaukee, Wis.

Fowler, M. M., B. S. E. E., '01, 841 W. Adams St., Chicago, Ill., Engr Dept., Western Elec. Co.

Fox, H., B. S. M. E., '92, 1620 N. Madison Ave., Peoria, Ill., U. S. Jr. Engr., Survey of Illinois and Des Plaines Rivers.

Frankenfield, B. D., B. S. E. E., '95, 2130 Lawn Ave., Sta. H., Cincinnati, Ohio., Engr. Dept., Bullock Elec. Co.

Fratt, F. W., B. S. C. E., '82, 1001 N. Broadway, Oklahoma City, O. T., Chief Engr., Texas & Oklahoma Ry. Co.

Freschl, E., B. S. M. E., '99, 3405 Wells St., Milwaukee, Wis., Supt. Kalamazoo Knitting Co.

Friend, J. H., B. S. E. E., '03, 296 10th St., Milwaukee, Wis.

Frost, D. K., B. S. E. E., '04, Pittsburg, Pa., Westinghouse Elec. Co.

Frost, O. J., B. S. M. E., '82; M. E., '85, 1752 Champa St., Denver, Col., Assayer.

Fugina, A. R., B. S. C. E., '98, No. 1 W. Kinzie St., Chicago, Ill., Asst. Engr., C. & N. W. Ry.

Fuldner, H. C., B. S. C. E., '97, 366 Greenbush St., Milwaukee, Wis., Engr. of Concrete Const., A. Mosted & Co.

Funk, W. F., B. S. M. E., '91, 1407 Main St., La Crosse, Wis., Supt., M. Funk Boiler Works.

Galloway, E. W., B. S. M. E., '04, Sugar Land, Tex., Asst. Chemist, with Ed. H. Cunningham & Co.

Gapen, J. C., B. S. E. E., '03, Chicago, Ill., Chicago Edison Co.

Gardner, Harry, B. S. G. E., '05, Urbana, Ill., Inst. in C. E., University of Illinois.

Gardner, Stephen, B. S. E. E., '02, New York Life Bldg., Chicago, Ill., Sales Manager Westinghouse Electric & Mfg. Co.

Garvens, G. W., B. S. C. E., '04, 523 School St., Des Moines, Iowa, Pres,, Sanitary Dairy Go.

Gates, H. B., B. S. C. E., '05, New York City. N. Y., Tunnel Work, Engr. Dept., Pa., N. Y. & Long Island Ry.

Geerlings, H. J., B. S. M. E., '03, 248 29th St., Milwaukee, Wis., Allis-Chalmers Co.

*Gerdtzen, G. A., B. S. M. E., '93., California.

Gerlach, T. A., B. S. C. E., '98, 15124 Turlington Ave., Harvey, Ill., Chief Draftsman, Paige Iron Works.

Gibson, W. J., B. S. M. E., '02, Madison, Wis., Asst. Supt., Fuller & Johnson Co.

Gilman, J. M., B. S. C. E., '04, Chicago, Ill., Engr. Dept., C., M. & St. Paul Ry.

Goddard, A. L., B. S. M. E., '96, Ardmore, Pa., Supt., with The Auto Car Co.

Goetz, E. A., B. S. G. E., '04, 725 Foster St., Evanston, Ill.

Gold, Solon, B. S. C. E., '05, 313 La Salle St., Chicago, Ill., Draftsman, Lake Shore & Mich. So. Ry.

Golder, L. W., B. S. M. E., '95; B. S. E. E., '96, Austin Station, Chicago, Ill., Engr. in charge of Tests, Sullivan Machinery Co.

Goodenough, C. F., B. S. G. E., '03, West Depere, Wis., Asst. Supt., Paper Mills.

Graff, C. F., B. S. C. E., '04, Seattle, Wash., Care of Division Engr., G. N. Ry.

Graham, G. A., B. S. C. E., '05, Long Island City, N. Y., Tunnel Work. Engr. Dept., Pa., N. Y. & Long Island Ry.

Granke, L. E., B. S. C. E., '00, La Crosse, Wis., U. S. R. S.

Greaves, A. C., B. S. C. E., '03, Spencer, Iowa, Civil Engr.

Gregerson, L. T., B. S. C. E., '95, U. S. Nat. Bank Building, Omaha, Neb., Asst. Engr., C. & N. W. Ry.

Gregg, H. B., B. S. M. E., '92, San Bernardino, Cal., Engr. of Tests, Lines West of Albuquerque, A. T. & S. F. R. R.

Grey, J. C., B. S. M. E., '02, Des Moinès, Ia., Engr., Capital City Gas Light Co.

Griffith, J. H., B. S. C. E., '93, 1113 Union Sta., Pittsburg, Pa.

Griswold, R. G., B. S. M. E., '04, 411 W. 6th St., Denver, Col., Engr. Asst., Denver Gas and Electric Co., 405 17th St..

Grover, A. J., B. S. C. E., '81; C. E., '83, Milwaukee, Wis., Resident Engr., Wis. Cent. R. R.

Grover, Allison, S., B. S. M. E., '95, South Milwaukee, Wis., Draftsman, Allis-Chalmers Co.

Haase, A., B. S. C. E., '03, 899 First St., Milwaukee, Wis., Illinois Steel Co.

Hackney, R. H., B. S. M. E., '93, 1719 Grand Ave., Milwaukee, Wis., Pres., Pressed Steel Tank Co.

Hadfield, R. H., B. S. M. E., '03, Ames, Iowa, Inst. in Mach. Design, Iowa State College.

Hagenah, R. E., B. S. M. E., 04, St. Louis, Mo., La Clede Gas Co.

Hahn, J. F., B. S. C. E., '03, St. Louis, Mo., with the St. Louis Expanded Metal Co.

Hain, J. C., B. S. C. E., '93; C. E. '05, New York, N. Y., Consulting Engr., with J. G. White & Co.

Haley, G. H., B. S. C. E., '05, Watertown, N. Y., City Engineer's Office.

Hall, E. M., B. S. E. E., '04, Chicago, Ill., Sullivan Machinery Co.

Hall, M. G., B. S. C. E., '04, Weston Block, Clinton, Ia., with Iowa Engr. Co.

Hambuechen, C., B. S. E. E., '99; E. E., '00, E. St. Louis, Ill., Expert on Improvements, Pittsburg Reduction Co.

Hamilton, H. F., B. S. C. E., '92, Havre, Mont., Asst. Engr., G. N. Ry.

Hammerschlag, J. G., B. S. M. E., '02, Milwaukee, Wis., Foreman, Illinois Steel Co.

Hancock, L. M., B. S. M. E., '88; M. E., '05, Fortuna, Cal., Consult. Engr.

Hankinson, R. L., B. S. G. E., '05, 57 Jackson St., Tompkinsville, N. Y., Draftsman, U. S. Lighthouse Service.

Hansen, C. A., B. S. E. C., '05, Schenectady, N. Y., Research Laboratory, Gen. Elec. Co.

Hansen, Oscar, B. S. E. E., '94, Chicago, Ill., Chief Draftsman, Western Electric Co.

Hanson, F. H., B. S. E. E., '04, Evanston, Ill., with the North Shore Elec. Co.

Hanson, W. S., B. S. M. E., '95, Oklahoma City, Okla., Pres., Okla. Cotton Product Co.

*Hanson, H. O., B. S. E. E., '99, Elizabeth, N. J., Draftsman, Western Elec. Co.

Hargrave, R. W., B. S. M. E., '98, Atlanta, Ga., Prof. of Mach. Practice, Georgia School of Technology.

Harlacher, L. R., B. S. C. E., '05, Bovey, Minn., U. S. Steel Co.

Harris, H. J., B. S. Met. E., '93, Pocatello, Idaho, Asst Engr., O. S. L. R. R.

Harriman, F. J., B. S. C. E., '89, 903 Perry St., Appleton, Wis., City Engr.

Hartman, Rudolph, B. S. C. E., '02, Wells Bldg., Milwaukee, Wis., Engr. with Fire & Rust-Proof Const. Co.

Hart, C. W., B. S. M. E., '96, Charles City, Ia., Pres., Hart, Parr & Co., Mfrs. of Internal Combustion Engines.

Harvey, J. L., B. S. M. E., '00, 213 19th St., Milwaukee, Wis., Fred. M. Prescott Steam Pump Co.

Harvey, W. R., B. S. E. E., '05, Milwaukee, Wis., Wis. Tel. Co.

Hatter, C. P., B. S. E. C., '05, Chicago, Ill., Chicago Gas Co.

Hauser, W. H., B. S. M. E., '04, Topeka, Kas., Atchison, Topeka & Santa Fe Ry.

Haugan, C. M., B. S. E. E., '05, 1713 Deming Pl., Chicago, Ill.

Haven, G., B. S. Min. E., '76, Waterloo, Ia., Lumber Dealer.

Hawn, R. J., B. S. C. E., '01, Craigsville, Va., Engr., Va. Portland Cement Works.

Hayden, C. B., B. S. E. E., '96, Sun Prairie, Wis., Pres. Elec. & Laundry Co.

Heald, E. H., B. S. C. E., '00, 314 Pleasant St., Oak Park, Ill., Contracting Agent, Amer. Bridge Co., of New York.

Hejda, C. F., B. S. E. E., '03, 468 La Salle St., Chicago, Ill., Chief Operating Engr., Chicago Edison Co.

Hedke, C. R., B. S. C. E., '00, Ft. Collins, Col., Consulting Engr., Stein & Hedke.

Heidemann, W. R., B. S. E. E. '05, Denver, Col., Denver Gas & Elec. Co.

Heine, R. E., B. S. E. E., '98, Chicago, Ill., Elec. Engr. with D. H. Burnham & Co., Architects.

Helmholtz, A. W., B. S. E. E., '05, Chicago, Ill., Chicago Edison Co.

Helzer, A. E., B. S. E. E., '05, Milwaukee, Wis., Wis. Tel. Co.

Henry, R. R., B. S. E. E., '05, Anchorage, Wis.

Hile, C. H., M. E., '93, 552 Harrison Ave., Boston, Mass., Supt. of Wires, Boston Elevated Ry.

Hill, M. J., B. S. E. C., '03, Oshkosh, Wis., Fox River Light & Power Co.

Hinrichs, C., B. S. M. E., '90, Camden, N. J., with U. S. Ship Building Co.

Hippenmeyer, I. R., B. S., M. E. '02, Madison, Wis., Gisholt Machine Co.

Hirschberg, W. P., B. S. C. E., '01, 213 Lincoln St., Johnstown, Pa., Asst. Engr., Cambria Steel Co.

Hirshheimer, H. J., B. S. M. E., '91, 218 N. 8th St., La Crosse, Wis., Vice-Pres., La Crosse Plow Co.

Hobart, F. G., B. S. M. E., '86; M. E., '90, 1259 Chapin St., Beloit, Wis., Supt., Fairbanks, Morse & Co.

Hodge, J. S., B. S. M. E., '04, Waupun, Wis., Supt., Granite Falls Elec. Co., Granite Falls, Wash.

Hoefer, C. A., B. S. M. E., '05, Boston, Mass., Fellow, Boston Institute of Technology.

Hoefer, E. G., B. S. M. E., '05, Madison, Wis., with D. G. &. W. B. Jackson.

Hogan, J. J., B. S. E. E., '99, 5725 Ontario St., Austin, Ill., Western Elec. Co.

Hohnbach, R. O. G., B. S. M. E., '88, 1211 Elizabeth St., Joliet, Ill., Draftsman, Am. Steel and Wire Co.

Hopper, Chas. Van E., B. S. C. E., '05, 21 Courtland St., New York, N. Y., Terminal Improvements, Erie R. R.

Holloway, D. C., B. S. M. E., '04, Chicago, Ill., Engr. Dept., Chicago Telephone Co.

Holt, F. W., B. S. C. E., '85, 1110 8th St., N. W., Washington, D. C., First Asst. Examiner, U. S. Patent Office.

Hoskins, A. J., B. S. M. E., '90; M. E., '05, Golden, Col., Asst. Prof. of Mining Engr.

Hoskins, L. M., B. S. C. E., '83; C. E. '87, 365 Lincoln Ave., Palo Alto, Cal., Prof. of Applied Mathematics, Leland Stanford University.

Hotchkiss, W. O., B. S. G. E., '03, Madison, Wis., Instructor in Geology, U. of W.

Hover, W. A., B. S. M. E., '77, Denver, Col., Senior Member, W. A. Hover & Co.

Howland, H. P., B. S. M. E., '03, Chicago, Ill., Supt. West Side Plant, Illinois Steel Co.

Hoyt, R. S., B. S. E. E., '05, Boston, Mass., Fellow, Mass. Inst. of Tech.

Hoyt, W. A., B. S. C. E., '00, Kalamazoo, Mich., City Engineer's Office.

Huels, F. W., B. S. E. E., '03, Madison, Wis., Instructor in Mech. Lab., U. of W.

Humphrey, C. W., B. S. E. E., '00, Denver, Col., Denver Gas and Elec. Co.

Hunner, E. E., B. S. C. E., '00, Hibbing, Minn., Engr., U. S. Steel Co.

Hurd, J. T., B. S. C. E., '01, 7105 Princeton Ave., Chicago, Ill., Inspector of Tunnels and Subway, City of Chicago.

Hurd, N. L., B. S. M. E., '01, Joliet, Ill., Am. McKenna Process Co.

Icke, John F., B. S. C. E., '00, Madison, Wis., City Engineer.

Inbusch, H. S., B. S. E. E., '05, Chicago, Ill., Western Elec Co.

Inbusch, W. H., B. S. E. E , '05, 176 Martin St., Milwaukee, Wis., Engr. Dept., Wis. Tel. Co.

Irving, T. J., B. S. C. E., '05, Green Bay, Wis., Instrument Man, Const, Dept., C. & N. W. Ry.

Jacobs, E. R., B. S. M. E., '05, Aurora, Ill.

James, B. W., B. S. M. E., '97, Joliet, Ill., Asst. Master Mechanic, Joliet. Wks., Ill. Steel Co.

James, O. B., B. S. M. E., '91, Richland Center, Wis.

Jenson, C. W., B. S. C. E., '04, River Falls, Wis.

*Johnson, A. L., B. S. M. E., '03, St. Louis, Mo.

Johnson, C. A., B. S. M. E., '91, Madison, Wis., Gen. Mgr. Gisholt Machine Co.

Jones, G. H., B. S. E. E., '97, 139 Adams St., Chicago, Ill., Contracting Engr., Chicago Edison Co.

Jones, R., B. S. E. E., '05, Milwaukee, Wis., Wis. Tel. Co., Engr. Dept.

Jones, Wm. N., B. S. C. E., '05, 909 Paradrone Ave., Cincinnati, Ohio, City Water Works.

Jorstad, O. M., B. S. G. E., '04; C. E., '05, E. Pittsburg, Pa., Westinghouse Elec. & Mfg Co.

Joyce, P. F., B. S. C. E., '93, Abbottsford, Wis., Asst. Division Engr., Wis. Cent. Ry.

Kahn, G. E., B. S. C. E., '04, Wells Bldg., Milwaukee, Wis.

Kayser, E. M., B. S. C. E., '05, Green Bay, Wis., Const. Dept., C. & N. W. Ry.

Keachie, G. R., B. S. C. E., '03, Madison, Wis., Contractor.

Keller, C. A., B. S. E. E., '99, Chicago, Ill., Contracting Engr., Chicago Edison Co.

*Kelley, P. J., B. S. E. E., '02, Madison, Wis.

Kennedy, W. M., B. S. Met. E., '96, Highland, Wis., Pres. and Supt., Highland Mining Co.

Kiehl, W. P., B. S. E. E., '97, 52 Broadway, New York City, Electrician. Astor Estate.

King, A. C., B. S. M. E., '01, Madison, Wis., Northern Electric Co.

Kinne, W. S., B. S. C. E., '04, Madison, Wis., Instructor Structural Engr., U. of W.

Kirchoffer, W. G., B. S. C. E., '97; C. E., '01, Madison, Wis., Consulting Engr.

Klug, L. J., B. S. C. E., '98, 353 15th Ave., Milwaukee, Wis., Draftsman, Am. Bridge Co.

Knowles, J. H., B. S. C. E., '99, 112 N. Main St., Salt Lake City, Utah, Asst. Engr., S. P. L. A. & S. L. Ry.

Koch, W. J., B. S. M. E., '04, 222 12th St., Milwaukee, Wis.

Kohl, O. B., B. S. E.E., '02, Denver, Col., Denver Gas & Elec. Co.

Kremers, J. G., B. S. E. E., '98, Menominee Falls, Wis., Asst. Supt., Beet Sugar Refinery.

Kratsch, W. H., B. S. M. E., '97; M. E., '98, 232 W. Irving St., Oshkosh, Wis., Supt., Geo. Challoners Co.

Krippner, A. F., B. S. E. E., '04, St. Louis, Mo., Instructor in Elec. Engr., Washington Univ.

Krummrey, R. G., B. S. E. E., '03, St. Louis, Mo., Foreman of Construction, La Clede Gas Co.

Kurtz, C. M., B. S. C. E., '97, Ogden, Utah, Chief Field Draughtsman, Office C. P .R. R. Reconstruction.

Kurtz, E. M., B. S. M. E., '94, 4629 Wagner Place, St. Louis, Mo., Supt., La Clede Power Co.

Lacey, F. H., B. S. E. E., '01, Chamberlain, S. Dak.

Lademan, Otto T., B. S. E. E., '97, St. Louis, Mo., Engr., Kinlock Telephone Co.

*Landgraf, F. K., B. S. M. E., '98, Pittsburg, Pa., Keystone Mfg. Co.

Lapham, C., B. S. C. E., '81, 3118 Mt. Vernon Ave., Milwaukee, Wis., Div. Engr., C., M. & St. P. Ry.

Lardner, H. A., B. S. E. E., '93; E. E., '95, 29 Broadway, New York City, Chief Elec. Engr., J. G. White & Co.

Larson, Albert, B. S. M. E., '05, Milwaukee, Wis., Grad. Apprentice, Allis-Chalmers Co.

Larson, C. M., B. S. C. E., '05, Mexico City, Mex., Asst. Engr., National Ry. of Mex.

Lathrop, W. F., B. S. E. E., '02, Milwaukee, Wis., T. M. E. R. & L. Co.

Lathrop, L. H., B. S. E. E., '04, Milwaukee, Wis., T. M. E. R. & L. Co.

Laurgaard, O., B. S. C. E., '03, Washington, D. C., Asst. Engr., Reclamation Service, U. S. G. S.

Lawton, E. W., B. S. M. E., '89, De Pere, Wis., Secy. and Treas., C. A. Lawton Co.

Lea, H. S., B. S. E. E., '03, Iron River, Wis., With Alexander & Edwards Lumber Company.

Lea, John M., B. S. E. E., '02, Sta. U., Chicago, Ill., Western Electric Co.

*Lee, Allan, B. S. G. E., '04, 59 Rue de Paris, St. Denis, Seine, France.

*Lee, Norman, B. S. E. E., '04, 59 Rue de Paris, St. Denis, Seine, France.

*Legg, E. F., B. S. E. E., '01, 734 State St., Schenectady, N. Y., Testing Dept., Gen. Elec.Co.

Leich, O. M., B. S. E. E., '98, Rochester, N. Y., Stromberg Electric Telephone Mfg. Co.

Lemon, L. E., B. S. E. E., '96, 158 Iowa Ave., Aurora, Ill., Secy., Vindex Elec. Co.

Lennon, H. D., B. S. G. E., '02, Monadnock Blk, Chicago, Ill., With Railway Age.

Leuth, E. S., B. S. M. E., '97, Baraboo, Wis., Designer.

Leuth, P. F., B. S. M. E., '98, Milwaukee, Wis., Cutler-Hammer Co.

*Lewy, Daniel, B. S. M. E., '05, Chicago, Ill.

Lindeman, A. S., B. S. M. E., '85; M. E. '87, 2912 Highland Blvd., Milwaukee, Wis., Mgr., Imperial Spring Co.

Lisberger, S. J., B. S. E. E., '03, 918 Hayward Bldg., San Francisco, Cal., California Gas & Electrfc Co.

Lloyd, C. C., B. S. C. E., '96, 860 Cass St., Milwaukee, Wis., C. M. & St P. Ry.

Logemann, R. T., B. S. C. E., '99, Minneapolis, Minn., Structural Draughtsman, Minneapolis Steel and Machinery Co.

Lyons, B. F., B. S. M. E., '03, St. Louis, Mo., La Clede Gas Co.

Mabbett, W. F., B. S. C. E., '02, 23 E. 48th St., New York City, Asst. Res. Engr., N. Y. C. & H. R. R.

MacEachron, E. J., B. S. M. E., '04, West De Pere, Wis.

MacGregor, W. F., B. S. M. E., '97, Racine, Wis., Mech. Supt. J. I. Case T. M. Co.

Macmillan, H. St. C., B. S. M. E., '05, Ladd, Ill., Roundhouse Foreman C., M. & St. Paul Ry.

Maldauer, A., B. S. C. E., '96, 1742 Monadnock Bldg., Chicago, Ill., Bridge Engr. with R. Modjeski.

Malec, A., B. S. C. E., '98, Chicago, Ill., Western Elec. Co.

Mann, F. H., B. S. C. E., '05, Spokane, Wash., Timekeeper, G. N. Ry.

Mathews, O., B. S. Min. E, '76; Met. E., '78, P. O. Box 153, Colorado Springs, Col., Mining Engineer.

Marvin, A. B., B. S. E. E., '00, 1205 Union St., Schenectady, N. Y., Patent Dept., Gen. Elec. Co.

Mason, C. T., B. S. M. E., '99, 300 Mississippi Ave., Joliet, Ill., Illinois Steel Co.

Maurer, E. R., B. S. C. E., '90, Madison, Wis., Prof. of Mechanics, U. of W.

Mayer, August, B. S. C. E., '83, 810 Jordan St., Shreveport, La., Cotton Planter.

McArthur, A. R., B. S. M. E., '00, 1529, S. J. St., Elwood, Ind., Engr., Am. Tin Plate Co.

McArthur, D., B. S. M. E., '04, St. Louis, Mo., La Clede Gas Co.

McCollough, F. M., B. S. C. E., '03, Madison, Wis., Inst. in Mechanics, U. of W.

McDonald, C., B. S. C. E., '97, Chicago, Ill., Road-master, C. & N. W. Ry.

McDonald, H. L., B. S. C. E., '04, Washington, D. C., U. S. G. S.

McEvoy, G. E., B. S. M. E., '02, S. Milwaukee, Wis., Illinois Steel Co.

McKim, J. A., B. S. C. E., '91, 701 Roe Bldg., St. Louis, Mo., Sec'y-Treas., Westlake Const. Co.

McMullen, V. E., B. S. E. E., '05, Evansville, Wis., Draftsman Baker Mfg. Co.

McNown, W. C., B. S. C. E., '03, Ithaca, N. Y., Inst. in Civil Engr., Cornell Univ.

McWethy, F. H., B. S. M. E., '05, Aurora, Ill., Consolidated Gas Co.

Mead, G. A., B. S. E. E., '95, Mansfield, Ohio, Ohio Brass Works.

Mead, O. A., B. S. C. E., '92, Appleton, Wis., R. McMillan & Co.

Mellville, Jas., B. S. C. E., '75; C. E.,'78, Delafield, Wis., Supt., Home, and Farm School.

Merrian, H. N., B. S. C. E., '98, Revelstoke, B. C., Asst. Engr., Canadian Pacific Ry.

Merrill, Z., B. S. G. E., '04, Spokane, Wash.

Merriman, W. N., B. S. Met. E., '81, 202 Wolvin Bldg., Duluth, Minn. Geologist, Oliver Iron Mining Co. and Minn. Iron Co.

Merrick, E. G., B. S. E. E., '00, 46 E. Housatonic St., Pittsfield, Mass., Stanley Elec. Mfg. Co.

Meyers, A. V., B. S. E. E., '01, Provo, Utah, Const. Dept., Telluride Power Transmission Co.

Meyer, A. F., B. S. C. E., '05, St. Paul, Minn., U. S. Engr's Office.

Meyer, E. W., B. S. M. E., '95, 948 4th St., Milwaukee, Wis., Nordberg Mfg. Co.

Miller, A. H., B. S. M. E., '05, Milwaukee, Wis., Filer-Stowell Co.

Minch, H. J., B. S. M. E., '92, 502 W. Mifflin St., Madison, Wis.

Minch, O. F., B. S. M. E., '93, Odessa, Wash., Mgr., Odessa Milling Co.

Minch, W. B., B. S. M. E., '00, 350 Ashland Blvd., Chicago, Ill., Telephone Engineer, Western Elec. Co.

Moles, E. S., B. S. E. E., '05, Madison, Wis., Inst. in Mechanical Drawing, U. of W.

Monahan, J. J., B. S. C. E., '95, Milwaukee, Wis., Contracting Engr., The Filer & Stowell Co.

Monroe, Wm., B. S. C. E., '73; C. E. '78, Great Falls, Mont., Civil and Mining Engineer.

Moore, L. E., B. S. M. E., '00, Urbana, Ill., Instructor, University of Illinois.

Moore, S., B. S. C. E., '02, 4 Old Post Office Bldg., Detroit, Mich., Asst, Engr., U. S. Great Lakes Survey.

Moorhouse, L. B., B. S. M. E., '04, San Antonio, Tex., San Antonio Gas Co.

Morgan, W. D., B. S. G. E., '05, Reedsburg, Wis., Supt., City Water Works.

Moritz, E. A., B. S. C, E., '04, C. E., '05, 1021 W. Johnson St., Madison Wis., Inst. in Engineering Mathematics, U. of W.

Moroney, J., B. S. C. E., '73 ;C. E., '75, Dallas, Tex.

Morrison, R. H., B. S. M. E., '03, Milwaukee, Wis., Locomotive Testing Dept., C., M. & St. P. Ry.

Morrissey, P. W., B. S. M. E., '05, Milwaukee, Wis., with Smith Automobile Co.

Morrow, F. E., B. S. C. E., '92, N. Milwaukee, Wis., Draftsman, Wis. Bridge & Iron Co.

Mors, G. C., B. S. M. E., '92; M. E. '00, Carnegie Bldg., Pittsburg, Pa., Engr., Am. Tin Plate Co.

Mott, W. R., B. S. E. E., '03, 213 S. Highland Ave., Pittsburg, Pa., Experimental Work.

Mueller, E. B., B. S. E. E., '03, St. Louis, Mo., Union Light and Power Co.

Muir, R. C., B. S. E. E., '05, Schenectady, N. Y., Testing Dept., Gen. Elec. Co.

Munger, E. T., B. S. M. E., '92, Chicago, Ill., Master Mechanic, Metropolitan Elevated Railway.

Murphy, F. H., B. S. E. E., '04, Des Moines, Iowa, Prof. of Elec. Engr., Hyde Park College.

Murphy, N. M., B. S. E. E., '01, Chicago, Ill., Electrician, Marshall, Field & Co.

Musil, L. F., B. S. E. E., '04, 1068 9th St., Denver, Col., Denver Gas & Elec. Co.

Musser, J. M., B. S. E. E., '04, 1619 Orrington Ave., Evanston, Ill.

Nee, T. G., B. S. E. E., '99, Mexico City, Mex., Asst. to Mgr., Mexican Telephone Co.

Neef, J. H., B. S. C. E., '04, Milwaukee, Wis., Draftsman, B. & B. Dept., C., M. & St. P. Ry.

Nelson, C. L., B. S. C. E., '00, 1413 Prospect St., Racine, Wis., U. S. Geol. Survey.

Nethercut, E. S., B. S. C. E., '89, Harvey, Ill., Chief Engr., Paige Iron Wks.

Newman, F. J., B. S. E. E., '98, 442 42d Place, Chicago, Ill., Woods Motor Vehicle Co.

Nicholaus, A. A., B. S. E. E., '01, Chicago, Ill., Draftsman, Chicago Edison Co.

Nicholaus, A. W., B. S. C. E., '04, Omaha, Neb., Dept. of Statistics, U. P. Ry.

Noyes, J. D., B. S. E. E., '04, East Pittsburg, Pa., Westinghouse Elec. Co.

Ochsner, R. J., B. S. E. E., '94, Cleveland, Ohio., Draftsman, Brown Hoisting Machy. Co.

Older, C., B. S. C. E., '00, Slayter, Mo., Div. Engr., C. & A. Ry.

Olson, A. C., B. S. C. E., '02, 506 Exchange St., Joliet, Ill., E. J. & E. Ry.

Olson, H. M., B. S. E. E., '05, Lynn, Mass., Stanley Elec. Co.

Olson, A. C., B. S. C. E., '02, Joliet, Ill., Asst. Engr., Fisher Constr. Co.

Olson, M. C., B. S. E. E., '99, 1302 Union St., Schenectady, N. Y., Gen. Elec. Co.

Olson, L. W., B. S. E. E., '99, Mansfield, Ohio, Draftsman, Ohio Brass Co.

Omara, E. H., B. S. C. E., '04, Chicago, Ill., M. of W. Dept., I. C. Ry.

O'Neill, W. R., B. S. M. E., '87, Boise, Idaho, Foreman, Barber Asphalt Co. Plant, R. F. D., No. 1.

Orbert, E. G., B S. C. E., '05, Green Bay, Wis., City Engr.'s Office.

Ostenfelt, C. L., B. S. C. E., '85, 531 Unity Bldg., Chicago, Ill., Engr. for Oscar Daniels Co.

Owen, Ray, B. S. C. E., '04, Madison, Wis., Inst. in Topographic Engr., U. of W.

Owens, L., B. S. E. E., '97, 104 Flora Ave., Peoria, Ill., Elect. Engr., People's Gas & Elec. Co.

Paine, J. P., B. S. C. E., '77, 223 Pleasant St., Milwaukee, Wis.

Palmer, R. B., B. S. E. E., '01, 962 Berwyn Ave., Chicago, Ill., Union Traction Co., 444 N. Clark St.

Parmley, W. C., B. S. Met. E., '87, Cleveland, Ohio, Asst. City Engr. in Charge of Sewer Const.

Parr, C. H., B. S. M. E., '96, Charles City, Iowa, Sec., Hart, Parr Co.

Parsons, W. J., B. S. C. E., '00, 539 Rosedale St., Pittsburg, Pa., Acting Supt. of Building Const., Am. Bridge Co., of New York.

Pengra, P. W., B. S. E. E., '02, Chicago, Ill., Inspector, Chicago Edison Co.

Pennock, W. H., B. S. M. E., '83, 620 N. Y. Life Bldg., Omaha, Neb.

Peotter, R. S., B. S. C. E., '05, Inst. in Engr. Mathematics, U. of W.

Perkins, J. H., B. S. E. E., '96, Wilkesbarre, Pa., Mgr., Wilkesbarre Gas & Elec. Co.

Perkins, W. D., B. S. E. E., '05, Milwaukee, Wis., Signal Engr. Dept., C., M. & St. Paul Ry.

Perry, C. H., B. S. C. E., '03, Chicago, Ill., Track Elevation, C. & N. W. Ry.

Peters, C. S., B. S. E. E., '05, 1158 Grand Ave., St. Louis, Mo., with Wagner Elect. Mfg. Co.

Petura, F.J., B. S. E. E., '04, Madison, Wis., Inst. in Elec. Engr., U. of W.

Phillips, N. F., B. S. C. E., '77, 3024 Holmes Ave., Minneapolis, Minn. Treasurer, Twin City School Supplies.

Plumb, H. T., B. S. E. E., '01, Lafayette, Ind., Associate Prof., Purdue University.

Polley, G. A., B. S. C. E., '02, Winona, Minn., Mgr., Phœnix Iron Works.

Pope, G. W., B. S. C. E., '98, 324 Dooley Block, Salt Lake City, Utah, Const. Engr., Minneapolis Steel and Machinery Co.

Post, G. G., B. S. E. E., '04, Madison, Wis., Inst. in Elect. Engineering, U. of W.

Potter, J. C., B. S. E. E., '04, Madison, Wis., Inst. in Elect. Engineering, U. of W.

Potter, W. G., B. S. C. E., '90; C. E., '94, Winston, N. C., Asst. Engr. for J. L. Ludlow.

Potts, F. A., B. S. C. E., '05, Empere, Panama, Rodman, Panama Canal Service.

Powell, A. O., B. S. C. E., '80; C. E., '90, 418 Globe Bldg., St. Paul Minn., Prin. Asst. U. S. Engr.

Powell, E. H., B. S. M. E., '91, Scranton, Pa., Text-book Writer on Mechanical Engineering, International Correspondence Schools.

Powrie, W. R., B. S. M. E., '96, 382 24th St., Milwaukee, Wis., Asst. Engr., C. M. & St. P. Ry.

Prael, F. W., B. S. M. E., '91, Corner of Lombard and Battery Sts., San Francisco, Cal., Supt., Am. Can Co.

Price, J. R., B. S. E. E., '05 Schenectady, N. Y., Gen. Elec. Co.

Pugh, John, B. S. E. E., '03, 836 Park Ave., Racine, Wis., J. I. Case T. M. Co.

Purdy, C. T., B. S. C. E., '85; C. E., '86, Upper Montclair, N. J., Purdy & Henderson, 78 5th Ave., New York.

Quigley, A. J., B. S. E. E., '03, New Brighton, Staten Island, N. Y. with J. G. White & Co., 43 Exchange Bldg., New York City.

Quirk, J., B. S. C. E., '73, 1920 Vine Place, Minneapolis, Minn., Pres. and Mgr., James Quirk Milling Co.

Radtke, A., B. S. E. E., '00, Chicago, Ill., Assoc. Prof. of Power Plant Engineering, Armour Institute, Consulting Engr.

Ramien, C. H., B. S. M. E., '96, 560 4th St., Milwaukee, Wis., Draftsman, Allis-Chalmers Co.

Ramstad, A. G., B. S. E. E., '05, St. Croix Falls, Wis.

Ransom, G. B., B. S. C. E., '91, Portsmouth, N. H., Head of Department of Steam Engineering, U. S. Navy Yard.

Reed, R. S., B. S. E. E., '05, Racine, Wis., J. I. Case Co.

Reedal, P. E., B. S. E. E., '96, Milwaukee, Wis., Christensen Engineering Co.

Reilly, H. W., B. S. E. E., '97, 29 Broadway, New York City, Elec. Engr., J. G. White & Co.

Rendtorff, E. J., B. S. E. E., '95, Lake Forest, Ill., Professor of Physics, Lake Forest Academy.

Reuping, L. H., B. S. M. E., '03, Omaha, Neb., Omaha Gas Co.

Reynolds, W. E., B. S. E. E., '99, Room 42, 203 Washington St., Chicago, Ill., Electrical Engr. Chicago Telephone Co.

Rhine, C. A., B. S. E. E., '00, 615 Clybourn St., Milwaukee, Wis., Union Electric Co.

Rice, L. E., B. S. E. E., '05, Schenectady, N. Y., Gen. Elec. Co.

Richards, J. T., B. S. C. E., '95, Viroqua, Wis.

Richards, W. A., B. S. M. E., '99, St. Louis, Mo., La Clede Gas Co.

Richards, W. J., B. S. E. E., '93, Cincinnati, Ohio, Engr. Dept., Bullock Elec. Mfg. Co.

Richardson, W. H., B. S. M. E., '05, Pittsburg, Pa., Westinghouse Machine Co.

Richter, A. W., B. S. M. E., '89; M. E., '91, Madison, Wis., Prof. of Experimental Engineering, U. of W.

Robinson, Geo. P., B. S. E. E., '96, San Francisco, Cal., Traffic Manager, Pacific Coast Telegraph & Telephone Co.

Robinson, R. F., B. S. E. E., '05, St. Louis, Mo., Union Light & Power Co.

Rodenbaeck, G. A., B. S. E. E., '05, Boston, Mass., Asst., Mass. Inst. of Technology.

Rogers, W. A., B. S. C. E., '88; C. E., '97, 1205 Manhattan Bldg., Chicago, Ill., Vice-Pres., Bates & Rogers Co.

Rollman, A. C., B. S. E. E., '01, The Dixon, 201 Wells St., Milwaukee, Wis., Asst. Engr., Cutler-Hammer Clutch Co., 12th St. & St. Paul ave.

Rood, C. M., B. S. M. E., '05, Seattle, Wash., Sec'y Y. M. C. A., U. of Wash.

Rosenstengel, R., B. S. E. E., '94, 537 Broadway, Milwaukee, Wis., Draughtsman, Christensen Engineering Co.

Rosenstengel, Wm. R., B. S. M. E., '87, 179 Laurel St., Buffalo, N. Y., Elec. Const. Engr., McCarthy Bros. & Ford.

Ross, H. H., B. S. E. E., '96; B. S. C. E., '97, Cleveland, O., Asst. Engr., L. S. & M. S. R. R.

Rote, A. F., B. S. Met. E., '82, Monroe, Wis.

Rowe, W. A., B. S. E. E., '04, Virginia, Minn., with U. S. Steel Co.

Rowe, W. J., B. S. E. E., '03, Chicago, Ill., Chicago Edison Co.

Rowell, L. D., B. S. E. E., '01, Milwaukee, Wis., Arnold Magnetic Clutch Co.

Rowley, F. B., B. S. M. E., '05, Madison, Wis., Graduate Scholar, U. of W.

Ruka, F. W., B. S. E. E., '96, Boscobel, Wis., Ruka & Sons.

Rumsey, S. S., B. S. C. E., '97, 610 Wolvin Bldg., Duluth, Minn., Asst. Mech. Engr., Oliver Mining Co.

Sanborn, J. N., B. S. M. E., '81; C. E., '84, Marshall, Tex., Master Mechanic, Texas Southern Ry.

Sanborn, R. A., B. S. E. E., '01, Richland Center, Wis., Freeborn & Sanborn.

Sands, E. E., B. S. C. E., '00, Washington, D. C., Engr., U. S. G. S.

Saridakis, F. J., B. S. M. E., '05, Milwaukee, Wis., Manual Training Dept., West Div., H. S.

Saunders, A. B., B. S. M. E., '02, Hinsdale, Ill., Western Electric Co.

Saunders, H. J., B. S. C. E., '03, Omaha, Neb., Engineer in Charge of Terminal Improvements, U. P. R. R.

Savage, J. S., B. S. C. E., '03, Washington, D. C., Asst. Engr., Reclamation Service, U. S. G. S.

Sawyer, A. R., E. E., '96, Lansing, Mich., Prof. of Physics and Elec. Engineering, Michigan Agricultural College.

Sawyer, W. P., B. S. G. E., '05, Chicago, Ill., Draftsman, Bridge Dept., I. C. Ry.

Schafer, Otto, B. S. C. E., '98, Minneapolis, Minn., Civil Engr., C., M. & St. P. Ry.

Schapper, Kurt, B. S. M. E., '02, 1832 Arlington Pl., Chicago, Ill.

Schattschneider, S., B. S. C. E., '05, Washington, D. C., U. S. Coast and Geodetic Survey.

Scheiber, A. V., B. S. E. E., '99, Oran, Mo., Mgr., Independent Telephone Exchange.

Schildhauer, E., B. S. E. E., '97, 1023 Leland Ave., Chicago, Ill., Chief Draftsman, Chicago Edison Co., Secy., Minerallac Co.

Schmidley, Wm. R., B. S. E. E. '05, St. Louis, Mo., Union Elec. Light and Power Co.

Schmidt, C. J., B. S. E. E., '97, 1450 Monadnock Blk., Chicago, Ill., Patent Attorney, with Chas. A. Brown.

Schmidt, F. E., B. S. C. E., '00, 220 Broadway, New York City., Asst. Editor, Engineering News.

Schmidt, W. F., B. S. E. E., '05, Chicago, Ill., Chicago Edison Co.

*Schroeder, A. T., B. S. C. E., '86, 31 W. 33d St., New York City, Attorney.

Schroeder, F. A., B. S. E. E., '99, Johnstown, Pa., Cambria Steel Co.

Schuchardt, R. F., B. S. E. E., '97, 139 Adams St., Chicago, Ill., Elec. Engr., in Testing Laboratory, Chicago Edison Co.

Schulz, A. G., B. S. C. E., '75, Porterville, Cal., Pres., Schulz Hardware Co., and Porterville Lib. Co.

Schneider, H. C., B. S. M. E., '98, Evansville, Wis., Supt., Baker Mfg. Co.

Schwendener, H. G., B. S. E. E., '04, Milwaukee, Wis., Milwaukee Telephone Co.

Scott, A. C., B. S. E. E., '02, Austin, Tex., Prof. of Elec. Engr., Univ. of Texas.

Scott, G. A., B. S. E. E., '02, 244 E— 60th St., Chicago, Ill., Testing Dept., Chicago Edison Co.

Scott, H. H., B. S. E. E., '96, Madison, Wis. Gen. Supt., Madison Gas & Elec. Co.

Seaman, Harold, B. S. E. E., '00, 600 Prospect Ave, Cleveland, Ohio, Engr., Electric Storage Battery Co.

Seaman, Irving, B. S. E. E., '03, Marquette Bldg., Chicago, Ill., Electric Storage Battery Co.

Servis, F. A., B. S. E. E., '04, E. Pittsburg, Pa., Westinghouse Electric Co.

Severson, Harry A., B. S. C. E., '01, Rockford, Ill., Secy., Barber-Colman Co.

Seymour, M. E., B. S. E. E., '98, 44 Broad St., New York City, Constr. Engr., General Electric Co.

Seyton, H. J., B. S. C. E., '05, St. Joseph, Mo., Main. of Way Dept., C., B. & Q. Ry.

Shealy, E. M., B. S. E. E., '04, Madison, Wis., Inst. in Steam Engr., U. of W.

Sheldon, S. R., B. S. E. E., '94, Moscow, Idaho, Prof. of Elec. Engineering, Univ. of Idaho.

Shelton, A. W., B. S. C. E., '83, Rhinelander, Wis., Lawyer.

Sherron, F. J., B. S. G. E., '05, Elwood, Ind., Amer. Tin-Plate Co.

Short, F. J., B. S. M. E., '97, Grove City, Pa., Prof. of Civil & Mech. Engr., Grove City College.

Short, J. M., B. S. C. E., '89, 1251 Madison Ave., Indianapolis, Ind., Estimating Engr., Noelke-Richards Iron Works.

Shuster, J. W., B. S. E. E., '99, Madison, Wis., Asst. Prof. of Elec. Eng., U. of W.

Simmons, Geo. M., B. S. E. E., '05, Chicago, Ill., Engr. Dept., Metropolitan West Side Elevated Ry.

Silber, F. D., B. S. E. E., '94, Atwood Bldg., Chicago, Ill., Sawyer, Wheeler & Silber.

Sinz, Edw., F., B. S. C. E., '05, Empere, Panama, Panama Canal Service.

Sloan, W. F., B. S. E. E., '04, 369 W. Jackson St., Chicago, Ill., Testing Dept., Chicago Edison Co.

Smith, A., B. S. E. E., '98, 203 Washington St., Chicago, Ill., Supt. of Country Lines, Chicago Telephone Co.

Smith, A. I., B. S. E. E., '93, Wauwatosa, Wis., Smith Bros.

Smith, F. H., B. S. C. E., '91, 595 Association Bldg., Chicago, Ill., Civil Engineer.

Smith, H. A., B. S. E. E., '98, Chicago, Ill., Gen. Elec. Co., Monadnock Bldg.

Smith, H. B., B. S. Met. E., '85, Colton, Cal., Cashier, First National Bank.

Smith, J. E., B. S. C. E., '04, Milwaukee, Wis., Care of Chief Engineer, Wisconsin Central Ry.

Smith, John A., B. S. M. E., '05, Chicago, Ill.

Smith, L. S., B. S. C. E., '90; C. E., '95, Madison, Wis., Asst. Prof. of Topographic and Geodetic Engineering, U. of W.

Smith, P. S., B. S. E. E., '98, 421 W. Monroe St., Chicago, Ill., Kellogg Switch Board & Supply Co.

Smith, R. T., Jr., B. S. C. E., '02, 324 Roland Ave., Roland Park, Baltimore, Md., Draftsman, Diederich & Harvey Machine Co.

Smith, S. T., B. S. C. E., '00, 1472 Camp St., New Orleans, La., Timber Agent.

Spalding, W., B. S. E. E., '03, Highwood, Ill., Chicago & Milwaukee Elec. Ry.

Spence, H., B. S. E. E., '98, 1353 Kane St., La Crosse, Wis., Principal, 5th Dist. School.

Spencer, R. C., Jr., B. S. M. E., '86, Steinway Hall, Chicago, Ill., Architect.

Spindler, Max H., B. S. C. E., '98, 49 Breck Ave., Cleveland, O., Osborne Mfg. Co.

Staack, J. G., B. S. C. E., '04, Washington, D. C., U. S. G. S.

Stanchfield, B., B. S. M. E., '94, Fond du Lac, Wis., Mech. Engr., Fred. Reuping Leather Co.

Stanchfield, G. H., B. S. C. E., '92, Fond du Lac, Wis.

Starks, S. P., B. S. M. E., '02, Madison, Wis.

Stevens, C. H., B. S. C. E., '02, Araphoe Agency, Wyo., Asst. Engr., C. & N. W. Ry.

Stevens, H. T., B. S. C. E., '03, La Crosse, Wis., Consulting Engr. in Private Practice.

Stevens, J., Jr., B. S. M. E., '89, 842 College Ave., Appleton, Wis.

Stewart, A. T., B. S. E. E., '04, Elyria, Ohio.

Stewart, J. A., B. S. E. E., '04, Milwaukee, Wis., Chief Draftsman, Wis. Tel. Co.

Stewart, R. W., B. S. C. E., '99, Colfax, Cal., Roadmaster, Southern Pacific Ry.

Steiler, F. C., B. S. E. E., '02, 451 Broadway, Milwaukee, Wis., T. M. E. R. & L. Co.

Stillman, F. C., B. S. M. E., '04, Hibbing, Minn., U. S. Steel Corp.

Stockman, L. R., B. S. C. E., '02, Washington, D. C., Asst. Engr., U. S. R. S.

Stone, M. B., B. S. C. E., '00, Minneapolis, Minn., Engr. with A. Y. Bayne & Co., Contractors.

Sturtevant, H. B., B. S. C. E., '80; C. E., '88, Duluth, Minn., Mgr. of Mines for Rogers, Brown & Co.

Sunderland, I. C., B. S. C. E., '02, Detroit, Mich., Asst. Engr., U. S. Great Lakes Survey.

Swan, G. D., B. S. E. E., '05, Chicago, Ill., Sec., Y. M. C. A., Chicago Univ.

Swaty, D. Y., B. S. C. E., '98, 1116 Union Station, Pittsburg, Pa., Asst. Engr., Penn. Lines West of Pittsburg, North West System.

Swenson, M., B. S. Met. E., '80; M. S., '83, Madison, Wis., Pres., Walburn-Swenson Co., Chicago, Ill., Mgr., American Cotton Co., New York City, Regent, U. of W.

Swenson, B. V., E. E., '01, 114 Liberty St., New York City, N. Y., Sec., Amer. Street and Interurban Ry. Assoc.

Sweet, J. F., B. S. M. E., '93, 285 Farwell Ave., Milwaukee, Wis., Designer and Asst. Supt., The Browning Mfg. Co.

Swinborne, E. D., B. S. M. E., '88, Chicago, Ill., Chief Engineer, Whitman & Barnes Mfg. Co.

Taylor, J. C., B. S. E. E., '01, Salt Lake City, Utah, Sullivan Machinery Co.

Terrel, E. E., B. S. C. E., '04, Superior, Wis., Roadway Dept., G. N. Ry.

Terven, L. A., B. S. E. E., '02; E. E., '04, New York City, N. Y., with L. K. Comstock & Co.

Tessier, L. F., B. S. M. E., '93, De Pere, Wis., Supt., De Pere Elec. Light & Power Co.

Thompson, J. R., B. S. Met. E., '81; Ironwood, Mich., General Manager, Newport Mining Co.

Thon, G. L., B. S. C. E., '05, 685 Monroe St., Chicago, Ill., with J. W. Alvord, Consulting Engineer.

Thorkelson, H. J. B., B. S. M. E., '98, Madison, Wis., Asst. Prof. of Steam Engineering, U. of W.

Thorkelson, W. L., B. S. M. E., '02, Racine, Wis., With Racine-Sattley Co.

Thorkelson, M. W., B. S. C. E., '04, Memphis, Tenn., with Memphis Street Ry. Co.

Thorp, G. G., B. S. M. E., '91, The Rookery, Chicago, Ill., 2nd Vice-Pres., Ill. Steel Co.

Thygeson, N. M., B. S. Met. E., '85; Dispatch Bldg., St. Paul, Minn.-Lawyer, Munn & Thygeson.

Thuringer, C. B., B. S. C. E., '93, 132nd St. and Willis Ave., New York City, Asst. to Div. Engr., N. Y., N. H. & H. R. R.

Tibbitts, H. L., B. S. C. E., '94, 814 Wells Bldg., Milwaukee, Wis., Secy., Tibbitts-Cameron Lumber Co.

Townsend, H. I., B. S. E. E., '01, Chicago, Ill., Chicago Telephone Co.

*Townsend, J. R., B. S. E. E., '04, Youngstown, Ohio, Electric Supply Co.

Trautman, G. H., B. S. M. E., '96, 2667 N. Hermitage Ave., Ravenswood, Chicago, Ill., Asst. Supt. of Inspection, International Harvester Co.

Treber, A. P., B. S. E. E., '04, St. Louis, Mo., La Clede Gas Co.

Trippe, H. M., B. S. C. E., '96, Room 3, Marine Bldg., Chicago, Ill., Asst. General Bridge Inspector, C. & N. W. Ry.

Trowbridge, J. B., B. S. C. E., '76, Hayward, Wis., Physician and Surgeon.

True, E. B., B. S. E. E., '96, 701 Jackson St., Peoria, Ill., Shop Foreman, Peoria Gas & Elec. Co.

Tubesing, W. F., B. S. C. E., '05, Cincinnati, Ohio, Asst. Engr., City Water Works.

Turner, J. M., B. S. C. E., '77, General Delivery, Central Station, Chicago, Ill., Pres. and Gen. Mgr., Wis. Outing Club.

Turner, P. B., B. S. E. E., '05, 1631 Orrington Ave., Evanston, Ill., with North Shore Elec. Co.

Uehling, O. C., B. S. C. E., '90, Wells Bldg., Milwaukee, Wis., Architect Uehling & Linde.

Uihlein, W. B., B. S. M. E., '04, Milwaukee, Wis., Schlitz Brewing Co.,

Updegraff, M., B. S., C. E., '84; M. S. '86, Washington, D. C., Astronomer, U. S. Naval Observatory.

Van Hagan, L. T., B. S. C. E., '04, Mexico City, Mex., Engr. Dept., Interoceanic R. R.

Van Hise, C. R., B. S. M. E., '79; M. S., '82; Ph. D., '92, Madison, Wis. Pres. of University of Wisconsin.

Van Ness, L. G., B. S. E. E., '96, St. Louis, Mo., Auditor, La Clede Gas Co.

Van Ornum, J. L., B. S. C. E., '88; C. E., '91, "Clayton," St. Louis, Mo., Prof. of Civil Engr., Washington Univ.

Vaughn, F. A., B. S. E. E., '95, Milwaukee, Wis., T. M., E. R. & L. Co.

Vea, F. J., B. S. M. E., '01, Stoughton, Wis., Pres., Stoughton Wagon Co.

Vinson, A. W., B. S. M. E., '05, Milwaukee, Wis., Wis. Tel. Co.

Wade, C. G., B. S. M. E., '84, 346 1st Ave., Wauwatosa, Wis., Consulting Engr.

Wagle, O. O., B. S. E. E., '05, Valley City, Nor. Dak., Engr. for Valley City St. & Interurban Ry. Co.

Wagner, R. T., B. S. E. E., '05. Schenectady, N. Y., Gen. Elec. Co.

Waldo, G. E., B. S. M. E., '85, 1234 Monadnock Bldg., Chicago, Ill., Patent Lawyer.

Waldo, M. A., B. S. M. E., '84, 226 3rd Ave., Leavenworth, Kan., Mo. Bridge & Iron Wks.

Wales, C. M., B. S. M. E., '85, 11 Broadway, New York City, Mgr., N. Y., Office, Cleveland City Forge & Iron Co.

Walter, R. G., B. S. C. E., '05, 909 Paradrone Ave., Cincinnati, Ohio, with Ward Baldwin, Consulting Engr., Commercial-Tribune Bldg.

Warner, H. M., B. S. C. E., '04, Pittsburg, Pa., P. C. C. & St. L. Ry. Co.
Warner, H. R., B. S. M. E., '98., St. Louis, Mich.
Warner, F. D., B. S. M. E., '96, Lewiston, Idaho.
Warner, M. F., B. S. E. E., '95, 100 Williams St., New York City, Asst. Mgr., Asbestos Dept., H. W. Johns-Manville Co.
Washburn, F. E., B. S. C. E., '01, 1742 Monadnock Bldg., Chicago, Ill., Engr. with Ralph Modjeski.
Wassmansdorf, O. F., B. S. C. E., '00, Lewiston, Mont., Deputy U. S. Mineral Surveyor.
Wasweyler, H. W., B. S. M. E., '85, 251 Lapham St., Milwaukee, Wis., Pres. and Gen. Mgr., Milwaukee Brass Mfg. Co.
Watson, C. T., B. S. C. E., '04, Milwaukee, Wis., Asst. Engr., Wis. Cent. Ry.
Watson, J. W., B. S. E. E., '02, Madison, Wis., Instr. of Elec. Engr. U. of W.
Weber, F. C., B. S. E. E., '03, Plattsmouth, Neb., Mgr. Plattsmouth Elec. Light Co.
Wedemeyer, A. A., B. S. M. E., '03, Galena, Ill., Galena Iron Works.
Weed, L. B., B. S. C. E., '00, Eveleth, Minn., Mining Engr., Royal Iron Co.
Weld, H. K., B. S. G. E., '05, 203 Washington St., Chicago, Iil., Engr. Dept. Chicago Tel. Co.
West, A. J., B. S. M. E., '87, Pittsburg, Pa., Westinghouse Mach. Co.
Wharry, M. E., B. S. M. E., '05, Madison, Wis., Gisholt Machine Co.
Wheeler, Wm. S., B. S. M. E., '05, New Castle, Pa., Engr. Dept. Penn. Engr. Co.
Whelan, J. A., B. S. C. E., '77, Hartford, Wis., Junior Engr., Milwaukee Dist., River & Harbor Improvements.
Whinery, R. H., B. S. C. E., '05, 306 10th St., Minneapolis, Minn., Sanitary Engr. for Minn. State Board of Health.
Whitby, G. N., B. S. C. E., '04, St. Paul, Minn., M. of W. Dept., G. N. Ry.
Whiting, M. A., B. S. E. E., '04, Marion, Ohio, Marion-Bucyrus Railway & Power Co., Elec. Ry. Constr.
*Whittemore, H., B. S. M. E., '03, Clairmont, N. H., Asst. Supt. of Sullivan Machine Co.
Whomes, H. R., B. S. M. E., '00, 41 Hamlin Ave., Chicago, Ill., Motive Power Dept., C. & N. W. R. R.
Wiley, R. R., E. E., '98, Petersborough, Ont., Packard Elect. Co.
Williams, C. H., B. S. M. E., '96; M. E., '00; E. E., '04, La Crosse, Wis., Gen. Mgr., Wis. Light & Power Co.
Williams, L. A., B. S. M. E., '00, 1450 Monadnock Bldg., Chicago, Ill., Patent Attorney.
Williams, W. H., B. S. E. E., '96, 917 W. Green Street, Urbana, Ill., Asst. Prof. of Elec. Engr., Univ. of Ill.
Williams, L. D., B. S. C. E., '01, Madison, Wis., Instr. in Civil Engr., U. of W.
*Williamson, E. L., B. S. C. E., '00, Chicago, Ill., Asst. Engr., C. R. I. & P. Ry.

Willison, C. D., B. S. E. E., '05, 207 S. Leavitt St., Chicago, Ill., with Chicago Tel. Co.

Willson, F. G., B. S. E. E., '03, Urbana, Ill., Asst. at U. of Ill.

Wilson, E. F., B. S. M. E., '84, 161 E. Randolph St., Chicago, Ill., Mechanical Engineer and Patent Solicitor.

Wilson, John, B. S. C. E., '03, 214½ E. Monroe St., Bloomington, Ill., C. & A. Ry.

Wise, P. L., B. S. C. E., '88, 434 Shawanee Ave., Topeka, Kan., Chief Engr., Topeka Ry. Co.

Wolter, B. C., B. S. C. E., '75, Appleton, Wis.

Wood, H. H., B. S. M. E., '01, Stoughton, Wis., Stoughton Wagon Works.

Wood, W. W., B. S. C. E., '76, Rushville, Neb., Attorney.

Woodward, W. L., B. S. M. E., '94, 1011 Wells Bldg., Milwaukee, Wis., Lawyer.

Worden, E. P., B. S. M. E., '92, 359 Kane Place, Milwaukee, Wis., Mech. Engr., Fred M. Prescott Steam Pump Co.

Worden, B. L., B. S. C. E., '93, Milwaukee, Wis.

Woy, F. P., B. S. E. E., '03, 43 Exchange Place, New York City, J. G. White & Co.

Wray, Edw., B. S. E. C. '05, Madison, Wis., Graduate Scholar, U. of W.

Wray, J. G., B. S. E. E., '93, 203 Washington St., Chicago, Ill., Chief Engr., Chicago Telephone Co.

Wulfing, H. E., B. S. E. E., '05, Chicago, Ill., Elec. Dept., Rock Island System.

Young, H. W., B. S. E. E., '02, 510 Marquette Bldg., Chicago, Ill., Associate Editor, Western Electrician.

Zabel, M. B., B. S. E. E., '98, Chicago, Ill., Sales Mgr., Am. Elec. Telephone Mfg. Co.

Zaramba, E., B. S. E. C., '04, Chicago, Ill., Am. Foundry & Mach. Co.

Zimmerman, C. I., B. S. E. E., '03, Buffalo, N. Y., with Carborundum Co.

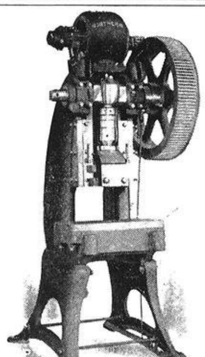
Zimmerman, J. G., B. S. E. C., '04, Milwaukee, Wis., Mgr., Elec. Vehicle & Supply Co.

Zimmerman, O. B., B. S. M. E., '96, M. E. '00, 622 Otjen Ave., Milwaukee, Wis.

Zinke, P. F., B. S. E. E., '04, 1420 Grand Ave., Milwaukee, Wis., Wis. Telephone Co.

Zinn, W. A., B. S. M. E., '98, 2908 Highland Blvd., Milwaukee, Wis., Malting Co.

Zwietusch, E. O., B. S. M. E., '86; M. E. '88, Salzufer, Charlottenburg, Germany, Elec. Engr., Petsch, Zwietusch & Co., Telephon-Appart-Fabric.



Northern Motor Driving Consolidated P. & P. Co. Punch

¶ Advertising space for sale in The Wisconsin Engineer. Address Business Manager.