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The Wisconsin Engineer

Vol. 20 MARCH, 1916 No. 6

ELECTRIC DYNAMOMETER

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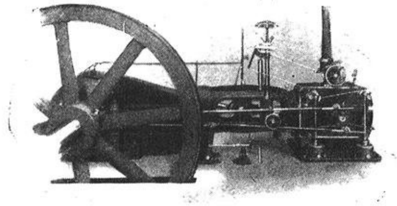

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The Wisconsin Engineer

VOL. XX MARCH, 1916 NO. 6.

THE ELECTRIC DYNAMOMETER

F. E. Fisher, '06

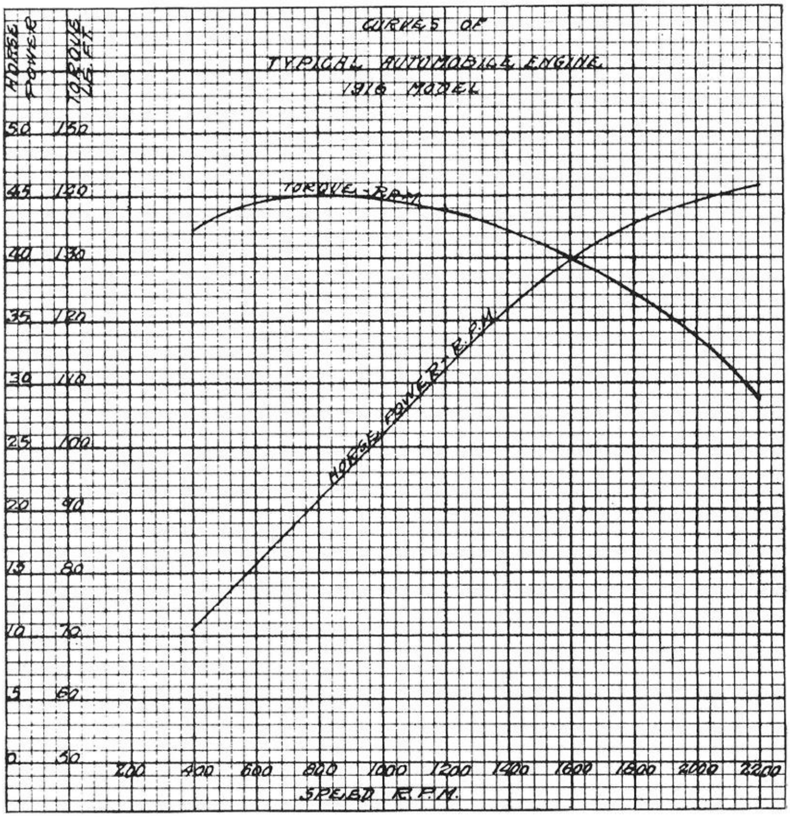
The rapid development of several classes of rotating apparatus during the last two or three years, has created a field for dynamometers of various types.

It has been customary to call any load absorbing device for rotating units a dynamometer. The word "dynamometer" comes from two Greek words meaning "force" and "measure" which would imply that only force is measured, whereas work, that is force times distance through which it acts, is what is actually measured. It would seem that the more preferable name would be "ergometer," compounded from the Greek words "work" and "measure." The word "dynamometer" has been in universal use for so long, however, particularly in the automobile industry, that a machine bearing this name is recognized as a work measuring device.

Dynamometers may be divided into three general classes: namely, gravity, frictional (including absorbtion machines) and transmission types. The most popular and universal of these divisions is the frictional or absorption type, and under this class comes the Electrical Absorption or Cradle Dynamometer, which will be discussed in this paper.

Probably a large proportion of machines of this type in use today are in automobile plants or plants where automobile engines are developed and built.

The horsepower speed curve of a properly designed automobile engine is practically a straight line over the working range. The horsepower varies approximately as the speed and the action is somewhat similar to that of a direct current series wound motor. If the load is increased, the speed falls off. If the load is decreased the speed increases. Curve No. 1 is a typical engine curve of a 1916 model engine. The tendency in engine design is toward higher speeds and greater horsepower. For a long period of years 2,000 RPM was considered a fast engine speed, indeed until the advent of the eight and twelve cylinder engine, most of the automobiles were equipped with engines having a normal operating speed of approximately 1200 to 1400 RPM. Several manufacturers are now advertising 75 HP at 2800 RPM, 100 HP at 3000 RPM, 60 HP at 4000 RPM, etc. Short strokes, light reciprocating parts, light weight and popular demands for "power under the hood" are factors in the development of modern high speed engines.



Curve No. 1.

A dynamometer to take care of the needs of an up to date engine testing laboratory must fulfill the following essential requirements:

(*a*) It must be simple and positive in operation and as nearly "fool proof" as possible.

(*b*) It must be capable of absorbing the load developed by the engine over the entire range of speed, with the throttle wide open or partially closed.

(*c*) It must operate quietly and without appreciable vibration.

(*d*) It must be accurate within one per cent and sensitive enough to measure small changes in load and speed under all conditions of test.

(*e*) It must be a dependable piece of apparatus that needs little attention. The automobile engineer is testing engines, not electrical equipment.

Machines have been built to fully meet these requirements, and Fig. 1 shows in general the usual arrangement.

The yoke or frame *A* of the machine is made of cast steel and is turned inside and out, in order to insure mechanical and magnetic balance. The distribution of pole pieces, windings, bolts, etc., is made with a view of maintaining mechanical balance.

The yoke is supported between two cast iron end covers *B*. These end covers form housings for the bearings *C* in which the armature rotates.

The main pole pieces *D* are of the laminated type and are held in place by tap bolts. The interpole pieces *E* are of mild steel or wrought iron and are supported in a similar manner.

The brush rigging *F* is supported from the motor frame giving a more rigid construction than support from the end bracket and also permitting the removal of the armature without disturbing the brush position. The brush holders *G* are supported on a grooved spindle and can be revolved out of the line of the shrink rings when the armature is to be taken out. The field coils *H* are form wound and are made moisture proof by the vacuum impregnation process. The armature is built in accord with turbine design on account of high speeds. The shaft *I* is made of a special grade of nickel steel and is designed so that the critical speed is approximately 50 % above the highest speed

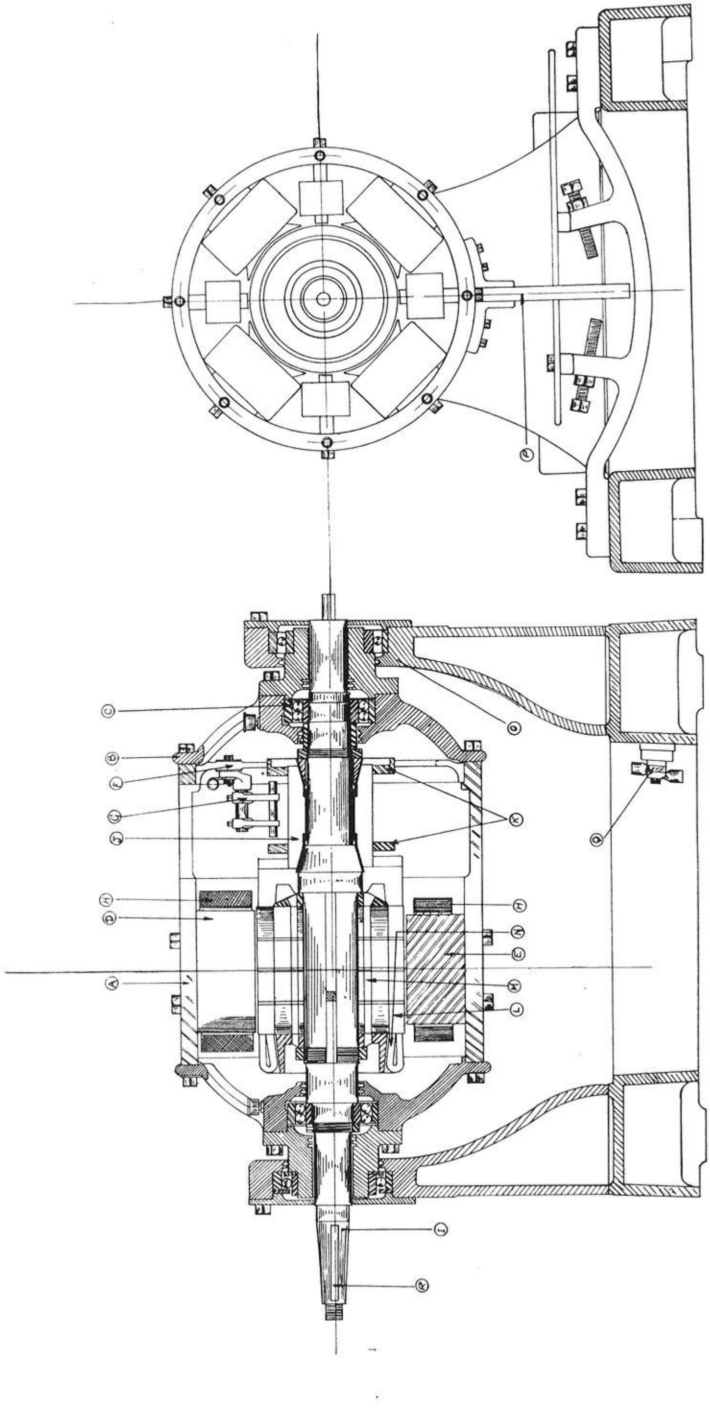


Fig. 1.—A Typical Dynamometer.

the machine will reach in service. The commutator *J* is built directly on the shaft and is made up of hard drawn copper bars insulated by amber mica segments. The mica is undercut between bars. It is held together by heavy nickel steel rings *K* carefully shrunk into place. These rings have grooves turned in them, into which weights can be screwed for balancing the armature. Further provision for balancing is provided on the back armature end flange. The armature discs *L* are assembled directly on the shaft and are keyed in place. Axial vent holes *M* and ventilating discs *N* provide air paths for cooling the armature. Form wound armature coils are held in place by maple wedges and core bands. Heavy end bands prevent the coils from "flaring" out at high speeds.

The end covers are extended into pedestals *O* and ball bearings support the entire weight of the above briefly described machine. Careful balancing of the entire machine, and the selection of proper bearings are essential for sensitive operation. A well balanced machine, weighing approximately 3,000 pounds can easily be turned with very little effort.

A stop bracket and arm *P* are provided to insure against accidental breaking of scale parts.

Leads from armature and field circuits should be brought out and supported in such a manner as to minimize retardation of the rotative action of the frame.

One method is to loop the leads into a pit about three feet deep, and to mount the terminal block *Q* on the base as shown in Fig. 1. A second method is to mount the terminal block on top of the machine and bring the leads down from the ceiling.

A tapered shaft extension *R* is provided for reception of half coupling. It is tapered to make easy the task of withdrawing the half coupling. The short extension with small diameter, on the commutator end, is for the gear which drives the magneto of the electric tachometer.

Fig. 2 is a photograph of a recent equipment. A dynamometer of this type may be considered an electrical Prony brake. For measuring the torque, a beam scale and a spring balance are provided. A link and lever motion as shown in the figure give a correct reading of the scale with either direction of rotation. The beam is supported on knife edges and the pull in each case is against a knife edge. The horse power formula for the dynamometer is $\frac{2\pi NPL}{33000}$. N equals revolutions per minute, P equals weight in pounds as indicated on the scales, and L,

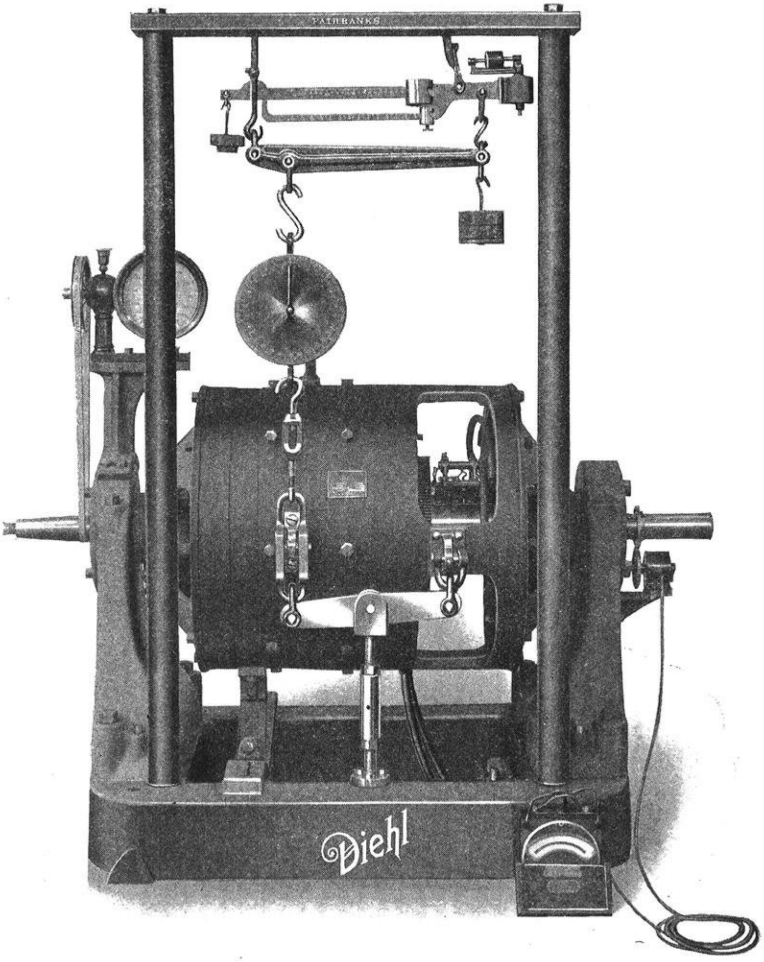


Fig. 2.—Modern Cradle Dynamometer.

the lever arm, is the distance from the center line of the shaft to the point of scale support. Two tachometers are usually furnished, one of the electrical type and one of the mechanical type. The flexibility of the former with an indicator which can be easily mounted on a switch board, makes it the more desirable.

A direct current machine is used for the following reasons: *First*—adjustable speed and the large range of speed required made the control of alternating current very difficult. *Second*—it is often desirable to crank an engine, which requires a large starting torque. *Third*—in order to properly measure engine losses, the dynamometer must run as a motor at different speeds.

The control of the dynamometer for quick manipulation of load is as follows: a multiple switch starter has banks of iron grid armature resistance connected between steps, which is used not only for starting purposes and for running as a motor at low speeds, but is also used as electric load for absorbing current generated in the armature under various conditions. A double pole double throw switch throws this resistance from the direct current supply line, across the dynamometer armature circuit. Adjustment of load can be made by cutting in and out banks of resistance. Finer adjustment is obtained by field control. The combination of the two affords ample range and

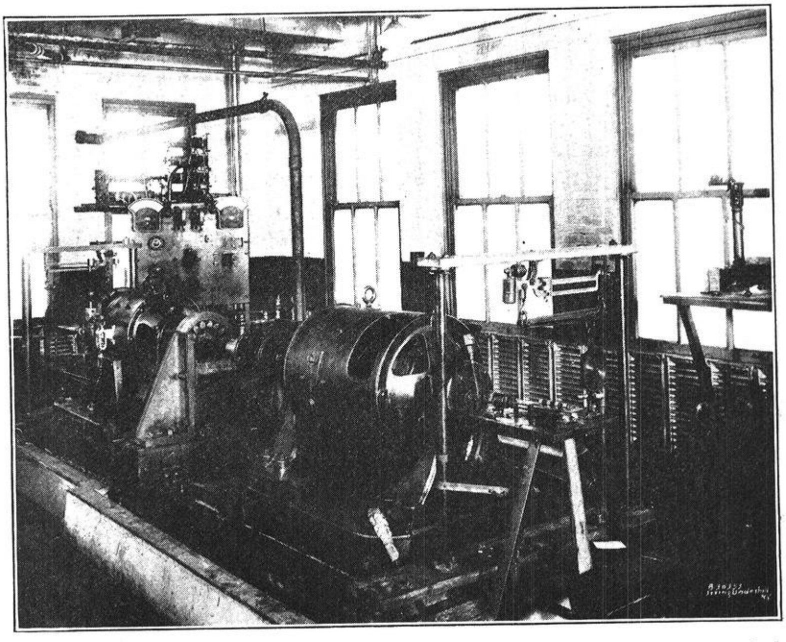


Fig. 3.—60 H. P., 230 Volt, 500-2000 R. P. M. Diehl Dynamometer, coupled to 100 H. P., 230 Volt, 800-3000 R. P. M. Diehl Dynamometer.

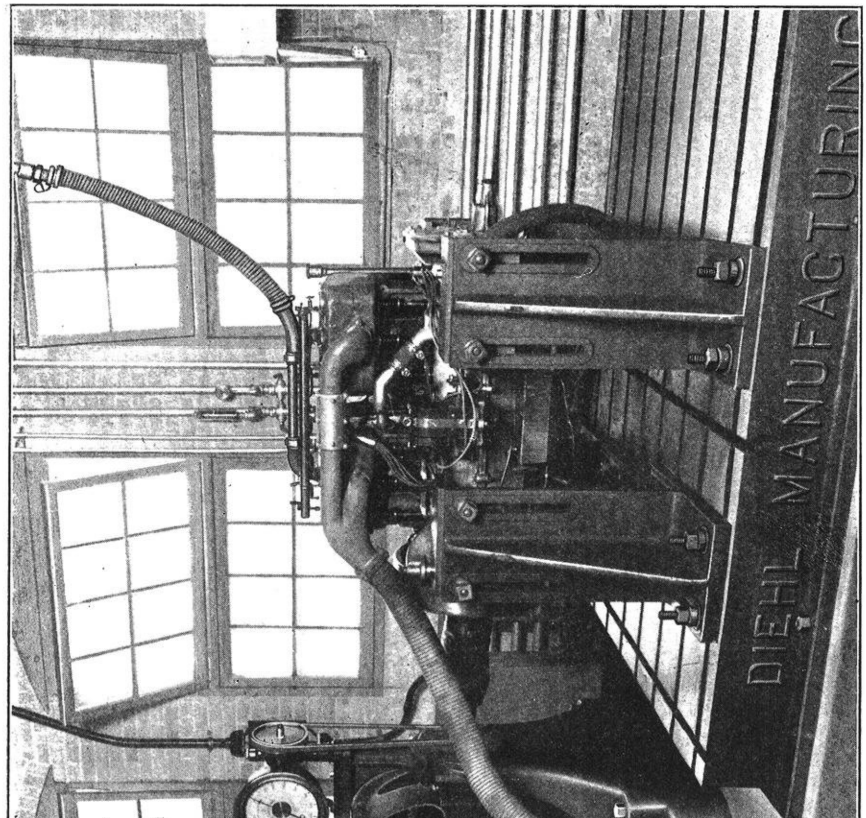


Fig. 4.—60 H. P., 230 Volt, 500-2000 R. P. M. Diehl Dynamometer. Wheeler & Schebler.

small enough increments for practical purposes. The usual tests run on engine equipments consist of endurance runs, speed-horsepower curves, measurement of friction losses, cranking torque, etc.

Fig. 3 shows a view of two dynamometers at the Automobile Club of America, New York. The apparatus under test is a speed reducing gear. One machine is being used as a motor and the other as a generator and the efficiency of transmission at various loads and speeds is being determined.

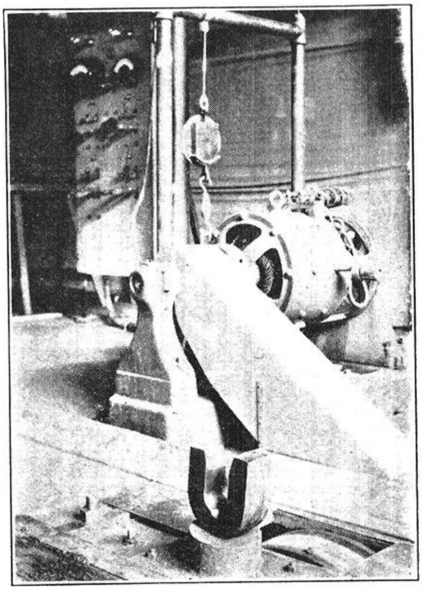


Fig. 5.—Chassis Testing Dynamometer, Maxwell Motor Car Co.

Figs. 4 and 6 show other representative engine testing installations.

Another branch of the automobile industry is finding use for dynamometers. State laws are being enacted and are in force in several states which make road testing of chassis or finished car very expensive or impossible. A finished car or chassis can be tested with apparatus shown in Fig. 5. The car is held in position by "U" jacks which are operated by a hand lever. The rear wheels rest on a pair of cast iron drums. These drums are

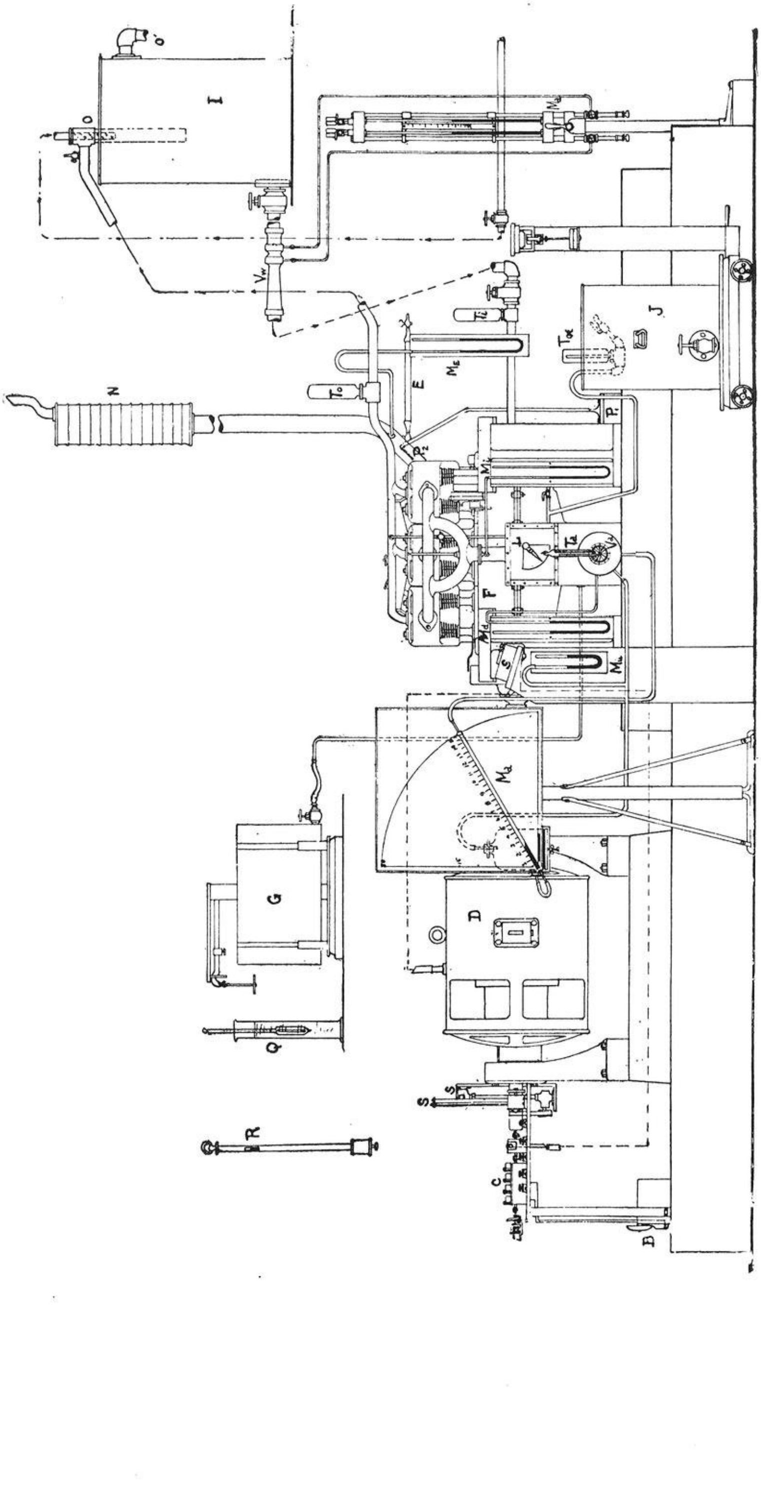


Fig. 6.—Typical Engine Testing Laboratory Layout.

supported on a shaft which turns in ball bearings. This shaft is connected by means of a silent chain drive to the dynamometer, which is controlled as outlined above.

A finished car is tested and made "right." This car is run on the rolls and the apparatus is calibrated. Each car must show a certain torque, registered on the scales in low, medium, and high gear. It is possible to stall a car weighing 3,000 pounds without tire slippage and with plain cast iron pulleys for drums. This equipment can take care of approximately forty cars per day and has the following advantages:

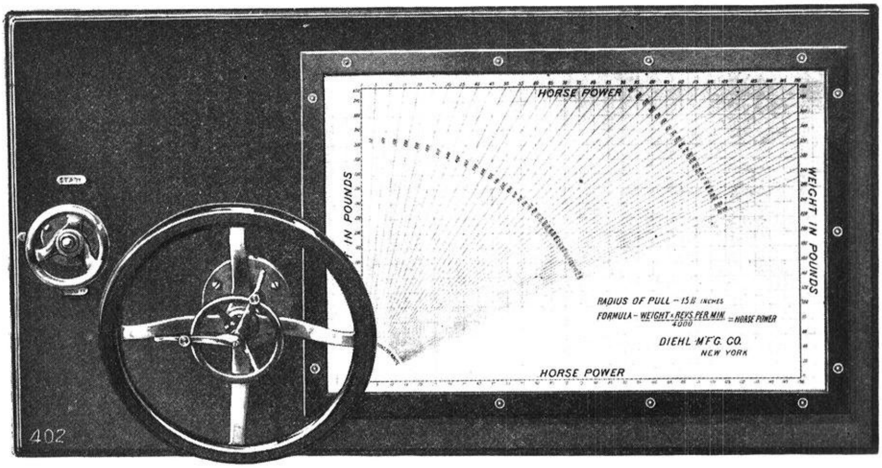
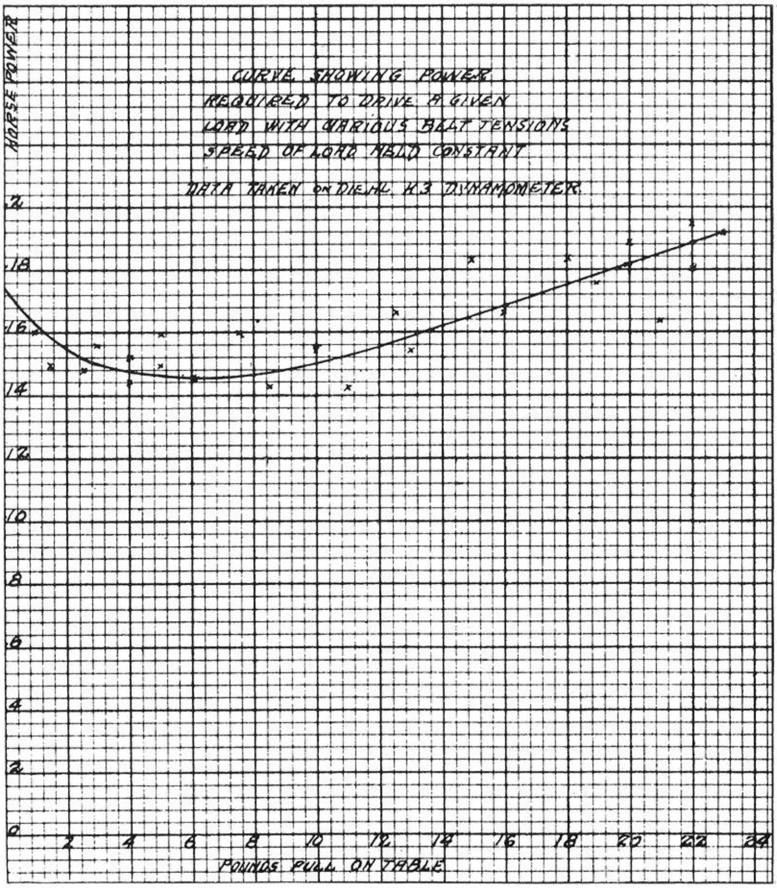


Fig. 7.—Horse Power Chart for Use With Dynamometer.

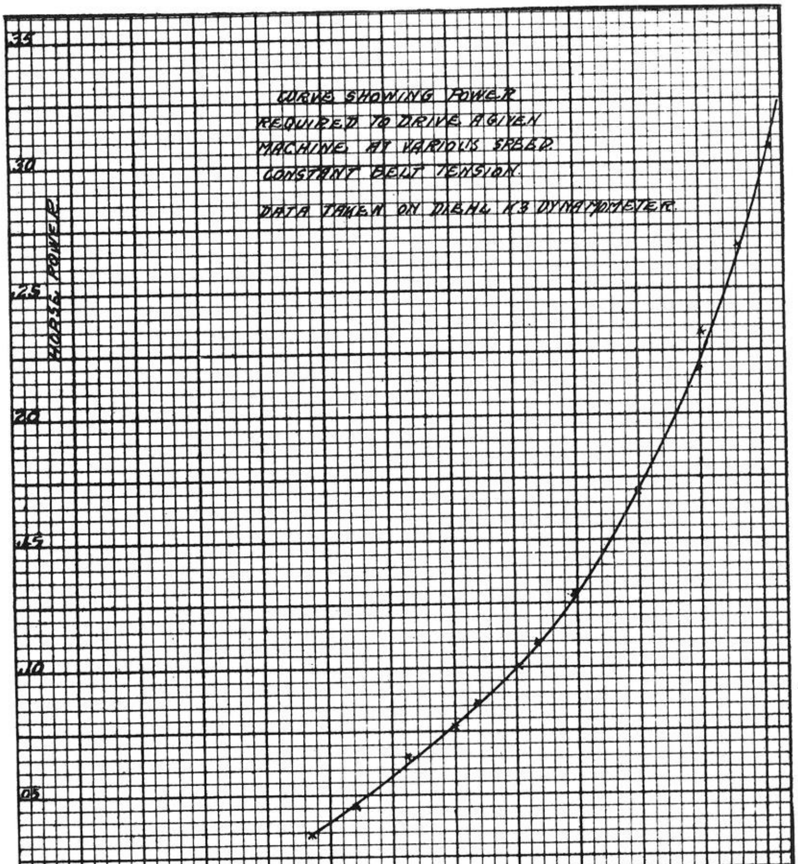
1. Finished cars can be tested in all kinds of weather.
2. Cars need not be washed after test.
3. Test tires are not necessary.
4. Carburetor and other adjustments can be made with the engine running *under load.*
5. An accurate record of car performance is obtained.
6. Reduced time and cost of testing.

A third branch of the automobile industry that uses a dynamometer is the starting, lighting, and ignition system. A starting motor is series wound and various in speed from stalled condition to 4000 or 5000 RPM. Lighting generators and magnetos operate over the same range. A dynamometer run either as a motor or a generator and small enough in size to be sensitive to small loads is a valuable piece of apparatus for development or tests of this apparatus or for finding how much additional load is imposed on the engine by these accessories.



Curve No. 2.

The fact that a dynamometer can be run as a motor to determine quickly and accurately power required for driving various kinds of rotating apparatus opened a new field for this equipment. If an ordinary motor is used, you must know its efficiency at every load and at every speed. Evidently it is almost impossible to get accurate results. No electrical readings are necessary for horse power measurements when using a dynamometer, scale and speed readings are all that are needed. A chart can be plotted similar to Fig. 7 which will give instantly



Curve No. 3.

horsepower developed. Applications of so-called "motor-dynamometers" have been made at pump works, blower and fan works, chain and belt testing plants, motor cycle engine and manufacturing establishments.

A very interesting installation consists of a ¼ HP dynamometer having a speed range of 500 to 4000 RPM. The product to be tested is a small machine and the power required varies with the speed. It is necessary, on account of manufacturing conditions to operate the dynamometer as a belted machine. The manufacturers of this machine were unable to check results accurately until they mounted the dynamometer on a table. The table was mounted on ball bearing wheels which ran on a knife edge track. By proper arrangement of apparatus a definite belt tension was arranged after which the tests agreed remarkably well. Curve 2 shows a calibration test on a belt. The driven load was kept at a constant value and speed and the belt tension varied. Curve 3 shows the variation in horsepower at different speeds. This curve shows the accuracy and sensitiveness of the dynamometer with small loads. The armature or rotating part of this dynamometer weighs approximately 40 pounds and the yoke, end covers, etc., weigh approximately 150 pounds.

Manufacturers are just beginning to appreciate the ease of operation, accuracy, reliability, and general usefulness of dynamometers and sales are increasing daily.

RECENT DEVELOPMENTS IN INCANDESCENT LAMPS

M. D. COOPER, e '08, E.E. '10

In the field of incandescent electric lighting, the greatest improvement of recent years has been the use of lamps embodying a coiled filament operating in an atmosphere of some inert gas. The first requirement in the development of the early incandescent lamp was some means of protection of the filament from oxidation in order that this filament might be operated at a sufficiently high temperature to give an economical production of light. Even in the early days efforts were made to obtain higher temperature by means of protection with an inert gas which would not unite with the filament material when hot. This method did not prove to be satisfactory since the gas carried away a large portion of the heat of the filament, thus requiring an excessive amount of current to maintain the temperature, and also, as was the case with a carbon filament and nitrogen gas, the gas did unite with the filament material. The other alternative was to enclose the filament in a bulb from which all of the air and other gases had been extracted. The use of a vacuum had the disadvantage that the removal of all pressure from the surface of the filament greatly increased the rate of vaporization at any given temperature; and particularly with a carbon filament, this rate of vaporization was the limiting criterion of the temperature obtainable rather than the melting point of the filament material. When the filament material evaporated it was of course deposited upon the bulb, forming a black coating which rendered the lamp unsightly and greatly decreased the transmission of light by the bulb. For these reasons it was impossible to use higher filament temperature as a means of getting improved efficiency with the early carbon lamps.

The progress in methods for making efficient incandescent lamps was confined very largely to the search for more refractory filament materials which could be operated at higher temperatures in vacuum. These efforts brought out in succession the metalized-carbon, the tantalum, the pressed-tungsten, and later the drawn-wire tungsten filament. In a vacuum, the tungsten filament can be operated with a commercial economy at a temperature of 2,100° Centigrade as against 1,800° Centigrade for a carbon filament. This advance of only 300° in operating temperature resulted in a gain in efficiency of light production of about three to one.

Soon after the advent of drawn tungsten wire as a filament material came the possibility of restricting the filament into a relatively small space, primarily for the purpose of obtaining a better control of the light distribution or utilization. Lamps with coiled filaments found first application in small decorative Mazda lamps for 110 volt service, in long tubular Mazda lamps for show-case use, and in Mazda lamps for stereopticon service.

Shortly after this it was discovered that inert gases could be used in connection with these coiled filaments. The draw-back which had previously been found to be the principal objection to the use of inert gases in incandescent lamps had been the amount of energy which was conducted away from the filament by conduction and convection in the gas. These losses were found to be nearly independent of the diameter of the filament, although proportional, of course, to its length.* With a filament wound into a close helix it was found that the conduction and convection losses were of the same order of magnitude as the losses which would be met with a filament of the outside diameter of the helix. The equivalent length having been thus greatly reduced, the energy loss by conduction and convection was also greatly reduced. The pressure of the gas upon the filament surface acts to reduce the rate of evaporization of the filament material, hence with the coiled-filament-and-inert-gas method of construction it has been found possible to operate the filament at a considerably higher temperature than in the case of the vacuum lamp. In the high wattages of lamps the loss through the gas is found to be relatively quite small, due to the compact arrangement of the filament in the center of the bulb, and the gain in commercially practicable efficiency is about 100 per cent.

Like every other improvement, the use of the gas-filled construction in lamp-making is not without its disadvantages. A gas pressure of a magnitude of about one atmosphere at the operating temperature makes it possible to operate the filament up to 2,400° Centigrade instead of 2,100° Centigrade; yet the fact

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*Langmuir, A. T. E. E. 1913, p 1911.

that some of the heat energy is lost in conduction and convection in the gas, necessitates a greater wattage input than would be necessary in a vacuum lamp to maintain the same filament at the same temperature.

For any given size of lamp, the question of superiority as between the gas-filled and vacuum types of construction is therefore a question of the relative magnitude of the gain due to higher temperature of operation with the gas-filled construction and the lesser power input with the vacuum construction. For a given length of filament the conduction and convection losses would be decreased as the diameter of the helical coil is increased. On the other hand, maintenance of conformation imposes a mechanical limit to increase in the diameter of the helix. The larger and stiffer the wire, the greater will be the possible helix diameter. It therefore follows that the larger and heavier the filament the greater will be the possible gain in operating efficiency of the gas-filled type of construction over the vaccum type of construction.

For a large lamp, say one of 1,000 watts rating, the heat loss through the gas is relatively a small proportion of the total wattage, and the efficiency is about twice as high as it would be with a vacuum lamp of a corresponding wattage. The heat loss through the gas is somewhere of the same order of magnitude in actual watts regardless of the size of the lamps; hence as we consider smaller and smaller lamps we finally reach a point where the heat loss through the gas more than offsets the increased amount of light obtained by operation at the higher temperature made possible because of the pressure of the gas, and beyond this point the gas-filled construction no longer has an advantage in efficiency over the vacuum lamp. Up to the time of writing this article, the Mazda C lamps are not made commercially in wattages less than 100.

The advantages of the Mazda C lamps lie not only in the question of efficiency but also in the question of improved color quality. Although the efficiency of various sizes of Mazda C lamps may be different, this is because of a relatively different proportion of heat loss in the gas rather than by reason of a different filament temperature. As before stated, the filaments in the Mazda C lamps are all operated at about 2,400° Centigrade.

The advantage of the Mazda C lamps over the vacuum lamp in color quality is therefore as great in the case of the 100 watt lamp as in the case of a 1,000 watt lamp.

Since any increase in the operating temperature of an incandescent substance (within the range of temperatures considered in this article) results in a relatively greater increase in the amount of light of short wave lengths than in the amount of light of long wave lengths, and since as compared with daylight, incandescent lamps in general are deficient in light of short wave lengths, and give a superfluous amount in long wave lengths, the increased temperature of operation in a Mazda C lamp makes this lamp a very much closer approach to daylight. This, in itself is a very distinct commercial advantage, but also it is an advantage in this way—that the more even distribution of light through the visable spectrum makes it more easily possible to get an exact or approximate duplication of daylight or any other color desired. By the use of color screens it is possible with a Mazda C lamp to reproduce north skylight for color-matching purposes with an efficiency of 3.5 watts-per-candle, and noon sunlight with an efficiency of 1.2 watts-per-candle. It is interesting to note that these efficiencies are equal respectively to those of the earlier carbon and tungsten lamps. The relatively greater proportion of light of short wave length in the spectrum of the Mazda C lamps gives this light a particularly high photographic actinicity, and has brought about a widespread commercial use of Mazda C lamps by photographers as an inexpensive and efficient illuminant for portrait and commercial studios, and also their use on a very great scale in the lighting of motion picture studios.

Not the least advantage of the new type of construction is the compactness of the filament which makes readily possible the more efficient design of reflecting equipment to produce any desired distribution of light, particularly in the field of projection. More efficient lamps for stereopticon use and the illumination of prominent buildings by projected light have become available because of this particular advantage of the Mazda C lamp. The first commercial example of this method of lighting building exteriors, or flood lighting, as it is called, was the famous Woolworth Tower in New York City. The advertising value of such form of lighting is so easily recognized that this example has been followed in many cities throughout the country and it is now a matter of common experience when riding through a city at night to note many buildings which are thus illuminated from projectors containing Mazda C lamps.

The Mazda C lamps, with their high efficiency and the pleasing white color of their light, have wrought revolutionary changes in outdoor lighting both for spectacular and utilitarian purposes. The high wattage multiple lamps for theater fronts, amusement resorts, large outdoor areas, etc., and the series lamps for street lighting now being adopted on every hand are evidences of the importance of this development that has made Mazda the universal illuminant. The Mazda lamp will now meet all requirements, for aside from its general advantage of simplicity and adaptability, it has an efficiency which makes the cost of light by its use comparable with that of any other commercial illuminant.

THE FOUNDATIONS OF THE UNION NATIONAL BANK BUILDING, CLEVELAND, OHIO

R. B. Buettell, e '13

The design of foundations in any large or important structure is often the most important and difficult problem which the engineer is called upon to solve. Particularly is this true in the case of the foundations of tall buildings in the crowded downtown sections of large cities, where restricted areas and the foundations of neighboring buildings make it impossible to extend the exterior footings beyond the building lines, and necessitate some other method of bringing the exterior column loads within the building area. The magnitude of these loads, their spacing, the bearing value of the soil, and the effect of wind moments are some of the more important considerations which determine the specific method to be employed.

An interesting example of problems of this kind is found in the case of the Union National Bank Building, now nearing completion in Cleveland, Ohio. This building, with seventeen stories and two basements, is 45 ft. 4 in. wide on the Euclid Avenue front and 135 ft. 0 in. long on the East Third Street side. Above the third floor an exterior court 9 ft. 0 in. by 79 ft. 0 in. occupies the south half of the East Third Street side.

The upper floors are designed for business offices. The entire first floor is given over to the main banking room, which, for architectural and practical considerations, was designed with a clear ceiling height of 40 ft. 0 in., and without interior columns. The interior columns above the banking room were therefore seated on heavy trusses in the banking room ceiling, and practically the entire weight of the building above this room was carried down to the foundations through the exterior columns, the center lines of which were about 1 ft. 9 in. from the building lines. The loads carried by these columns were greater on the east side of the building than on the west side, due partly to the exterior court on the west side, partly to the fact that the east wall, being on an interior lot line, had to be built a blank wall, and partly to the fact that the large pent-house on the roof was on the east side.

The chief considerations in the design of the foundations, aside from the distribution of the loads to be carried, were: first, the character of the soil; secondly, the desirability of carrying the foundations deep enough to insure safety in case deep foundations were ever installed for an adjoining building on the east; and thirdly, the similar desirability of providing for safety in case subway excavations were ever made under Euclid Avenue in the front. Preliminary borings on the site revealed the typical trata of quicksand and hardpan which underlie the downtown section of Cleveland. It should be borne in mind, however, that the terms "quicksand" and "hardpan," as used in Cleveland, imply different materials from those ordinarily understood by these terms. The quicksand which underlies Cleveland is a coarser sand than the true quicksand, not so thoroughly saturated with water, and much less treacherous and unmanageable. Hardpan, usually considered a very compact gravel, is in this case a very stiff blue clay, somewhat moist. For about 20 ft. below grade the borings showed alternate layers of sand and gravel. At 23 ft. 0 in. below grade, or about the top of piles in the upper basement level, ground water was encountered. Below this point, for a distance of about 20 ft., extended several strata composed very largely of "quicksand," followed by so-called "hardpan."

Immediately adjoining the building site on the east is the Stone building, a wall-bearing structure of three stories and a basement. Across the alley in the rear stands a four-story building; and across East Third Street, which is very narrow, is a new six-story building.

A reinforced concrete mat over the entire building area was first considered, as the weight of the building and the allowable direct bearing demanded that the entire area be utilized. The non-uniformity of the column spacing in a north-and-south direction, however, as shown on the plan, rendered the problem of adequate reinforcement an indeterminate one; and further complications were introduced by the fact that the column loads on the east side of the building are much greater than those on the west side. For these reasons it would also have been impossible to distribute the loads uniformly over the building site, since the center of gravity of the loads would not have coincided with the center of gravity of the mat. This scheme was therefore abandoned as unsatisfactory.

Further investigations indicated that concrete piles offered the most satisfactory solution of the problem from all points of view. To carry the loads groups of piles, of course, had to be used as shown. The center of gravity of each group of piles, however, could not be brought closer than a certain distance to the point of application of the column load, this distance being detemined by the minimum spacing allowable for the driving of the piles. The proper solution of the problem lay therefore in spanning the distance between opposite columns by concrete or steel girders bearing on the pile caps, and carrying the columns at their ends.

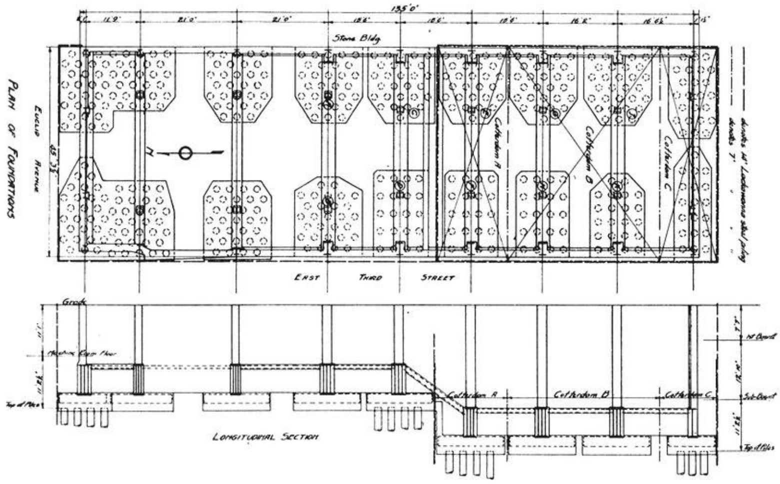
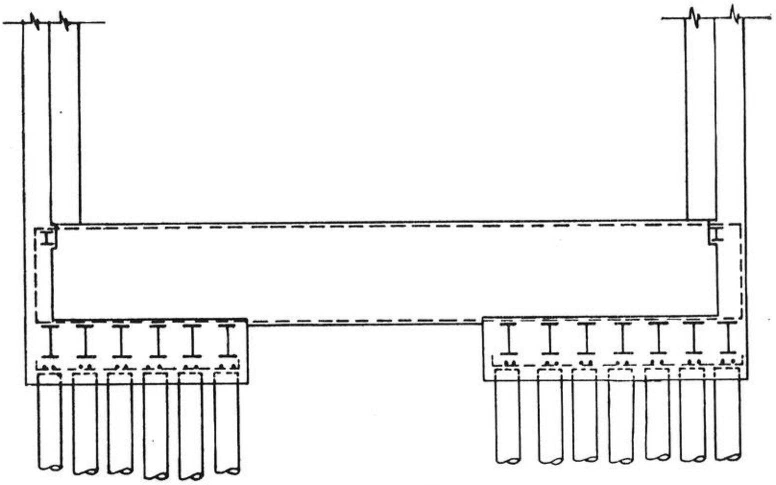


Figure 1.

The chief reason for choosing steel girders over concrete girders was not because of the difficulty of designing a reinforced concrete girder of sufficient strength, but because adequate connections between the steel columns and the concrete could not have been made. Every building in a district of heavy traffic is constantly vibrating more or less; and every tall building vibrates perceptibly in a strong wind. In this structure, the effect of the wind is comparatively negligible in a north-and-south direction, due to the length of the building. In the opposite direction, however, the building is very narrow for its height, and the effect of the wind blowing from the east or from the west would be to set up very slight vibrations or movements at the point of anchorage of the steel to the concrete. The cumulative effect of these vibrations would, it was thought, weaken any bolted connection to a point where it would become dangerous, and would affect similarly any other kind of connection, by destroying in time the bond between the concrete and the steel.



TRANSVERSE SECTION

Figure 2.

Steel girders were therefore chosen, and the effect of wind vibrations was overcome by riveting a heavy plate to the outside of the lower end of the column, this plate extending down the entire depth of the girder at its end. The rivets through this plate, acing in single shear, were more than sufficient to counteract the effect of any vibrations. The girders, as shown by the sections, were secured to I-beam grillages in the pile caps. Each was designed for the maximum bending moment given by the loads at its ends and the reactions at the centers of gravity of the pile groups. The plan of the foundations shows the general arrangement of pile caps and girders. The interior columns designated by letters do not extend above the banking room floor, and therefore do not carry very heavy loads.

The installation of the foundation work is worthy of note because of the precautions taken to insure safety to the surrounding buildings during the progress of the operations. As the excavation, especially in what was called the deep section at the south end, had to be carried to a much lower level than the foundations of these buildings, it was necessary to effectually prevent the possibility of movements of the earth from beneath these foundations, and thus avoid dangerous settlements. It is a well-known fact, of course, that even water-bearing sand will furnish good bearing if kept confined. Even if the water in the sand is free to escape, there is little or no danger as long as it is not free to carry any of the sand with it. If, however, it is free to carry some of the sand with it, then the condition becomes dangerous.

After the old building on the site had been wrecked, 14 in. Lackawanna steel sheet piling was driven to the necessary depths on three sides of the site, as shown on the plan, and the excavation was carried to the level of the bottoms of the concrete pile caps in the upper section. This sheet piling was braced across the entire width of the lot by heavy timbers held by jacks against horizontal waling-pieces on the East Third Street side of the building, and butting directly against vertical waling-pieces on the wall of the Stone Building. The object of providing vertical rather than horizontal waling-pieces against the Stone Building wall was to facilitate the moving of each heavy timber independently, in order that the pile-driver (which was mounted on top of the bracing) could operate with sufficient clearance between the timbers. When the heavy piling had been driven, a line of 7 in. Lackawanna piling was driven across the site between the deep section and the upper section, and excavation was started in the deep section. At the same time a trench was dug along the wall of the Stone Building, and this wall was carefully underpinned and carried down to the required levels below the new work. After the underpinning was completed. 7 in. piling was driven along that part of the Stone wall adjoining the deep section.

As excavation proceeded in the deep section, 7 in. piling was driven to form three cofferdams, as shown on the plan and the longitudinal section. The reasons for installing these cofferdams were: first, to provide additional protection against the possible failure of the heavy steam and water mains in East Third Street, which might have been caused by the continual jarring of the earth during the driving of the piles; secondly, to localize any possible trouble due to the failure of the heavy piling; and thirdly, to obtain better prevention of the seepage of water and sand into the excavation, as the lighter piling was considered much more water-tight than the heavy piling, having been driven under more favorable circumstances.

In cofferdam B a sump-pit was sunk by driving 7 in. piling in a circle of the smallest possible radius, and the pit was provided with a centrifugal pump. The purpose of this pit was to lower as much as possible the level of the ground-water, and thereby facilitate the excavation. The bottom of the piling was kept one foot above the top of the "hard-pan," in order that the water might enter the pit at the lowest possible point, and not seep in through the piling.

The work in the deep section was carried on, therefore, in three units; and when the concrete piles had been driven and the pile caps placed, the light steel piling was pulled and the concrete basement walls run up to grade. The scheme of cofferdams was found to be entirely satisfactory; almost no water entered the excavation through the piling, and what little did find its way in brought no sand with it. Raymond concrete piles were used, each pile being reinforced by six 5/8 in. rds.

The architects for the new building are Walker and Weeks, of Cleveland, to whose engineer, T. J. Bryson, the writer is indebted for the outline of the methods followed in the design. The general contractors are the Crowell-Lundoff-Little Co., of Cleveland.

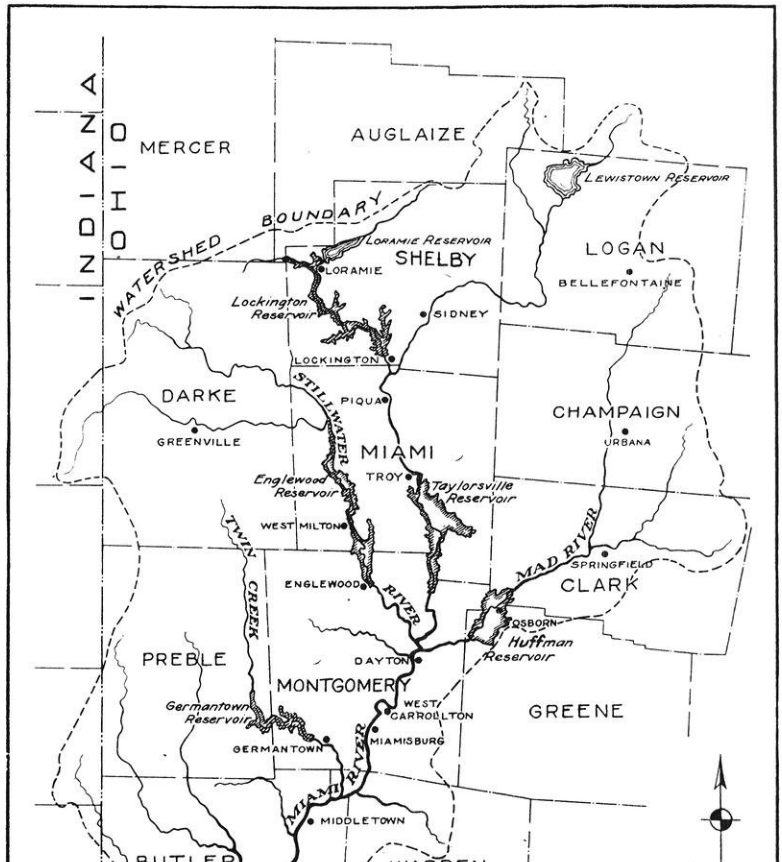
FLOOD PROTECTION PLANS FOR DAYTON

Cuthbert P. Conrad
Fellow in Hydraulic Engineering

One of the most notable engineering projects in this country today is the plan of flood prevention for Dayton, Ohio, and the Great Miami Valley. The successful completion of this pioneer work will show the feasibility of flood protection, and will lead other river communities to seek relief; and although the methods adopted at Dayton might not fit elsewhere, much that has been done there will be of general value. The purpose of this paper is to outline the distinctive features of the plan of protection adopted, and to point out some of the problems encountered. A brief summary of the events leading to the inception of the project will be necessary to an understanding of the plan.

An exceptionally heavy rainfall over the whole watershed of the Miami river lasting from March 23 to 27 caused the flood of 1913. On an already saturated surface fell one to two inches of rain on the 23d, two to five inches on the 24th, four inches on the 25th, two inches on the 26th, and scattering showers on the 27th. The rate of precipitation was not exceptionally great, but the duration of such a rate was unparalled in the records of the weather bureau. The average amount of rain that fell over the whole drainage area in four days is given by the weather bureau as eight and eight-tenths inches, or about one-fifth of the annual average precipitation for that region. The peak of the resulting flood reached Dayton on the afternoon of the 25th. The accompanying map explains why the flood conditions at Dayton were worse than in any other part of the valley. There the Stillwater river from the west and the Mad river from the east flow into the Miami river. By this fan-like arrangement the flood peaks are superimposed.

The levees were overtopped at Dayton and water flowed through the streets long before the crest of the flood came. Throughout the lower valley the river covered its flood plain reaching practically from hill to hill, a distance of two miles in some places. The flood rose so quickly that many people were unable to escape to higher ground. Three hundred and sixty-one are known to have been drowned and many more died from



STATE OF OHIO
THE MIAMI CONSERVANCY DISTRICT
MAP OF
MIAMI RIVER DRAINAGE AREA
SHOWING
PROPOSED DETENTION BASINS

August 28, 1915.

exposure and hardships. The property loss has been estimated at over a hundred million dollars, the loss in Dayton alone being placed at $47,254,000. Frame buildings were carried away by the force of the current, twelve feet deep in some of the streets, and the interior of all the houses submerged was damaged by the muddy water. Railroad losses were heavy through the washing out of embankments and the destruction of bridges, seven being partially or totally destroyed. Highways were washed out and thirty country bridges were damaged or destroyed. Valuable farm lands in the lower valley were ruined by the erosion of the top-soil or the deposition of banks of gravel.

Before the flood waters had subsided the residents of the valley began to think of protecting themselves from future inundations. The governor appointed The Citizens' Relief Committee which immediately set about to devise means of preventing a recurrence of the disaster. A subscription of two million dollars was raised in the valley to defray the cost of investigating the problem of flood prevention.

Mr. Arthur E. Morgan, president of the Morgan Engineering Co. of Memphis, Tenn., was called in by the committee to determine whether the valley could be protected from floods, and if so, how. He put men in the field to make topographic surveys of the valley, and a study of the channel conditions, especially the encroachments of bridges and buildings in the cities. He made a study of rainfall and runoff of the flood and of general rainfall conditions of the region. To direct the study of the problem Messrs. Mead, Alvord and Woodward were called in as consulting engineers. Two general plans of protection were considered: First, creating a floodway down the valley of sufficient capacity to carry the maximum discharge; second, constructing detention reservoirs in the upper part of the valley to hold back the crest of the flood waters. The first plan, similar to that used on the lower Mississippi river, would have necessitated the construction of levees of great height all along the stream and up its tributaries to high ground. The cost of this plan was prohibitive, as all existing bridges would have had to be replaced with new ones of far greater length at the high levee grade, a wide strip along the river of the most densely built up part of the cities would have been taken for levees and increased channel width, the grades of approach for the railroads crossing the river would have been excessive, and some form of pumping would have had to be provided to keep the drainage of the land adjacent to the river from accumulating behind the levees. When it is remembered that the flood of March, 1913, reached from hill to hill along the valley, some idea of the size of a leveed channel of sufficient capacity to carry this flow can be formed. It would have been impossible to secure the required floodway by deepening and straightening the river, because the present level of the river bottom is that resulting from an equilibrium between the velocity of flow of the stream and the amount of material carried by it. If a stream is deepened its velocity will be less and it will not be able to carry away the sediment brought to it by its tributaries. This sediment will form as bars until the bed of the stream is built up to "grade," as the geologists call the level corresponding to the condition of equilibrium.

The second method, that of detention basins, seemed particularly well suited to the watershed of the Miami. There is no precedent for it in this country, but the principles upon which it is based have been tested in European works. Instead of a channel sufficient to carry the peak of the flood, reservoirs near the headwaters are provided to hold back the flood flow, allowing it to pass down the stream gradually at a rate which the normal channel can carry, giving a moderately high water flow for several weeks, instead of a flood for a few days. Several topographic features of the valley combine to make reservoirs of sufficient capacity for the purpose feasible at moderate cost. Narrow places in the valleys where the hills rise abruptly almost from the river bank are found on the streams. At some points a dam a mile long and less than a hundred feet high would complete a natural reservoir of three to twelve thousand acres water surface and four to fifteen billion cubic feet capacity, equal to from four to twelve inches of runoff from the tributary watershed. A feature more important even than the favorable dam sites is the flat slope of the upper reaches of the streams in this valley. Indeed a rare condition is found here in the fact that the fall per mile is less in the upper than in the lower reaches of several streams. The fall of the Miami river from Lewistown reservoir to Lockington [see accompanying map] is three feet per mile; from Lockington to Dayton, three and five-tenths feet; from Dayton to Twin Creek, three and three-tenths feet, and through Butler County, four feet per mile. Now the length of the reservoir created by a dam is equal to the height of the dam divided by the slope per mile of the stream above it, and sites were found on the Miami and on its tributaries where dams of moderate length and height would create reservoirs of sufficient capacity to hold the excess of flood waters. If the dams were constructed with open conduits under them of discharge capacity equal to that of the river channel, only when the flow of the stream exceeds its bankfull capacity would any water be stored in the reservoirs. Thus the land behind the dams would be inundated only in times of flood flow, the greater part of it only once in a large period of years. At all other times it would continue to be used for its present purposes, with the important exception that no dwelling houses or barns would be allowed to remain on it. Agriculture would be little interfered with because floods of a size to bring the reservoirs into use generally occur in the early spring. Only twice within the period of the records have considerable floods occurred during the crop growing season.

After careful study this dry reservoir system was recommended as the cheapest, most complete and safest method of protecting the valley.

No law then existed in the state of Ohio under which a flood prevention plan for the whole valley could be carried out. To meet this need the Conservancy Act was passed at a special session of the Ohio legislature in 1914. Under this act Conservancy Districts for the execution of flood prevention, river control, drainage, and irrigation work may be organized by the court upon petition of a majority of the free holders in the district. The Conservancy District is under the supervision of a court composed of one judge from each county having land within its boundaries. This court appoints three directors to prepare plans for the proposed work. These plans are submitted to the court and if they are approved the directors proceed with the execution of the work. The cost of the project is paid by the property owners benefited in proportion as the value of their holdings is enhanced by protection from flood. The benefits are determined by a board of appraisers appointed by the court, who also fix the value of the lands damaged or acquired in executing the plan. If any property owner is dissatisfied with the findings of the appraisers he may have a jury trial of the case. The benefit assessment may be paid forthwith, or bonds may be issued against it by the directors. No general tax is levied, except that counties and towns owning structures, such as court houses or bridges or highways, that will be protected from flood damage by the work are required to pay their share of its cost, and to meet this payment may levy a general tax on the property within their jurisdiction. Except for this county or city tax the people within the district whose property is not benefited pay no part of the cost of the project.

In carrying out their work the board of directors may employ any agents necessary, and may co-operate with the Federal government or any other agencies. They may acquire property by condemnation, and in this respect have a dominant right over all owners, except the state itself.

The law met with much opposition from the counties in which reservoirs were to be located, the people there feeling that their property was being damaged to protect the cities, which could, if they would, take care of floods by channel improvement. Its constitutionality was tested and affirmed by the courts, and it successfully withstood attempts made by the anti-reservoir committee to have it amended by the 1915 legislature in a way that would have killed it. The Miami Conservancy District finally came into existence under the law on August 1, 1915. It took over the data, plans, and surveys of the Flood Prevention Committee, retained the engineering staff organized by the Morgan Engineering Company, and continued the preparation of the plan, which, as the official plan, will be submitted to the court before this paper goes to press.

The official plan has been developed along the line of a system of detention basins, each performing its part in a general scheme. They are five in number; one on the Miami river, and one on each of the principal upper tributaries. The channel capacity that could economically be provided at controlling points on the river was determined by stream gagings and estimates from Chezy's and Kutter's formulae, using carefully selected values of Kutter's n. A rainfall of fourteen inches over the drainage area in seventy-two hours was assumed as the condition that would produce the maximum probable runoff, or a flood about fifty per cent greater than that of 1913. To protect the valley the capacity of the reservoirs had to be equal to the accumulated difference between such a flood flow and the channel capacity.

The Taylorsville reservoir on the Miami river has a larger catchment area than any other in the system, about eleven hundred and twenty square miles, and will submerge a large amount of land, something over twelve thousand acres. The storage capacity in this case was limited by the height to which the dam could be built without submerging the city of Troy on the river above. The dam will be fifty-five feet high to the spillway crest, with fifteen feet of freeboard, making a total height of seventy feet above the river bottom. The length at the crest will be about 3,100 feet. The dam will be built of earth with a crest width of twenty feet and side slopes varying from three to one at the bottom to one and a half to one at the tops, with berms ten feet wide every twenty feet. Arched concrete conduits will be provided through the dam in the present river channel to carry the normal flow of the stream. The size of these conduits will be such that should the fourteen inch rainfall in seventy-two hours occur the water in the reservoir will rise just to the crest of the spillway. This concrete spillway is provided to safeguard the dam, and prevent its being overtopped should there occur a flood greater than that for which the outlet conduits are designed or should these conduits become blocked. They have no gates or other obstructions in them and are protected from floating debris by log booms.

The other four dams are similar to the one at Taylorsville, the same section, modified to fit the topography, being used. Lockington Dam is about sixty-five feet high and forty-five hundred feet long. Huffman Dam is sixty-five feet high and thirty-four hundred feet long. Germantown Dam is one hundred and one feet high and about sixteen hundred feet long. Englewood Dam, by far the largest of the system, is one hundred and twelve feet high and a mile long. With the discharge from Taylorsville reservoir fixed by the necessity of keeping the water level below the elevation of Troy, the discharge from the other three reservoirs above Dayton [Lockington, Englewood, and Huffman] could not exceed the remainder of the channel capacity at the controlling points. It was also desirable to keep down the size of Huffman reservoir on Mad river to a minimum because it was of uneconomical shape. On account of the flat slope of the land the area submerged is great in proportion to cubic capacity, and the cost per acre is high because the land is all suitable for cultivation. Osborn, a town of eight hundred inhabitants, situated within the proposed reservoir will be bought by the District and razed. This is the only town of any size that will be wiped out for the proposed detention basins. They have all been located so as to disturb as little as possible the existing settlements. To compensate for the large discharge at Taylorsville and Huffman, the Englewood, Lockington, and Germantown reservoirs have small conduits and detain a much greater percentage of the runoff from their catchment areas. Storage is cheaper in these long, narrow reservoirs with steep sides, because the average is greater, and the steeply pitching lands are mostly in woods and pasture.

The total area of the watershed contributing to the flow at Dayton is twenty-five hundred and thirty-two square miles. The combined catchment basins of the four proposed reservoirs above the city total twenty-three hundred and seventy square miles; so that the runoff from ninety-four per cent of the watershed will be controlled by the proposed plan. Of the drainage area above Hamilton, seventy-five per cent will be controlled by the five reservoirs.

The damming of the valleys will interfere seriously with the existing routes of communication, and some of the knottiest problems met by the engineers in planning the project were found in connection with the relocation of railways running through the proposed reservoirs. The law provides that no railway shall be relocated on a grade heavier than the ruling grade already existing on that division. Thus at Huffman the engineers had to get roads of heavy traffic like the Erie and the Big Four over the summit formed by the dam without exceeding the low ruling grades which those lines had obtained at great expense. The general plan was in this case to get the line up as high as the rate of grade permitted in the available distance, cut through the ridge at the dam site somewhat below the elevation of the spillway crest, and protect the tracks within the reservoir by levees until they reached high ground. The tracks of the G. H. and D. presented a similar problem at Taylorsville. A number of electric interurban lines had to be changed, but the steeper grades and sharper curves commonly used on this class of track made the problem simpler. In the Taylorsville Reservoir provision also had to be made for relocating the old Miami and Erie canal above the flow line. The plan provides for carrying the canal on a level grade from Troy to the dam site, and concentrating the natural fall of that distance in a flight of locks at the dam; but the relocation will probably never be made, as this portion of the canal has long been abandoned.

The problem of relocating the highways affected was not so serious. Free communication across the valley with better grades than before was assured by placing a roadway on top of each dam. The case differed from that of the railways because it was permissible to interrupt traffic on some of the highways during the greater floods likely to occur only at rare intervals, whereas provision had to be made for maintaining traffic on the railways at all times. It is planned to detour roads and pole lines to higher ground from elevations likely to be flooded frequently, but since the land within the reservoirs will be used most of the time the existing roads will never be abandoned.

Some improvements will be made to increase the discharge capacity of the present stream channels up to the maximum possible with their present size. A sharp turn in the Miami at its junction with the Mad in Dayton will be rounded off. The banks will be cleaned of snags and other obstructions. The minimum openings for bridges at various points along the stream consistent with the channel capacities to be developed will be prescribed; so that some existing structures will have to be removed or remodeled.

The intelligent planning of the work outlined above was made possible by the accurate topographic maps of the district prepared from stadia surveys. These were divided into sets of standard size sheets, one set for the lands along each of the rivers benefited by the proposed reservoirs, and one set for the lands within each reservoir. A scale of five hundred feet to the inch was used. The contour interval varied from one foot in bottom lands, to ten feet along the bluffs. All buildings were shown, and, from the high water marks, the boundaries of the area inundated in 1913 were drawn in. Sets of property maps, co-extensive sheet for sheet with the topographic maps were drawn from surveys and deed descriptions. On these were shown the boundaries of all parcels of land, the names of owners, and the acreages. The buildings, the 1913 flood line, and in the reservoirs the flow line were traced on from the topographic maps. Where smaller scale topographic maps were desired, those published by the U. S. Geological Survey were used. These maps were available for all except two quadrangles of the district.

For the use of the appraisers a description by metes and bounds of each parcel of land within the flow line of the reservoirs was made from the property maps. By law the district was given the option of buying the land to be flooded in the reservoirs or of securing a flood easement, that is, buying the right to flood the land instead of securing the fee title. Since the cost of this easement would depend on the frequency and duration of flooding, the engineers had to determine these factors for the appraisers. From a careful study of past records the probable frequency of occurrence of floods of various magnitudes was estimated. Typical floods were routed through the reservoirs and with known rate of inflow, reservoir capacity, and conduit discharge capacity the length of time during which the water would remain above any given elevation was determined for floods likely to occur every year, and every five, ten, or fifty years.

The pioneer nature of the work has made necessary special studies of many subjects on which information was needed before the plans could be prepared. The rainfall records of the whole Mississippi valley were investigated to determine maximum probable rainfalls, and to see if these great storms followed any periodic law. A searching analysis of the available data on flow in open channels was supplemented by experiments. Experiments on a small model were made to find a way of dissipating the energy of the water to be discharged at enormous velocities from the conduits. The largest earth dams in this country were visited and studied by a member of the staff. No pains have been spared and no labor has been shirked in the attempt to design a plan of protection that shall forever safeguard Dayton and the Miami valley.

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EDITORIALS

In our engineering work, we are constantly met by problems which must be solved accurately and carefully. Often there comes the temptation to take the results that some one else has worked out; we feel that this is merely so much to be done without regard to the method. It is very important that we obtain accurate results,—the most perfect theory can be wrecked by careless methods—but we must remember that accuracy implies truthfulness. If a contractor or engineer makes a success by appropriating another's work, he is not respected and is very apt to get into serious trouble. In the same way our work should be individual as far as the work which is credited to us as personal, is concerned.

* * *

In the next issue of the ENGINEER we intend to publish some of the best papers prepared for the meeting of the Engineering Society of Wisconsin. We had hoped to have at least one of these papers in this issue, but the postponing of the meeting until the last of February caused a change in our plans. The members of this society are all practical engineers, and we feel that the papers will prove of interest to our readers.

* * *

On March 10 the 1916 Engineer's Minstrels will make their bow. The minstrels have encountered many serious difficulties and the members of the committee have been forced to expend much time and energy to insure their success. Eligibility proved a bugbear as usual, but at the present writing all things are looking favorable again. If you are not actively in the show the best thing to do is to give it your financial support and "boost" as much as you know how.

* * *

Much is being said of "preparedness" at the present time. Many interpretations have been placed upon the term; but the greatest of these is the preparedness to serve. Extent of service is the rule by which all true success is measured. "Whenever we find a great man taking advantage of a great opportunity and rising equal to a great emergency, we find invariably that, consciously or unconsciously, usually the latter, he has been prepared for that emergency and that opportunity—prepared by training, by character (which is the outcome of training), by experience, by study and special knowledge: and these all contribute to his success. There is no such thing as *luck* in such matters. Fortunate combination of circumstances there may be, but if the man is not ready to profit by the combination, the combination will never come to him." Bacon intimates the importance of preparedness in his remark, "A wise man will make more opportunities than he finds."

Efficiency is the ratio of success to opportunity. Surely the most noble aspiration is the rendition of abundant service. He is most efficient who converts into reality noble service at his every opportunity. Ability to serve is the result of preparedness. It is the outcome of mental velocity, capacity, and scope, resulting from a rigorous personal schooling; of serious effort to cultivate the habit of hard work; of thorough understanding of one's personal situation, and of the professional outlook and requirements.

One's mental capacity and speed identifies him with some one of the general types of men. Know thyself. Patch up the weak spots in your mental habits. Acquire accuracy and speed. Establish system of thought, for "the systemization of all that one does in connection with his professional work is one of the most important steps that can be taken toward the attainment of success". Establish a reference index covering books and periodicals in your line of work, and maintain the same. Seek mental scope through experience, which is attained in three ways: by reading; by observing the operations of the work of others; and by the performance of your own work. Books are the basis of college study, the forerunner of all well-ordered experience. Observation is the result of a thinking mind, whence it becomes an unconscious performance. It is the cheapest form of experience and the one least heeded. There is hardly a technical subject on which you are now studying that is not furnished with a splendid example by the work in progress in this town. What do you know of such examples? What right to neglect them, especially when you are trying to gain the experience they so interestingly afford?

Concerning the habit of hard work, Dr. Eliot says: "You ought to obtain here the trained capacity for mental labor, rapid, intense, and sustained. That is the great thing to get in college, long before the professional school is entered. Get it now. Get it in the years of college life. It is the main achievement of college life to win this mental force, this capacity for keen observation, just inference, and sustained thought, for everything that we mean by the reasoning power of man. That capacity will be the main source of intellectual joys and of happiness and content throughout a long and busy life."

"The question for you from day to day is how to learn to work to advantage, and college is the place and now is the time to win mental power." Remember that power is the time rate of doing work.

Strive early to broaden the horizon of your outlook on your chosen profession. The breadth of view establishes the loftiness of ideals and of ultimate goal. Read as much as possible of the history of engineering, and of the lives and writings of great engineers. Acquaint yourself with that part of the lbirary devoted to your line of work, and as soon as may be branch out into the other shelves. There was once a senior who did not know how to draw a book from the engineering library. And far worse, his ghost lives on!

Keep in mind that your incompetence reflects unjustly upon your college, and seriously hampers those who are worthy, those who stand for Wisconsin's high standard. So you owe to yourself the policy of preparedness; those who have aided you expect it of you; Wisconsin demands it of you.

ALUMNI NOTES

Having noticed our request for letters from alumni, a Madison friend of L. A. Wilmot, c '14, has contributed the following:

After graduation, "Al" returned to his home in British Columbia, where he was engaged in construction work for the Pacific Great Eastern Railway. Upon Great Britain's entrance into the war, he answered the call for Canadian volunteers, and since he is a graduate of the Royal Military College at Kingston, Ontario, he had no difficulty in getting a lieutenant's commission with the 29th Vancouver Overseas Battalion.

His unit remained in training at Vancouver until May, 1915, when they were sent to Shorncliffe, England. After additional instruction in trench digging, sharp-shooting, etc., the Battalion was transported in September to Flanders, where it has since remained on the six-mile front which is being held by the Canadians around Ypres.

As the past winter has been a quiet one, Al has had only one thrilling experience to relate when a shell of the sort which tears a hole in the ground some ten feet across, landed four feet away from him. Its failure to explode was due to the carelessness of the gunner, who had neglected to insert a percussion cap.

Christmas he spent in the trenches. There was no open truce, such as took place last year, but firing ceased by mutual consent, and both sides were free to enjoy their Christmas dinners, which in Al's case consisted of salmon rissoles, cold turkey, sausage, green peas, plum pudding, tea, cake, candied fruit, and chocolates.

Al has recently been placed in command of the Battalion scouts consisting of twenty scouts and nine snipers. In this capacity his knowledge of surveying and mapping will be extremely useful. So evidently one of our engineers has been having some experiences quite out of the ordinary. Under the circumstances we can well believe that the "WISCONSIN ENGINEER'S" request escaped his observation.

Since the receipt of the above communication we are informed that Mr. Wilmot was wounded in a charge. We hope for a speedy recovery.

* * *

Mr. John E. Dixon, Assistant Manager of Sales of the American Locomotive Co. has been appointed Vice-President in charge of sales of the Lima Locomotive Corporation with headquarters at 50 Church St., New York City. Mr. Dixon is a graduate of the University of Wisconsin in mechanical engineering. In 1900 he entered the shops of the Brooks Works at Dunkirk, N. Y., and in 1905 was made a salesman and later manager of the Atlantic Equipment Co., a subsidiary of the American Locomotive Co. In 1907 he was appointed assistant manager of sales of that company.

* * *

In a discussion on "Modern methods of burning blast furnace gas in stoves and boilers," recently held before the American Iron & Steel Institute Mr. Henry P. Howland took part. Mr. Howland graduated from the University in 1903. Part of the discussion is as follows:

A year ago at the Wisconsin Steel Company we attempted to increase the efficiency of our gas-fired equipment. Thus far we have installed three pressure burners on our stoves and sixty-six Birkholz-Terveck burners at our boilers. Our first step in approaching this problem was the installation of checkers in the bottom 25 feet of the combustion chamber of No. 1 stove. This increased the stove efficiency but impeded the flow of gas to such an extent that we were unable to use the stove to its full capacity. The next move was the equipping of No. 2 stove with a pressure burner. The air for this burner was supplied through an 18 inch pipe by a No. 9 Sturtevant fan. Having all other air inlets closed we were now able to compel the stove to burn all the gas desired.

We had an excellent opportunity to test nine of our boilers equipped with thirty-six Birkholz-Terveck burners. Only one furnace being in operation we carefully measured the gas to the stoves and boiler house, and accurately figured the gas produced by the furnace thus checking our gas input. The feed water and gas was measured for a period of eight hours. The burners were not touched by any one—in other words it was a regular operating condition. The result was 68 per cent efficiency. We believe this represents a big improvement over our practice on these same boilers equipped with the common burner.

You have seen that we accomplish the desired gas saving by using the checkers in the combustion chamber in connection with the pressure burner. Due to their location these checkers are four times as efficient per square foot of heating surface as the original checkers.

We would conclude as follows: For use on stoves we believe the pressure burner to be preferable. Regarding boiler burners, first, the point of automatic regulation does not seem to us to be vitally essential; second, it should be admitted by all that a big step in advance has been taken in equipping a boiler house with burners capable of easy hand regulation in the place of the so-called "common burner."

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From a recent letter received from Rinold H. Grambsch e '15, we take the following interesting extracts:

"I should say I am enjoying my work and am more than satisfied with the start that I have made in life. I am now holding the position of job foreman in the Service Repair Department of the Delco Co., a great deal of responsibility for a boy like myself, but I have been making a success of it. I have found that the more problems a man runs up against the more he will learn, and also that the greater the responsibility is, the more interesting the work becomes.

"As a bit of news for the ENGINEER I might say that Harry Anderton was married on Jan. 20 to Miss Mildred Makely of this city. Harry is now in the sales department of the John O. Heinze Company, Springfield, Ohio, and I know that he is making good there.

"When a fellow gets out of school, any news about the fellows or the school is extremely welcome. That is one reason why the ENGINEER appeals to me and I always read the alumni section first. The bigger that section is the better I like it and I think you will find others feel the same way about the magazine. I wish you continued success with the WISCONSIN ENGINEER.

"There are quite a few college men with the Delco, and so last fall we organized the Delco Technical Club among the technical graduates. We have meetings once a week at which we have talks either by members or by factory officials. These meetings are surely worth while because we hear the practical stuff.''

* * *

We have in possession a very interesting letter from Paul Coddington, a 1914 graduate. He is at present connected with the Laclede Gas Light Co., Station A, 148 Rutger St., St. Louis. He writes as follows:

''The Laclede Company completed and started to operate their new $2,000,000 coke plant at St. Louis last June. Mr. McArthur organized the engineering force for this new station by taking some of the men from the old gas manufacturing plants, stations A and B, and took Parker and myself to fill two of the vacancies at the old stations. Parker has charge of the laboratory at Station B, and I have charge of the by-products, tar and ammonia, at station A.

''We separate the tar and ammonia as they come from the scrubbers and condensers by allowing them to settle in a large well. The tar is boiled several hours in tanks equipped with steam coils to drive off the moisture, and is sold in tank cars to the American Tar Products Co. The weak ammonia liquor, containing about 0.1 of a pound of ammonia per gallon is concentrated in two five-foot stills, to liquor containing about 15 per cent of ammonia by weight, which is sold to the National Ammonia Co. for making anhydrous ammonia. My work is to keep account of the yield of tar and ammonia per ton of coal carbonized (we are getting about ten gallons of tar and 5.5 pounds of ammonia per ton), to supervise all shipments of tar and ammonia, and to superintend the operation and repairs of the ammonia stills.''

* * *

M. G. Hall c '04, has, indeed, been successful. He is civil and sanitary engineer in Centerville, Iowa. Not long ago we obtained a folder telling of the magnitude of his work. The pamphlet shows that in the last year he had about $400,000 worth of improvements under construction. In the past four years the work mentioned below has been handled through his office, and has been constructed under his supervision. Sewers—$322,700; Waterworks—$198,000; Sewage disposal—$8,800; Water purification—$35,000; Street pavement—$951,000; and Miscellaneous—$80,000. Total—$1,675,000.

His force of engineers consists of F. J. Stewart, Henry Traxler, and Harding Withington. Mr. Hall says that he has been loyal to Wisconsin in getting assistants in his work, and he finds that they are as a rule more to be depended on and better prepared for service than any others he has tried.

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CHANGES OF ADDRESS AND POSITION

A. L. B. Moser c '06, who was formerly with the U. S. R. S., is now with H. S. Crocker, who is engaged in viaduct work. Address—308 Tramway Bldg., Denver, Colorado.

Jos. Zwolanek m '07, who was formerly engineer for the International Steam Pump Co., is now manager of the Creamery Supply Mfg. Co., at Clinton, Wis.

Fernando Margarida ch. '15, is assistant chemical engineer for a concern in Porto Rico. His address is: Central Constancia-Toa Baja, Porto Rico.

M. J. Kline C. E. '13, is Junior Engineer for the Interstate Commerce Commission. Address—914 Karpen Bldg., Chicago, Ill.

G. E. Hawthorne m '13, who was formerly salesman for the United Refrigerator and Ice Machine Co., is now with the Curtiss Aeroplane Co. of Buffalo, N. Y.

C. Van E. Hopper c '05, is now local manager of James L. Waterbury Company Florida Lands, at Bradentown, Fla.

F. H. Madson min '13, who was with the Oliver Iron Mining Co., is now mining engineer for the Newport Mining Co. at Bessemer, Mich.

F. Cnare c '10, who was formerly with G. C. Cnare & Son, is now statistician for the Wisconsin Highway Commission.

C. E. Bennett m '12, who was formerly Inspector in the State Insurance Dept., is now superintendent of the gas plant of the Madison Gas & Electric Co., Madison, Wis.

F. V. Sherburne c '10, has changed his position as structural steel draughtsman from the American Bridge Co. to the Worden Allen Co. of Milwaukee, Wis.

O. J. Schieber C '12, who was draughtsman in the hydraulic department of the Pacific Light and Power Co., is now junior engineer in the U. S. R. S. on the Salt River project, at Phoenix, Arizona.

G. N Dorr m '12, who was formerly an apprentice with the Rock Island R. R., is now a member of the valuation board on government physical valuation of the Rock Island Road. Address—47 St., Chicago, Ill.

H. P. Wood c '13, who was with the Missoula Light and Water Co., is now draughtsman in the bridge department of the N. Y. C. lines west, with office at Cleveland, Ohio.

C. R. Fisher c '11, who was with the Canadian Bridge Co., is now junior topographer on the U. S. Geological Survey at Globe, Arizona.

M. C. Koenig c '11, is now in the employ of A. Eichwald, at Cuba, New Mexico.

C. A. Fourness ch '14, is chemist at the Niagara Mill of the Kimberly-Clark Co., at Niagara, Wis.

G. E. Laue e '14, is electrical engineer for the Cutler-Hammer Mfg. Co., Milwaukee, Wis.

A. D. Keller e '11, who was in the foreign department of the General Electric Co., is now engineer for the Warren & Jamestown St. Ry. at Warren, Pa.

J. T. Ryan m '15, is at Tempe Normal School, Tempe, Arizona, in the manual training department. He is head of the forge, foundry and machine shops.

J. Berg c '15, who was formerly civil engineer in Chicago, is now assistant engineer with Ralph Modjeske, consulting engineer, 220 S. Michigan Ave., Chicago, Ill.

H. M. Olson e '05, has recently been promoted to the sales department of the Kennicott Company, Chicago Heights, Ill. He has been in the employment of this company for the past six years and has made a very good record.

P. S. Biegler e '05, has been promoted to the rank of assistant professor of electrical engineering at the University of Illinois. He was granted his professional degree, E. E., here last June.

R. A. Fucik e '10, has recently severed his connection with the Wisconsin Railroad Commission and is now employed with the State Public Utilities Commission of Illinois at Springfield.

S. D. Wonders c '13, who recently held a position as statistician, is now efficiency engineer for the Metropolitan Paving Brick Co. of Canton, Ohio.

C. E. Edmund m '07, who was employed as chief inspector for the Seager Engine Works, is now mechanical engineer for the Drop Forge Co., Lansing, Mich.

G. S. Falk g '10, who was connected with the Milwaukee Patent Leather Co., is now in the engineering department of the city of Milwaukee, Wis.

K. E. Wagner c '10, who was engineer for Swift and Co., Chicago, is now sales manager for the Barton Spider Web System, Medinah Bldg., Chicago, Ill.

M. A. Tack c '13, who was assistant engineer for the Wisconsin Steel Co., is now civil engineer for the Federal Furnace Co., East Side Station, Chicago.

W. W. Mathews c '08, who recently was connected with the sanitary district of Chicago, is now with the Robert Grace Contracting Company. Address—2127 S. Ridgeway Ave., Chicago.

E. G. Merrick e '00, who for a long time was on the "lost" list, has been found and gives his address as—44 Bedford Road, Schenectady, N. Y.—Engineer, General Electric Company.

E. Phelps Langworthy m '13, who was special apprentice with the American Steel Foundry Co., is now employed at the Indiana plant as melter on a six ton Heroult Electric Furnace.

C. M. Kehr g '05, who was auditor for the Woodland Co., is now with the Atlas Crucible Company of Dunkirk, N. Y.

Successful Wisconsin Engineers.

Carl Hambuechen, e '99, E.E. '01

Mr. Hambuechen graduated from the University of Wisconsin with the degree of Bachelor of Science in 1899, and the degree of Electrical Engineer in 1901.

Hardly had he graduated from college, when his fame as a man of research of the most exacting nature, began to spread. His ability and capacity to do work were well demonstrated while at college. The Science Club awarded him its first Science Club Medal on his bachelor thesis: The Corrosion of Iron. This subject was one that interested him, not only then, but after graduation. He developed much knowledge about the corrosion of iron, much of which has led to practical results. In connection with this work he also discovered a process for the manufacture of pure iron by means of electricity.

After graduation he was employed by the Western Electric Co. There he gained much information and experience in the field of dry batteries, which he made use of a few years later.

From there he went to the American Aluminum Co. During his association with that company he worked out some notable economies in their plant in the manufacture of aluminum oxide from bauxite. Upon his return from the American Aluminum Co. he worked with Professor C. F. Burgess on investigations along electro-chemical lines. He became a member of the Northern Chemical Laboratories, later known as the C. F. Burgess Laboratories. In this capacity he assisted in the development of dry cells and flash-light batteries which are now marketed throughout the country.

With J. D. Phillips he developed an electrolytic method for the removal of oxides from metals. In this field his inventions and discoveries have been of such practical importance that the method and types of apparatus were patented in this and foreign countries, the first patent being issued on January 11, 1910. This led to the invention of apparatus for the removal of tarnish from silverware. The apparatus is now in general use in practically all the large hotels in the country.

At the present time Mr. Hambuechen is Superintendent and Secretary of the American Battery Co., East St. Louis, Mo., where he has charge of about a hundred men.

Mr. Hambuechen is an honorary member of the Tau Beta Pi, and a member of the American Society of Chemical Engineers. He is very active in the engineering societies of St. Louis, especially in the Electrochemical Society to which he has contributed various papers.

Mr. Hambuechen has won an enviable position in the chemical engineering field. It was mainly due to his untiring effort when conditions seemed extremely discouraging. He, however, will succeed, who has learned to endure, and Mr. Hambuechen stands as a model to the men in the world of practical research today.

CAMPUS NOTES

CHEMICAL ENGINEERING DEPARTMENT

On Dec. 16, 1915, Mr. W. B. Pritz resigned to accept a position with The American Carbon and Battery Company at East St. Louis, Ill., as Assistant Superintendent. This is the company of which Mr. Carl Hambuechen '99, is the Secretary.

Mr. George W. Armstrong resigned on Feb. 1, 1916, to take a position with the Hercules Powder Company. He will be stationed at the acid plant in Kenvil, New Jersey.

Both of these men have the good wishes of their associates and students in their new positions.

Mr. H. D. Valentine, a graduate of the Chemical Engineering Course of the University of Illinois, has been appointed to the vacancy left by the resignation of Mr. Pritz. Mr. Valentine has been employed by the United States Rubber Company, Naugatuck, Conn., in the rubber reclaiming department.

Prof. O. P. Watts delivered an address before the Chicago Section of the American Electroplaters' Society at the annual meeting in January.

Through the courtesy of Mr. Beaumont Parks, Sup't of the Whiting Plant of the Standard Oil Company, the Department has been presented with samples of the raw and finished products which the Company handles and manufactures.

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METALLURGICAL TRIP

The metallurgical trip this fall took in the steel, lead and zinc plants at South Chicago, Peru and Depue, Illinois, and East Chicago and Gary, Indiana.

At South Chicago we visited the South Works of the Illinois Steel Company, where the iron ore mined by the Longwall method is roasted in mechanically rabbled furnaces and then hoisted in skips to the top of the Glover towers and charged into the softening furnaces. These furnaces produce ingots which are bloomed in desilverizing kettles and sulphuric acid, which is tapped every six hours from the furnaces and carried in ladles, which of course are acid lined, to the converters, where it is blown to hard lead. The residues from the basic open hearth plant at South Works are rabbled frequently, then pickled and afterwards run into the galvanizing vats, from which they are discharged as slabs, which are treated by the contact process in Herault electric furnaces, producing spelter, which is marketed for type metal.

At the International Lead Refinery at East Chicago, concentrates from Southwestern Wisconsin and from Joplin, Mo., are treated in soaking pits and then rolled down in three high Brassert whirlers to anodes, which are electrolyzed in open hearths fired by the gases from Hegeler roasters, after which the billets are retorted in blast furnaces 42 inches in diameter at the tuyeres and of about 400 tons daily capacity each.

At the Illinois Zinc Company's plant at Peru, Ill., there are eight blast furnaces refining the base bullion produced by Utah smelters. The doré metal from the bessemer converters is first passed through pug mills and then charged into Belgian retorts, from the mouth of which issues a flame about thirty feet long. These gases are collected and by means of a mud gun are charged into the cupelling furnaces, making 99.9 per cent anodes. Twin compound cross-tandem turbines are used to operate the crushers in the laboratory and one of the fireclay retorts has been in continuous operation for three years and five months without rebabbeting or renewing the piston rings.

At the Nassau Zinc Plant at Depue the power house is located in one large building, in which there are seventeen gas engines taking the gas from the roasters after it has been well cleaned in Gay-Lussac towers. Three per cent of the gas engines are replaced every morning after they have been annealed for three days in McClure stoves.

At the Gary plant a machine of considerable educational interest was seen. It is a skull breaker, and we were informed that the University of Chicago has entered an order for a large number of them.

THE 1916 MINSTRELS

Surpassing everything ever yet attempted by the Engineering College the 1916 edition of the Engineers' Minstrels will make its debut on Friday the 10th of March, with a repeated performance on Saturday. After a few minor difficulties in the matter of coaching, a few of the more terpsichorically, rhetorically, and vocally gifted of the upper classmen took the show in charge and have shot it full of double concentrated pep. There will not be a slow moment from rise to fall of curtain, and the ammunition will be grape shot that hits everybody, rather than a few scattering Busy Berthas that convulse for a moment and then leave a deathly silence for eons at a time. The men on the inside say that there are going to be two main divisions to the show, each of which will be so completely cut into piecemeal that the resulting performance may resemble a cubist drawing of a Buttonhole Crying for its Young.

Of course somebody was under the necessity of furnishing a few brains for the occasion, but the large part of the credit is due the rank and file of the engineers who provide the vehicles for the outcropping genius. The preparation has meant to these men giving up several evenings a week for some time, a sacrifice to loyalty of necessary time for school work, that is only repaid by perhaps a small amount of personal satisfaction. Away back in the "days of real sport" the seniors used to do the whole thing by themselves, but now that the faculty rises up and asks gently that a very small amount of the time be given to their work by the seniors they feel obliged to ask for the assistance that is so gladly given.

In eventual disposition of funds this production stands unique All proceeds over and above expenses are to be devoted to the Engineers' Loan Fund, which, while it exists now, has approached insolvency to such an extent as to be practically extinct. The producers do not ask support for the show on the grounds of this charity but are certainly not ashamed to casually mention such a worthy purpose in a whisper.

It will be worth the while of the alumni that are within dropping distance to drop in on this particular Friday or Saturday and hear the true version of Campus Life, Faculty Impressions, Student Fallacies, and, necessarily, a little Nonsense thrown in.

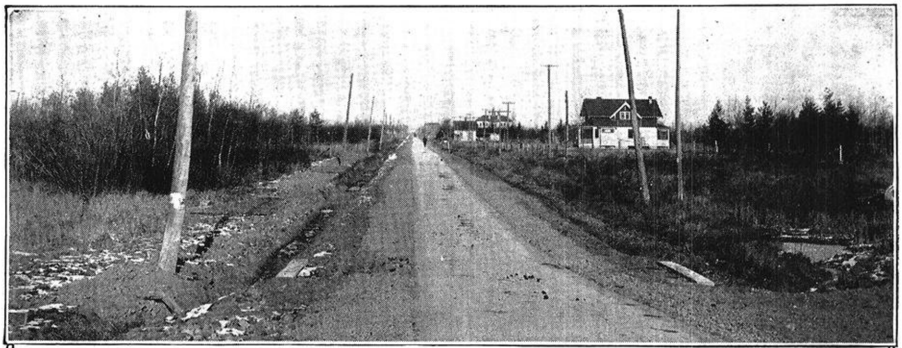
Pi Delta Phi, the new Honorary Mechanical Engineering fraternity, recently elected the following men:

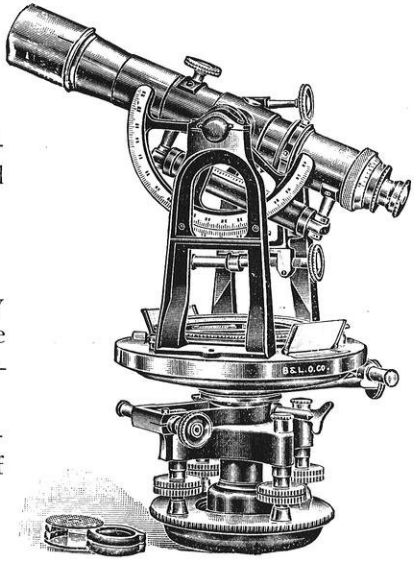
HONORARY MEMBERS

Professor J. S. Callan, Professor Wm. Black,
Professor A. L. Goddard.

ACTIVE MEMBERS

A. G. Hoppe, R. A. Grant, L. C. Newton,
D. L. Hay, R. C. Parlett, R. L. Wadsworth.

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