



LIBRARIES

UNIVERSITY OF WISCONSIN-MADISON

The Wisconsin engineer. Vol. 1, No. 2 October 1896

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

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

<http://rightsstatements.org/vocab/InC/1.0/>

The libraries provide public access to a wide range of material, including online exhibits, digitized collections, archival finding aids, our catalog, online articles, and a growing range of materials in many media.

When possible, we provide rights information in catalog records, finding aids, and other metadata that accompanies collections or items. However, it is always the user's obligation to evaluate copyright and rights issues in light of their own use.

Grossmark

The Wisconsin Engineer.



	PAGE.
FOUNDATIONS, W. A. TRUESDELL.	161
ABRASIVES, A. L. GODDARD,	173
COMPARATIVE COMMERCIAL QUALITIES OF ALTERNATING CURRENT MOTORS, W. H. WILLIAMS and J. H. PERKINS.	180
INTERNAL COMBUSTION ENGINES, C. W. HART and C. H. PARR.	192
ELECTRIC MOTORS IN FACTORIES, C. M. CONRADSON.	203
A COMPARATIVE TEST OF STEAM INJECTORS, G. H. TRAUTMANN.	212
NEW U. W. PUBLICATIONS,	223
EDITORIAL NOTES,	228
INDEX OF ENGINEERING LITERATURE,	229
INDEX TO ADVERTISERS,	274

Published Quarterly by The University of Wisconsin Engineering Journal Association,
Madison, Wisconsin.

DEMOCRAT PRINTING CO., MADISON.

The Northern Electrical Mfg. Co.



MADISON, WIS.,

MANUFACTURERS OF

MOTORS AND DYNAMOS.

SHOPS COMMODIOUS,
MODERN and FULLY EQUIPPED
FOR QUICK WORK.

Tests and Estimates Made on Electrical Equipment
of Shops and Factories.

Motors Direct Connected to Machines a Specialty.

The U. S. Government has adopted the Northern Dynamotors for use in New Library of Congress Building on account of novelty of design, superior construction, and high efficiency.

We make the only electric motor that will operate **inverted, suspended overhead to ceiling or bolted direct to side wall** as readily as if occupying floor space. Buy a Northern and Save all floor space.

Eugene Dietzgen Co.,

MANUFACTURERS AND IMPORTERS OF



Mathematical Instruments, T Squares,
Triangles, Scales, Drafting Inks, ✨ ✨
Drawing Papers, Blue-Print and Black-
Print Papers, Levels, Transits, ✨ ✨ ✨
Measuring Tools, Etc. ✨ ✨ ✨ ✨ ✨ ✨

...Chicago, Ill.

Illustrated Catalogue Mailed
on application.

Please mention Wisconsin Engineer when you write.

The Wisconsin Engineer.

PUBLISHED QUARTERLY BY THE STUDENTS OF
THE COLLEGE OF ENGINEERING, UNIVERSITY OF WISCONSIN.

Vol. 1.

Madison, Wis., October, 1896.

No. 2.

BOARD OF EDITORS:

W. F. MACGREGOR, '97, *Editor-in-Chief.*
BUDD FRANKENFIELD, '95, E. E. H. C. SCHNEIDER, '98.
LLEWELLYN OWEN, '97. C. T. WARNER, '99.
A. A. RADTKE, '98. H. J. PEELE, '99.
T. A. GERLACK, '98. E. E. SANDS, '00.
B. W. JAMES, '97, *Business Manager.*
R. D. JENNE, '98, *Ass't Business Manager.*

[Entered in the Post Office at Madison, Wis., as matter of the second class.]

FOUNDATIONS.

By W. A. TRUESDELL, PH. B., '67.
Our Oldest Graduate in Engineering Practice.

There is no subject in the whole art of construction more important than foundations, and the student and young engineer should be thoroughly informed on all that is known concerning it.

As the first object of all building is stability, the foundation of a structure should be secure and sufficient. It is by all means the most important part. It should be built with this idea in mind, and on the supposition that it is to last forever. If the foundation is good whatever is built upon it will, under ordinary circumstances, take care of itself. No time, trouble or money should be spared to make it satisfactory.

This is a subject which does not admit the application of mathematical formulas or any other kind of theorizing. Everything of any value that is known regarding it has been derived wholly from experience; theory is of no use whatever. It is only by studying and knowing what has been done in all countries and in all times—what has been successful and what has failed—that we are safe in designing and executing works of this character. All modern

methods of building on natural or artificial foundations now used by engineers rest on such observation and the engineer must be guided by his knowledge of what others have done before him and by his own judgment.

A great deal has been written about foundations and much more might be written for it is an extensive subject. This paper is not intended as any valuable addition to what has already been written or as any statement of facts, but what has been long known. It is only an embodiment of ideas and observations gathered during several years of practice and grouped together for the readers of the WISCONSIN ENGINEER. For all rules and principles relating to this subject as laid down by the best writers and for detailed accounts and descriptions of the most noted works the student must consult the standard text books and the various periodicals of engineering literature.

Of Natural Foundations—The supporting power of the different varieties of soils has been a subject of serious study and observation with engineers; for the very first principle of design is to plan and proportion a structure so that its weight on the supporting soil will not be so great as to endanger its safety.

Experiments have been made and rules framed to determine what loads different soils will sustain, but they are of little value. The natural soils which an engineer meets with are so various in their composition and character, that about all he can do is to learn what weight each variety has been successfully loaded with in existing engineering works and what weights have caused failures.

In each particular case, as it occurs in his practice, he must investigate existing successful structures which are built on soils similar to the one he is considering as near as he can determine, bearing in mind the fact that in any variety of soil whatever, the sustaining power is less as the compactness decreases and its saturation with water increases.

To ascertain the character of the soil in a proposed foundation of any magnitude the best method is by borings, but sometimes it is not reliable. Soundings are usually worthless.

Next to solid rock or a bed of boulders, coarse sand and gravel, when free from water, is the best material an engineer ever meets with, and if a structure is planned according to the rules of ordi-

nary construction there is no reason why that structure should not be successful. The supporting power of this material like all other soils varies with its hardness and freedom from water. For ordinary sand and gravel a safe load is three tons to the square foot, but there have been instances where the load was four and even five tons without any settlement, though this depends altogether on the compactness of the material.

The writer once built in this city (St. Paul, Minn.) a pier 6 feet thick and 125 feet long which supported a great weight and proportioned the footings so that the load was 4 tons. The material was coarse sand and gravel.

When sand is of a finer quality and any ways saturated with water its supporting power grows less and the loads must be governed accordingly. With fine sand when dry 2 1-2 and 3 tons is load enough. If saturated to any extent with moisture, or particularly if in that condition commonly called quick sand, any excessive loading will force the surrounding soil upward. In such a case the greatest care is necessary. Material of this character will do for a foundation if loaded to about 1 or 1 1-2 tons per square foot and the whole foundation confined inside of tight sheet piling.

Clay soils are of great variety. Some are hard and compact and free from moisture and incompressible. When found in this condition they have a good sustaining power and are considered reliable foundations, but it is difficult to give the limit of weight with which they should be loaded. In some instances when very hard, so that they yielded only to the pick, they have been loaded with 5 tons per square foot. In other cases hard pure clay has failed with the same load.

As a general rule, soil of this kind, that is, hard clay free from moisture, will bear a load of 2 tons and perhaps 2 1-2 tons with safety. Yet with this as a limit they are unreliable unless kept free from moisture. Instances could be mentioned where buildings have been erected on soil of this character with 2 1-2 tons load and have remained intact for years and then failed, probably because water found access in some way to the foundation.

Clay soils have a great propensity for retaining water when once admitted and in this condition they become yielding and

compressible and unreliable, when considered as a foundation. Here the greatest care must be taken. The foundation should be spread over as much area as possible, and then if in ordinary plastic condition, the load is sufficient at 1 or 1 1-2 tons per square foot, provided the whole foundation is confined by sheet piling.

Clay when mixed with coarse sand and gravel is a good soil for building. Its supporting power increases as the sand and gravel increases. Sometimes the clay appears to act as a cement and binds the mass together into a sort of concrete. When in this condition it is commonly called hard pan and is safe for the heaviest loads an engineer would ever think of putting on any kind of soil, say 5 tons or more.

In the various kinds of soil above mentioned, from wet and compressible clay or quick sand, to cemented clay and sand, the loads given as a limit are from 1 ton to 5 tons. Some engineers may disagree with these figures. If so no one will consider the objections more readily than myself.

The Washington monument is built on a foundation of clay and sand, but of what degree of hardness the writer does not know. The weight per square foot is given at 3 tons near the outer edges and 9 tons in the central part of the foundation.

This is the most excessive weight ever known to be placed on any natural foundation. The example should never be imitated and probably never will be. Much was said at the time the monument was completed about it and grave doubts were expressed as to the ultimate fate of the structure. Whether their criticisms were just or not may require a very long time to determine.

From the foregoing we might classify the natural foundations which an engineer meets with in ordinary practice, and which should occasion him no trouble so long as he keeps within the prescribed limits of loading, as follows:

- 1st. Solid rock, which will maintain any load however great, governed only by the crushing strength of the material and the allowance of a sufficient factor of safety.

2. Boulders and gravel—always a safe foundation to build on—and if the area is well proportioned, no danger of overloading.

- 3d. Clay and sand. When in a hard and cemented condition this foundation will sustain heavy loads approximating to the

softer kinds of rocks. This is considered a good natural foundation.

4th. Dry sand or sand and gravel is another ordinarily good foundation when not in any danger from running water and loaded not to exceed 2 or 3 tons per square foot.

5th. Compact clay, usually a good base to build on and reasonably safe if well guarded from water; one which will bear loads not to exceed 2 or 2 1-2 tons per square foot.

Of Artificial Foundations.—Whenever the soil is too wet and compressible to build directly on, the engineer must resort to some other method which the size of the proposed structure, the locality, and other circumstances only can determine.

The different kinds of artificial foundations now used by engineers are very few in number and might be enumerated as follows: concrete beds, concrete on piling, timber on piling, and timber caissons. Any artificial foundation should be one of these or a modification.

There are other methods recommended by some writers, such as sand piles, compressing a soft soil by short piling, and filling in with sand or gravel, but no practical engineer would ever think of using any of them.

If a wet and yielding stratum is underlaid by a firm and hard one, and is not too deep, the common practice is to remove the softer one entirely and build a bed of concrete, upon which the masonry structure is to rest.

It is sometimes good practice, when the proposed structure is not too heavy, to build the concrete directly on the soft material, giving the bed as large an area as possible. The engineer is governed by the amount of load and the compressibility of the soil when he adopts this method.

Concrete is very often used as a foundation for heavy bridge piers when piling can not be used or is unnecessary. When the river bottom is found to be a bed of mud or silt overlying some hard material such as hard clay, hard pan or rock, it is customary to sink a pier or bed of concrete enclosed in timber, or a caisson filled with the same material, through the soft and changing bottom to a substantial bearing on the hard stratum. This is the common practice and is the best method that can be used whenever a hard and reliable bottom can be reached. The bridges

over the Missouri river at Bismark and Plattsmouth are good illustrations of this method.

Concrete is a material which enters largely into engineering and architectural works and its use is still growing. Every practical engineer is expected to understand it and its preparation. Theoretically, or as we read about it in the text books, it is a good material to put in substructures. It is supposed to be an artificial stone, but as contractors are apt to make it, it is not always what is desired in good work. The best concrete the writer ever saw was what he made himself and what he has seen other engineers make—not contract work but by day's labor.

To make the best concrete, where it is essential to have good work done, Portland cement should be used. The additional cost will be money well expended. It is a good method and it is very often followed, where a large quantity of concrete is to be made, say three or four feet or more in thickness, to make the lower portions with American cement and the upper part with Portland.

Though concrete is usually a good foundation when laid on a medium soft soil and the weight above it is not too great, it is unsafe when these conditions are reversed, and it is sometimes difficult for an engineer to decide which to adopt—concrete or piling. If the soil is any ways wet and the superstructure to be of considerable size and weight, then there should be no hesitation about using piling.

Several years ago the Union Depot in this city was built on a bed of concrete where piles should have been driven. The location was on low ground near the Mississippi river and the soil was wet and soft. The fault was soon apparent after the building was completed.

A very unusual and at the same time a very interesting foundation was put in by the writer on the Great Northern Railway bridge over the Columbia River in Washington during May and June, 1895.

A timber trestle some 60 feet high and 275 feet in length was to be replaced by a steel structure. The old trestle was in most part built on a bank composed of basaltic rocks and chips mixed promiscuously which had been thrown in when the road was built some three years previously. The embankment rested on

solid rock. The new bridge required ten supports besides the abutment at one end. Four of the supports were on solid rock. The others were on the stony embankment where it was necessary to sink shafts or wells each 8 feet by 8 feet with curbing put in as the excavations were carried down through the made bank to solid rock. This was a most tedious operation, and required

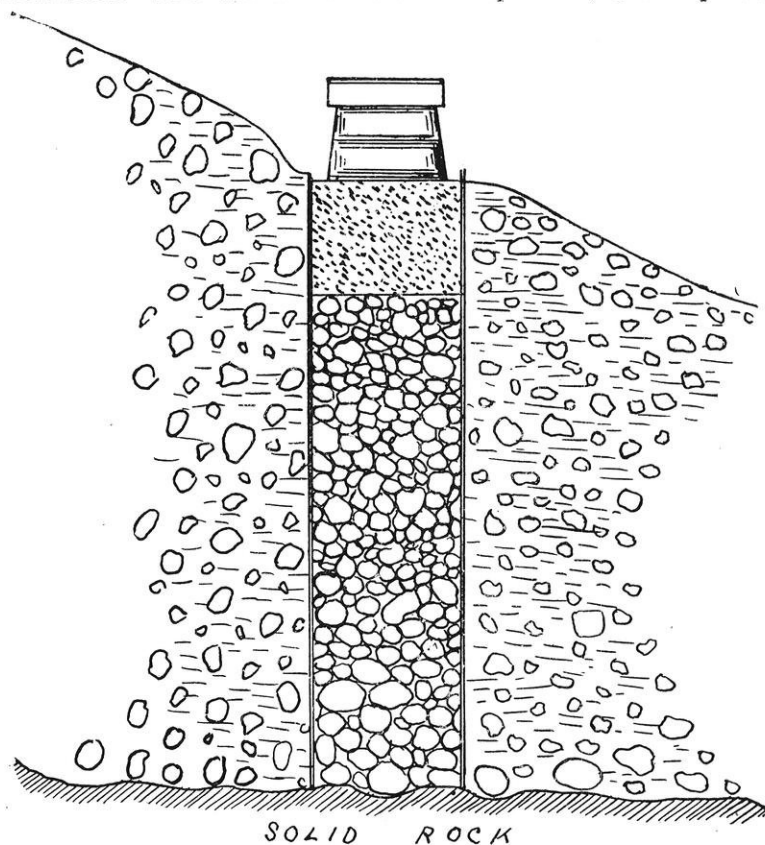


FIG. I.—One of seven foundations, Columbia river bridge.

time and great care, on account of the character of the material removed and the old trestle to be maintained intact. Two of these shafts were 32 feet deep, two others 26 feet. Each well when excavated was filled with broken rock, of different sizes, put in by hand and well rammed and pounded, and each layer of 1-2 feet grouted. This filling was carried to within 6 feet of the top. Then came 6 feet of the best concrete and after this a short masonry pier.

When a wet material is too deep to be excavated piles are invariably driven to secure a substantial support. If they are in soft ground only, they depend for their sustaining power on the friction of the surrounding material against their surfaces. If there is a hard stratum below and it can be reached, they are always driven to it, and if practicable into it, to a firm bearing.

Piles are extensively used in all kinds of heavy work, where the location requires it, and have been for ages. It is doubtful if anything cheaper or better will ever be devised. A practical knowledge of pile driving is essential to every engineer. The empirical rules for finding the weight a pile will bear from the fall and weight of the hammer may not have much value. Rankin gives as the safe load for a pile driven to a firm bearing 1,000 lbs. per square inch, and for a pile in soft ground, that depends only on friction, 200 lbs. (*See Civ. Eng., p. 602.*) That writer is cited because he is a very reliable authority. For piles of standard size this would be 50 tons and 10 tons. In all works in this country the loads on piling are between these extremes.

In this city there are a number of buildings five and six stories high and covering large areas of ground which are built on what was originally a swamp. All of them rest on pile foundations with beds of concrete surrounding the piles from two to three feet thick and sometimes a foot above. In some of these buildings the piles were from 25 feet to 30 feet in length and driven to a hard bearing. In others they were 50 and 60 feet long and driven without reaching bottom. In every instance these buildings are solid and stable. One of them is thirteen stories high.

Of course in all localities where pile foundations are put in, there is always sufficient water to insure the preservation of the piles. Wooden platforms on piling are built only when they are to be forever under water. Concrete beds should always be used instead of timber platforms whenever it is possible to do so.

Foundations of whatever kind should be deep. This is a principle of engineering always to be observed, whether it applies to an ordinary dwelling house, a pile bridge or a railroad or highway, or to a large bridge pier in mid stream. In all buildings they should be deep enough to be below the effects of frost if for no other reason. The roadway of a pile bridge will heave and warp out of line and grade if the piles are not driven below the reach of

frost. The foundations of bridge piers, if in a shallow stream must be below extreme low water mark and out of the reach of ice, and if the stream is deep and has a stiff current there must be no danger from wash and scour.

During the past year the writer was called to superintend the construction of a steel highway bridge over the Mississippi river at Aitkin, Minn. The contract had been let for some time on plans furnished by the contractor himself. All the men and

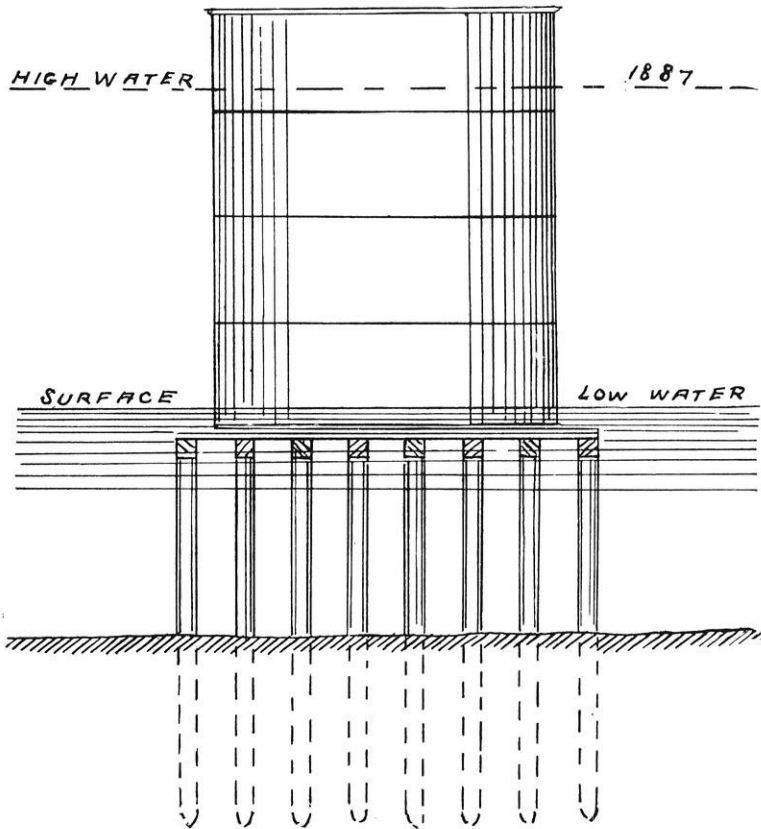


FIG. II.—Pivot pier, Aitkin bridge, as planned.

material were on the ground and work about to commence. The pivot pier to sustain the draw was to be built in mid stream and was to be a cylindrical drum filled with concrete, 18 feet in diameter and 22 feet high. It was intended to build this pier on the foundation shown in figure II.

This absurd piece of work was about to be imposed by the contractor on a board of unsophisticated county commissioners. The foundation was actually built as shown in figure III, which was the best that could be done under the circumstances. Instead of

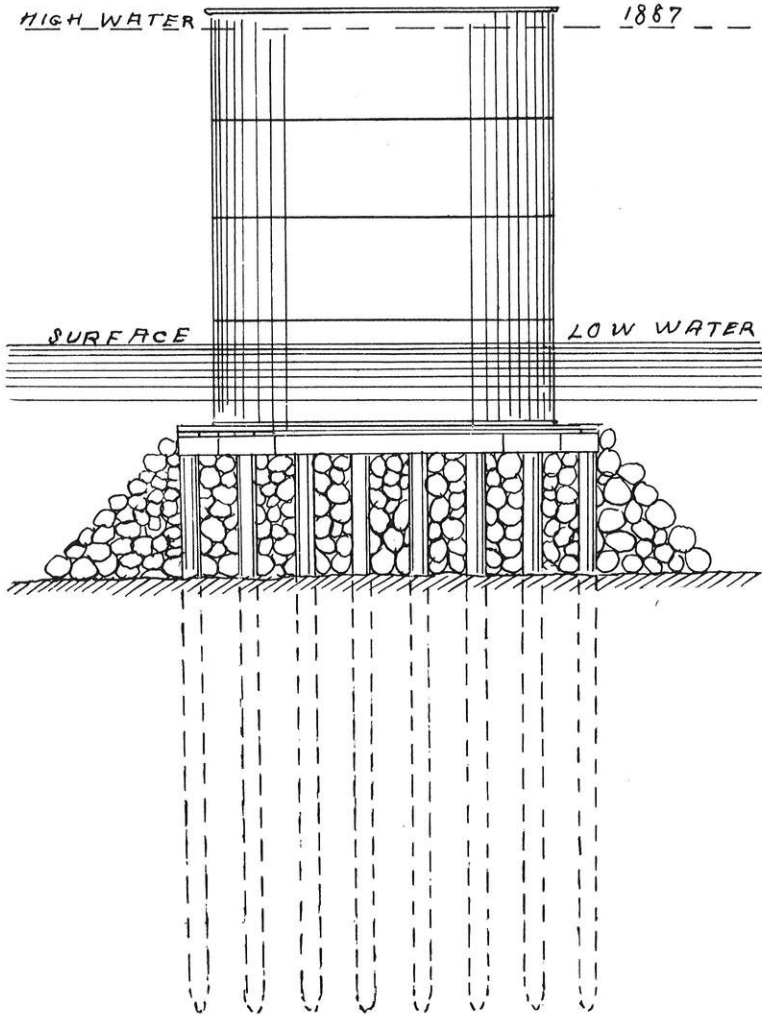


FIG. III.—Pivot pier, Aitkin bridge, as built.

piles 22 feet long, heavier ones 35 feet long were driven through the soft material into a harder one and to a solid bearing. These piles were cut off three feet lower than at first intended and would have been cut off six feet lower if the plan of the bridge above

had not been governed by high water mark. Finally after the cut off, over 100 loads of boulders were gathered from the surrounding country and placed between the piles and on the outside, after which the platform was sunk and bolted.

This change was a vast improvement on what was at first intended. It brought the timber platform below the reach of ice and gave more stability to the pier. Perhaps this foundation is not a model one but it is safe and substantial enough for an ordinary highway bridge where there is no scouring or wash. The whole load on each pile is about 10 tons.

A foundation to be stable, should be uniform throughout its whole area. One of the greatest difficulties an engineer ever has to contend with is when the soil is of variable character and of unequal hardness, as for example, rock or compact earth in one position and common earth or a yielding soil in another. So long as a foundation is of equal compressibility whether it is hard or soft the settlement is equal and no damage is liable to occur, but if the underlying soil varies in this respect then whatever is built upon it will settle accordingly. Any structure on such ground is bound to settle unequally and unequal settlement causes cracking.

In my opinion, a foundation in a swamp is preferable, for in such a case an engineer knows just what to do, but when the soil is of different supporting power he is sometimes uncertain how to proceed. About all he can do is to make it as uniform as possible, and take extra precautions in that part where the soil is softest. He should always endeavor to make a foundation to a uniform plan as near as circumstances will admit, that is to say, it should be all earth, all concrete or all piling, and not part one and part the other.

The east abutment of the Seventh Street Improvement Arches, built by the writer in this city in 1883, was a long piece of masonry about 225 feet in length, and supported on piles. At the south end the ground was very hard and piles were driven with difficulty. At the north end every thing was different, wet and soft. After the whole work was completed, unequal settlement took place and a slight crack vertical in direction occurred through the whole abutment from bottom to top, exactly at the dividing line between the hard and soft ground.

There is a large wholesale building in this city, which was built

with one end on sand rock and the other on piles. This building shows the same result from the same cause.

Foundations should be spread and the superstructure so designed that the weight will bear equally throughout the whole area. This is another principle to be followed. It is the only safe way to build on a bad foundation, and the principle holds good whether the foundation is bad or not. A long paper might be written on this subject alone detailing how this principle should be carried out in all structures and giving interesting illustrations, but time and space will not permit. The writer is now (July, 1896) engaged on the foundation of a large office building which rests on piles from 20 feet to 30 feet in length and driven to a hard bottom. The foundation is so planned that together with the outside walls and interior supports the load per pile will be from 10 to 11 tons.

Foundations should never be built on made ground. This is another principle of good engineering, though it is not liable to be violated in works of large magnitude. When made ground is sand and gravel it will come to rest in a comparatively short time, but if clay, it may be years before it reaches a final rest. Anything built on made ground is liable to settle and usually does. When a soft stratum rests on a hard one, some of our text books advise excavating the soft material and filling in with sand or gravel as a base to build on. This is bad practice whether the deposit of sand is rammed and puddled or not. One of the worst failures that ever occurred in this city was a wall built on such a foundation. This rule is not laid down because that particular failure is in mind, but because it is a well known fact with builders that made ground is not reliable.

To an engineer well posted in his profession the practice of foundation work should present no difficulty. Engineering science has made rapid strides in this country during the last 25 or 30 years, and many celebrated works have been constructed, which have been fully described and illustrated and are accessible to study and inspection. The engineer now about to commence his profession will find that so much has been done by others before him that his work is, in a great measure, only a process of imitation and very little opportunity is left for originality. It is well

perhaps that this is so. Foundation work from its very nature and importance must necessarily be a question of experience.

It is too hazardous to attempt any original and untried methods, and no engineer who has his reputation at stake would think of doing so. He must let experiment and theory alone. It is far better to follow the old beaten paths which heretofore have always lead to success.

ABRASIVES.

By A. L. GODDARD, B. S., '96.

During the last few years there has been a remarkable development in the manufacture and use of abrasives. The multiplicity of the applications of the various kinds of abrasives makes a general knowledge of the methods employed not only useful, but necessary to engineers.

Formerly the grindstone was used almost altogether for grinding. The stone was a soft, even sandstone. For shop-tool grinding it was run slowly, but for heavy grinding and grinding cutlery a fast speed was used. The stones were quarried and roughed out with mallet and chisel, then mounted and turned up with an old file or chisel or with a piece of soft iron gas-pipe. A slow speed was generally used for turning up and for trueing up in the shop; but if this was not easily obtained, the high spots were first marked with a piece of chalk or charcoal held against the revolving stone, and then the stone was stopped and these spots were picked with a pick or old chisel, after which they could be more readily turned off. The turning was always done dry except the finishing when water was sometimes used. If the stones were to be used for grinding tempered steel as axes or other edged tools, the surface of the stone was picked with a tool shaped like a small adze. This made it cut more rapidly with less likelihood of drawing temper. Hard or soft spots are very likely to occur in grindstones and cause much trouble as the wheels soon wear out of true and beside this hard spots will draw the temper of tools unless much care is used. Grindstones are not much used in this country now; the best ones here come from Ohio. In England, however, they

are still used. Mr. Paret, president of the Tanite Emery Co., in a visit to Sheffield in 1892, found the workmen in about all of the shops grinding razors and other cutlery on grindstones with the same methods that were used fifteen years ago. And this seems the more remarkable when we remember that these workmen have about as hard, dirty, disagreeable work as skilled workmen are obliged to do.

Corundum is an oxide of aluminum, having the formula Al_2O_3 . The gems, oriental amethyst, sapphire, garnet, oriental ruby and oriental emerald, are corundum crystals. The corundum which is used for grinding is mined principally in Georgia and Pennsylvania. The crystals are dark and very hard. Corundum having impurities, usually oxide of iron, is called emery. This occurs massive, sometimes in veins between other rock and sometimes it is found in large granular masses in the soil. That which occurs in veins splits easily with flat sides, but that which occurs in masses in the soil is amorphous and massive and is broken with difficulty. Corundum is much harder than emery. The hardest corundum is a light colored variety mined in Georgia. Emery is mined in Turkey, in the Island of Naxos, Greece, and in several places in this country. A very good emery is mined in Chester, Hampden Co., Mass. Westchester Co., N. Y., furnishes a somewhat softer emery than the Chester emery, although it has about the same composition. Westchester county emery is used by the Tanite Co. About three-fourths of all the emery that is imported comes as ballast. It is purchased at the ports of Turkey and Greece, not in proportion to the demand for it in the western nations but as it is needed for ballast, and when it reaches England or America it is sold to a broker. It varies widely in quality, and one must use his judgment in buying from the brokers as no guarantee can be given with the emery, for nothing is known about it. It is crushed in an ore crusher and graded to fineness by screens. The numbers 10, 20, 30, 100, etc., indicate the number of meshes to the inch in the screen. It is graded still finer by decantation. This is called "washed flour" emery. A number of reservoirs have water flowing through them in succession at a fixed rate and the emery which is held at first in suspension is deposited in these reservoirs. Of course the coarser particles settle in the first reservoir. It is marked F, FF, etc.

While corundum is essentially an oxide of aluminum, commercial corundum is far from being a pure oxide. The purest specimen of aluminum oxide on record was a sapphire gem which was 98.5% Al_2O_3 . Commercial corundum has from 20% to 40% of impurities, mostly silicates. Emery has from 30% to 50% or more of impurities, mostly oxide of iron. This oxide of iron is frequently magnetite. Corundum is the harder, but as stated before, this is not the only essential to a good abrasive in a grinding wheel. Where the abrasive is to be used as a loose powder, hardness is more to be desired.

There are two general methods of making emery and corundum wheels. One is that used in making "chemical" wheels as they are often called, in which the bond that unites the grains hardens of itself or at a comparatively low heat. The other is that used in making vitrified wheels. In this method the bond is composed of a silicate, usually feldspar (a silicate of aluminum) with litharge, gum copal and japan and sometimes other ingredients, different proportions being used to give different degrees of fluidity when hot and of hardness when cold. The emery and corundum, after being mixed with the bond, is molded into wheels and subjected to a heat of about $1,800^\circ$, which melts the bond and there firmly embeds each grain in the wheel.

Wheels known as "hard" have more of the bond than "soft" wheels and hence the grains are held in place longer. But "hard" wheels do not cut as freely as "soft" wheels; that is, when the corners of the grains have become rounded off in use the grain does not break off and allow other sharp grains to operate. This is obviated more or less by using a mixture of emery and corundum in the wheel. The emery is softer and more brittle than corundum and splits off, thus keeping the wheel sharp. Since emery is massive in structure it always leaves sharp, ragged edges when it breaks, so that it keeps the wheel sharp by breaking itself and exposing fresh particles of corundum. While some emery has greater crushing resistance than corundum, it does not necessarily follow that it will not break more easily on the wheel as this depends upon its brittleness.

It is claimed by the makers of vitrified wheels that they are stronger than the chemical wheels, but this assertion is disputed. In the larger chemical wheels a mesh of brass wire is imbedded in

the wheel to add to its strength. This cannot be done in the vitrified wheel as the high heat required for vitrifying would melt the brass. But the makers of vitrified wheels say their wheels do not need any such device to strengthen them.

In a wheel known as the "tanite" wheel, the bond is principally or entirely tanite, which is a hard, black substance formed from waste leather by a secret process. This tanite becomes plastic, and may be molded when subjected to heat and pressure; but what process it undergoes in the manufacture of emery wheels is not made public. It makes a very strong wheel. Where a wheel must be very thin compared to its diameter a composition of gutta percha is sometimes used as a bond. Rubber wheels, as these are called, 16 inches in diameter and from one-fourth inch to one-half inch thick, are often run at a periphery speed of more than a mile a minute. Such wheels gum up very quickly, however, if anything oily is used on them.

The average cutting speed for emery wheels is from 4,500 to 5,000 feet per minute. The usefulness of a wheel is much impaired by having the belt too loose or too small. This causes the belt to slip when heavy pressure is brought against the wheel and the wheel then wears away very fast and unevenly.

Wheels are made either of emery or of emery and corundum mixed, the mixture never containing more than one-half corundum, because the corundum is so hard that it will not split off when it becomes dull and the whole grain will not readily break loose as the bond, for safety, must be strong enough to hold it fast. That the face of an emery wheel wears away by splitting of the grains can be readily seen by comparing the size of the grains on the face of a wheel that has been used with the size of the grains on the side. The grains on the face will be of about half the size of those on the sides.

Polishing wheels, or buffing wheels, as they are sometimes called, are made up of wood to any convenient diameter, usually from six to twenty inches, and covered with leather pegged on. Generally this leather is sole-leather, but sometimes it is walrus hide, when the wheel must be somewhat yielding or must be turned or grooved to some special form on the face. To "set up" the wheel, the leather is given a good coat of hot glue and then is quickly rolled in a trough of emery. This imbeds the emery in

the glue and when dry the wheel is carefully balanced. It is then ready to be mounted on an arbor and used for polishing. For a finishing polish, a wheel that has been used till it is dull is still more smoothed off by holding a piece of smooth quartz against it and then a greased rag is applied. The wheel will then give an oil polish to the work which makes it less likely to rust. Polishing belts are leather or cotton belts of suitable width, coated on one side with glue and emery. They are stretched over two pulleys and run at a high velocity. They are used for polishing irregular forms and hollow corners and grooves which cannot be reached with a wheel.

Where the abrasive is to be applied in this manner—by means of glue—there is no advantage gained by using corundum, as corundum costs twice as much as emery and the glue does not form a bond strong enough to hold it till it becomes dull.

It should be remembered, in the use of emery and corundum, that hardness is not always proportioned to purity, and abrasive quality is not necessarily proportional to hardness. The abrasive should be suited to the work to be performed. However, perhaps the following general statement may be made: For hardened tools use a rather soft, free-cutting wheel with moderate pressure, while for softer steel and iron use a harder wheel. For tool grinding in machine shops hard corundum wheels are used with a shower of water falling on the tool to prevent drawing the temper. These wheels have almost entirely supplanted grindstones in machine shops, though some shops keep grindstones in addition for finish grinding.

Carborundum, which is being more and more generally used, is a silicide of carbon with the formula, SiC . It has been manufactured but a few years and was patented in 1893. It is the invention of Mr. E. G. Acheson, who attempted to crystallize carbon by dissolving it in melted silicate of aluminum and then allowing it to cool. Instead of getting crystallized carbon he got crystallized silicide of carbon, which is so hard that it may be used to polish diamonds. It is prepared by mixing 20 parts of crushed coke, 25 parts quartz sand and 5 parts of salt, and subjecting the mixture to the heat of an electric arc. The furnace is about six feet long, eighteen inches wide and twelve inches deep. The core of the charge is a layer of coarsely crushed coke twelve inches

wide and one inch thick. Four carbon electrodes, each two inches in diameter, are used at each end to bring the current into the charge. The charge is placed around the coke core, and covered with fire brick. The furnace produces about fifty lbs. of carborundum at each heat. It requires a current of about two hundred amperes a good share of the time. The time required for a heat is seven and one-half to eight hours. When the furnace is taken down, three degrees of the charge are found. That next the core is crystallized carborundum, that next this layer is amorphous carborundum and is of no use, and on the outside is found the unchanged portion of the charge. Actual tests of hardness of carborundum compared to diamond have not been made or at any rate not publicly recorded; but when finely powdered it apparently works about as well as diamond dust for polishing gems. The coarser crystals are too brittle to be used for this work so that it is only for finishing that carborundum can be used in polishing gems. It is, however, used extensively for grinding glass, in dental wheels for dentists' use and wherever extreme hardness is desired. It is also used considerably for grinding brass valves. It is also made into wheels for machine-shop grinding, but whether or not these wheels are better than emery and corundum wheels is a disputed question. It is held by corundum wheel manufacturers that if corundum is so hard that wheels are usually made with less than half of the abrasive of corundum, then it is useless to make wheels of anything which is so much harder than corundum, unless a much stronger bond can be made than any now in use. But the objection to the use of all corundum in a wheel was the toughness of the crystals and emery was put in to split away and keep the wheel sharp. The brittleness of the coarser carborundum crystals may make the use of this material in grinding wheels quite practicable, but the results of tests made with carborundum wheels in machine shops seem contradictory; some shopmen favor carborundum wheels and others object to them very decidedly. Possibly as the material becomes better known its use in this line may increase by reason of different treatment in manufacture and use.

At present the comparatively high cost of carborundum limits its use but this objection will doubtless be removed by improvements in the methods of manufacture. If anything approaching

a continuous process of manufacture could be obtained the material could be sold at comparatively very cheap rates.

Bort or black diamond is a form of carbon found massive, that is, not crystalline and having no cleavage. It is very hard and tough. In color it varies from gray to black. When powdered it is used for polishing diamonds and other gems. It is set in a soft metal setting and used for trueing up emery wheels. As it is tough enough to withstand the shocks of the emery wheel without splitting, the corners in time become rounded off. Then to resharpen it is best to chip off a small fragment.

There is a great difference in bort; the preference is usually for the darker variety. Though this is not always a sure test it is often used and leads to the practice of blackening poorer and lighter grades.

Crushed steel and steel emery are other new abrasives which are now coming into prominence. They are about the same thing, differing only in the degree of their fineness. The coarser grades are used for sawing stone and the finer grades for rubbing down and polishing stone and metal surfaces.

For sawing stone it is usually mixed with mud and fed to the saw, which may be either a revolving metal disc or a strip of soft steel stretched tightly in a frame and moving backward and forward horizontally. Stone saws usually run in gangs of varying numbers, depending upon the size of the work and the machine. The crushed steel is manufactured by tempering, crushing and hardening. It is in the shape of coarsely crystalline grains which are able to resist great crushing force and retain their cutting qualities for a long time. It is used over and over again in working stone. The sharp crystals charge into the saw and thus save much wear on the saw, and at the same time it insures their having to take the full force of the cut, and allows moderate pressure to be used on the saw.

Crushed steel is made from a poor grade of steel, probably with tungsten or something else besides carbon to harden it.

Chilled iron shot have been used for sawing and grinding stone to some extent. The name describes the abrasive. Different sizes of shot are used together. It cuts the stone by crushing it away. The balls have little more than point contact, owing to the practice of using different sizes together. Of course consider-

able pressure is required and this is a serious drawback for it is likely to make the saws buckle and run out.

Crocus is an oxide of iron, usually calcined. It is much softer than emery or even than sand, and is used for polishing brass and other soft metals. It is sold in powder or in sticks and is applied to a rag wheel with oil or tallow or a similar substance to make it stick on.

Rouge is a softer oxide of iron and is used in the same manner for polishing plated ware and the like.

French chalk, powdered pumice-stone, lime and other soft powders are used for similar work, depending upon the metal and its softness.

Water stones or razor hones are sometimes of a soft clay stone but the best ones are of white petrified wood.

Oil stones are of a fine grade of quartz. Good oil stones, whether hard or soft, must be even. A stone with either hard or soft spots will soon wear uneven in use and must be trued up. This is best done by rubbing upon a grooved iron block with coarse sand and emery. It may also be done more slowly by rubbing upon sand paper. Oil stone powder is used by jewelers for polishing steel.

COMPARATIVE COMMERCIAL QUALITIES OF ALTERNATING CURRENT MOTORS.*

By W. H. WILLIAMS, B. S., '96, AND J. H. PERKINS, B. S., '96.

The possibilities of long distance transmission and the demands of large central stations for a day motor load have resulted in the development of the alternating current motor, of which the most successful types have been either two or three-phasers. So urgent have been the demands, that although these motors are scarcely yet beyond the experimental stage, thousands of horse-power have already been installed. Thus far little exact data has been published in regard to them,—what has been given out coming mainly from the manufacturers, who, as interested parties, cannot

* Synopsis of thesis submitted for the degree of Bachelor of Science in Electrical Engineering.

be expected to speak impartially of them. Since a 500 volt, direct current motor service can be installed in cities where the distances are not excessive, the station manager wishes to know in considering the possibilities of alternating current motor service, first, if they can be operated from lighting circuits, and second, how their performance compares with that of direct-current motors.

A careful and impartial series of tests, which shows the comparative performance of alternating current motors with each other and with standard direct-current motors would therefore be of great value to station managers and other prospective purchasers of such apparatus. With this purpose in view we therefore ob-

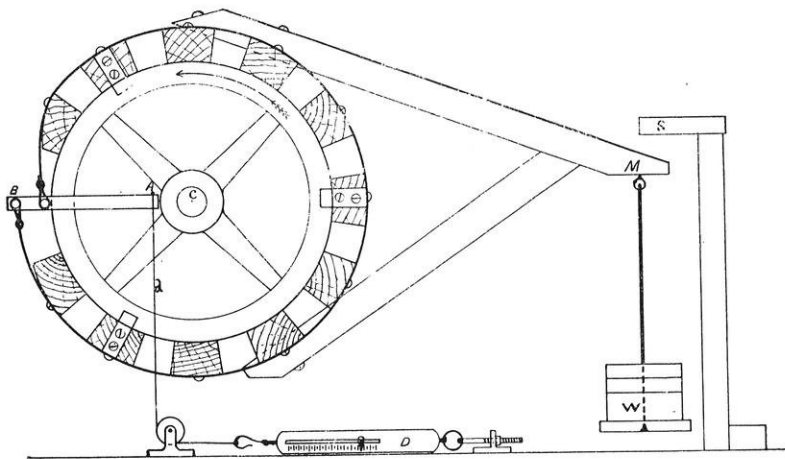


FIG. I.—Self-regulating Prony brake.

tained 5 H. P. alternating current motors of the following makes:

Westinghouse Electric & Manfg. Co., two-phase. Stanley Electric Manufacturing Co., two-phase. Fort Wayne Electric Corporation, self-starting, synchronous. General Electric Company, three-phase. Allgemeine Elektrizitäts-Gesellschaft, three-phase. Reliable data was also obtained of recent tests on an Oerlikon three-phaser, and a two-phaser made by C. E. L. Brown. A 10 H. P. Westinghouse two-phaser was also tested.

A 5 H. P. motor is probably about the average size used in central station service; and the tests may therefore be accepted as representing, for central stations, comparative results between the

average motors they are likely to use on alternating current systems; and the results may also serve as a basis for comparison between the performance of alternating and direct current motors.

Prof. Silvanus Thompson has stated as the requisites of a good motor:

First: It shall exert a good torque at starting.

Second: It shall be capable of running at a nearly constant speed at all loads.

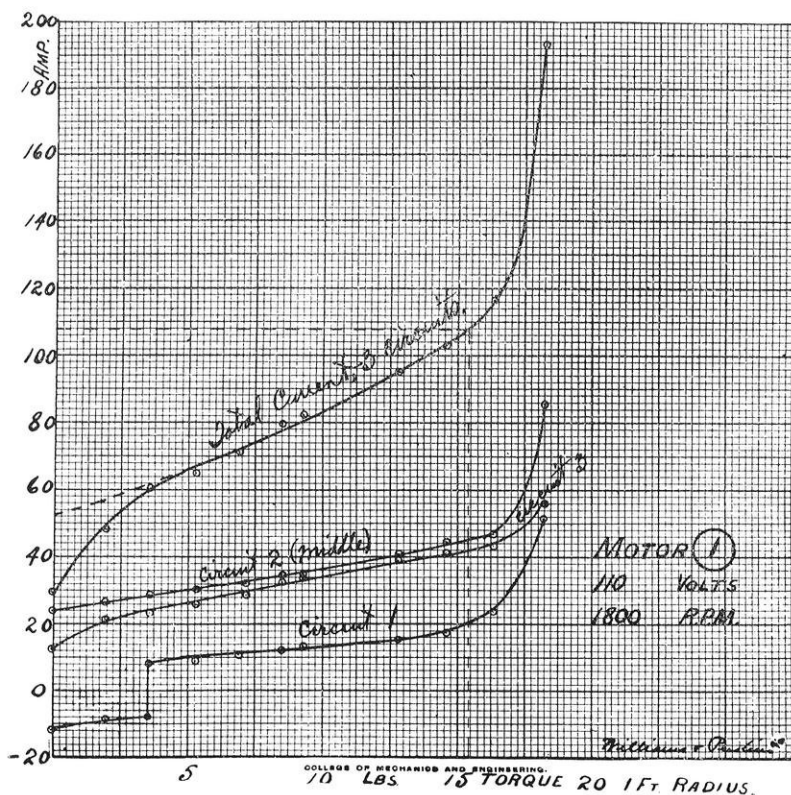


FIG. II.—Three-phase motor on monocyelic circuit.

Third: It shall have a high commercial efficiency.

To these we would add three additional requisites which determine to fully as great an extent the commercial success of the motor:

- (a) The motor shall have a high power factor.
- (b) It shall not require an abnormally large current from the lines at the instant of starting.

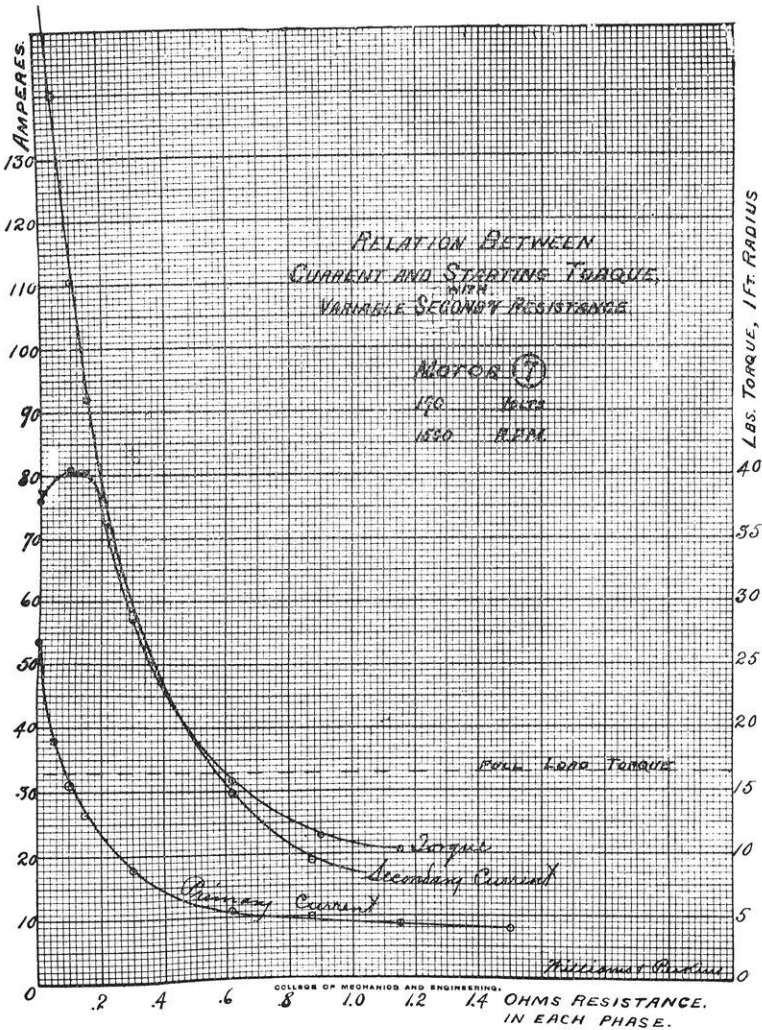


FIG. III.—Effect of variable secondary resistance.

(c) It shall not cause a large unbalancing of the line pressures of a polyphase circuit.

These last three requisites are of vital importance if the motors are to be operated on commercial lighting circuits.

Our tests therefore included:

- (a) Starting torque and current.
- (b) Speed regulation.
- (c) Commercial efficiency at all loads.

- (d) Power factor at all loads.
- (e) Effect on the line pressures when starting.

The measurements were made by the following methods:

The power absorbed by the motor was measured by direct reading watt-meters, the two watt-meter method being usually employed. Currents and apparent watts were obtained from the readings of ammeters and voltmeters in each circuit.

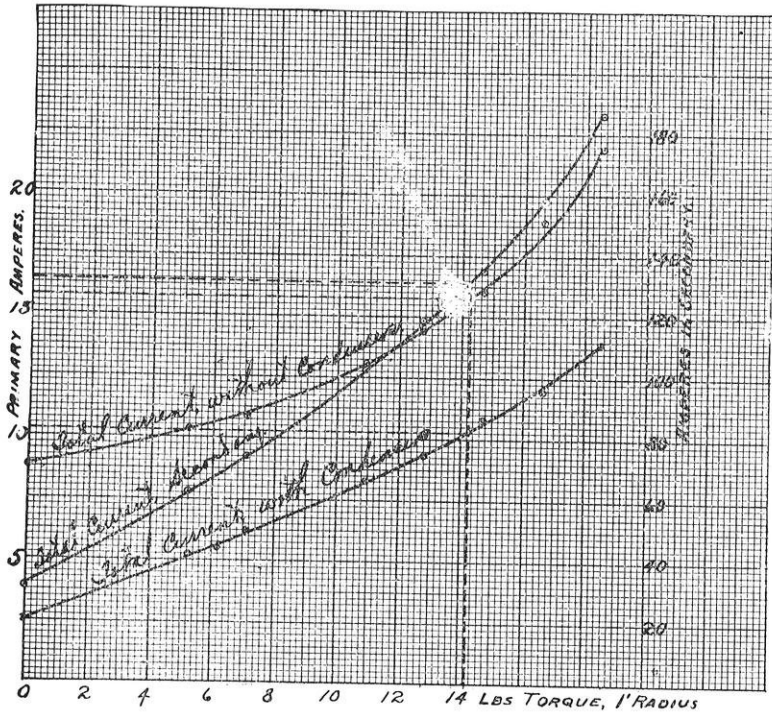


FIG. IV.—Effect of condensers, Stanley motors.

Outputs were measured by a special form of self-adjusting prony brake, shown in the accompanying illustration, Fig. I. This brake is exceedingly sensitive and steady in operation and enables all corrections to be accurately measured. It proved entirely satisfactory, and is by far the most accurate form of brake for this class of work.

Disturbances of the circuits upon starting the motors were determined by observing the effect upon incandescent lamps operated from independent transformers, and by voltmeter readings of the pressures on the lines.

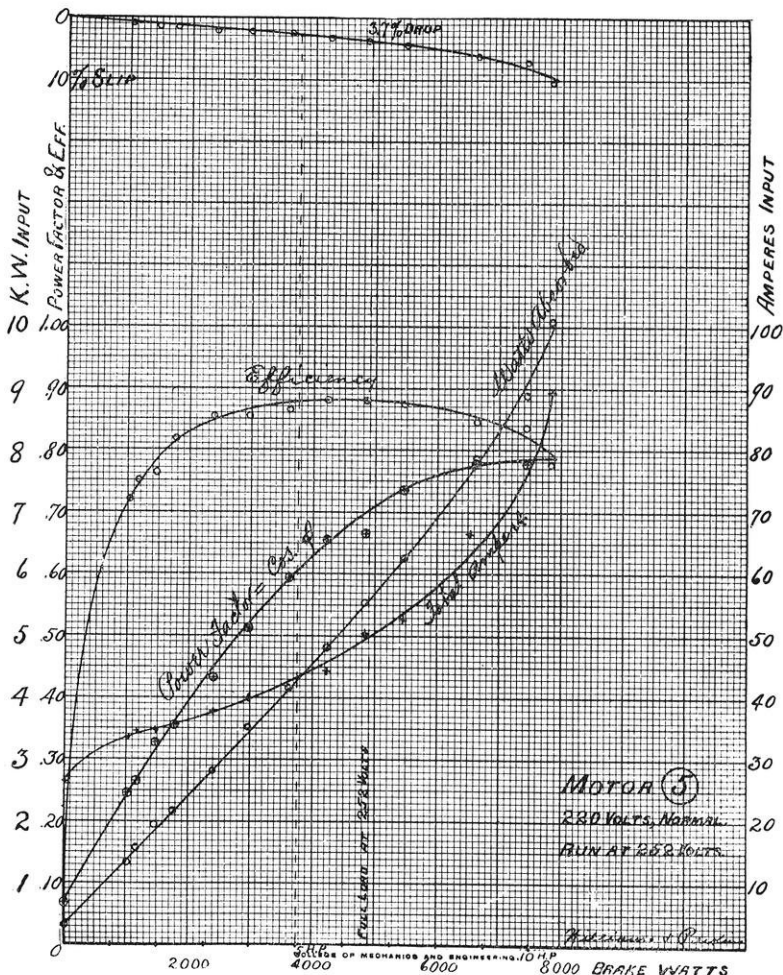


FIG. V.—A three-phase motor.

The *static torque* of the motor was found by clamping the brake up tight and then balancing the pull of the motor. The *true starting torque* was obtained by diminishing the load by successive units until one was found under which the motor would start from rest and pull up to full speed. Starting torque, we found, can be made approximately equal to static torque by using a properly adjusted and subdivided starting resistance.

The accuracy of all instruments used was checked by the laboratory standards.

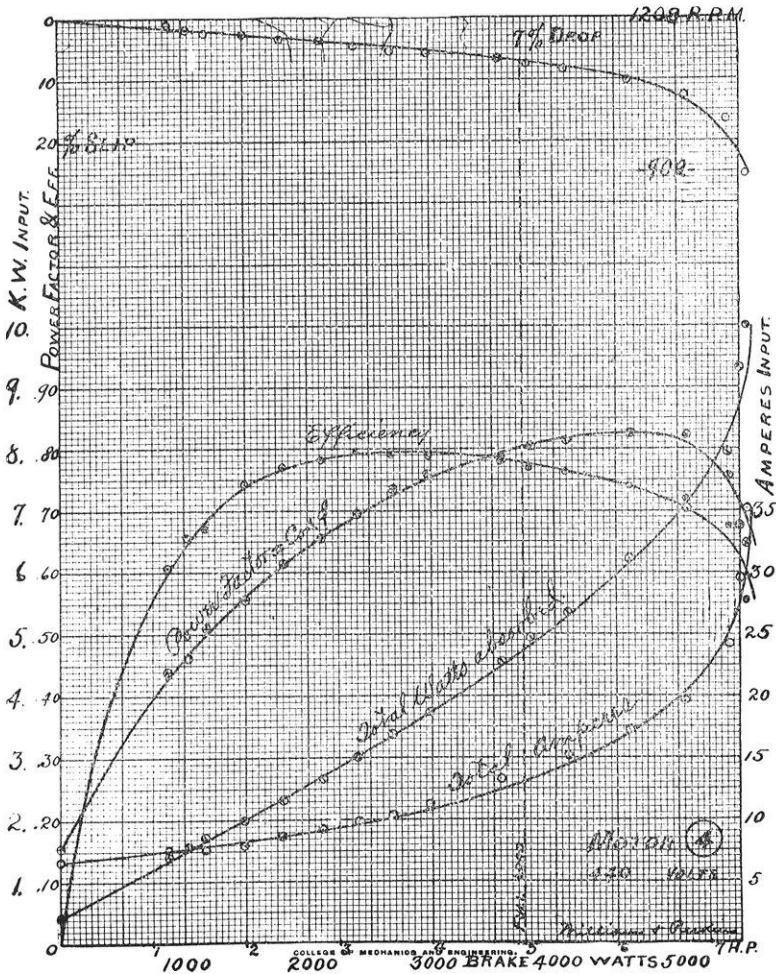


FIG. VI.—A two-phase motor.

The Stanley motor was tested on a Stanley generator circuit, and the Westinghouse motors were run by a Westinghouse generator. Two of the three-phasers were tested on the monocyclic circuit, the two transformers being connected so as to give an unbalanced three-phase circuit. The other three-phaser was tested on a balanced circuit.

Since most of the circuits used were usually slightly out of balance we have used total current (sum of the line currents) in our curves, instead of current in each phase.

The unbalanced three-phase circuit obtained from a monocyclic

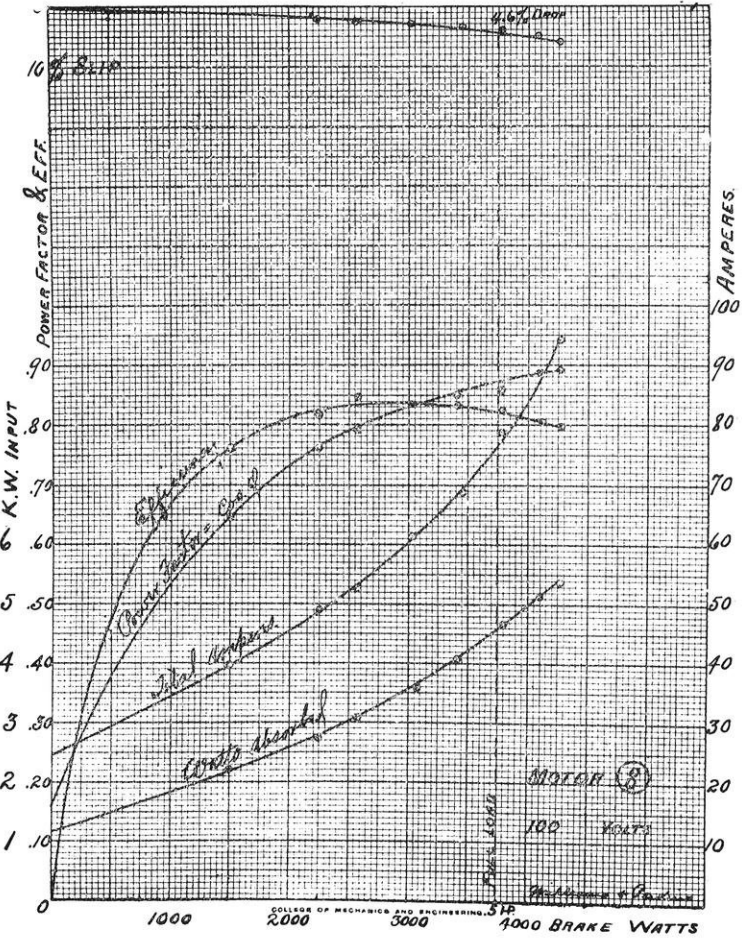


FIG. VII.—A two-phase motor.

generator may cause a peculiar current distribution in an induction motor, which is illustrated in Fig. II. At light loads the lag of current in one circuit of a star wound motor was over 90° ,—that is, it acted as a generator.

The relation between starting torque and current is well illustrated in Fig. III. (What is here called *starting torque* is in reality *static torque*.) As will be seen, the use of starting resistance gives a wide range of torque, capable of meeting all service conditions; but *very large* starting torque requires abnormal currents. Kapp has also shown that decreasing the self-induction increases the torque. We also found that subdividing the start-

ing resistance made the true starting torque practically equal to the static torque, since this allows the motor to attain its normal speed by successive steps, and the gradual cutting out of resistance does not lessen the torque sufficiently to cause the motor to slow down. It is evident therefore that with a motor having small self-induction, and a well adjusted and subdivided starting resistance, large starting torque may be obtained without an excessive flow of current. A glance at the table will show that most of the machines tested were not the equals of standard direct-current motors in starting torque; but as indicated above this defect is easily remedied.

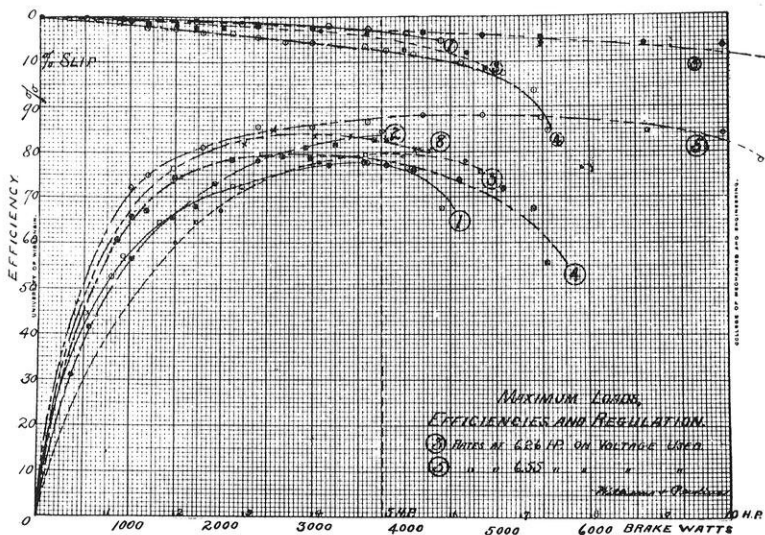


FIG. VIII.—Efficiency curves, alternating current motors.

In regulation and efficiency alternating-current motors are fully equal to the best direct-current motors as will be seen by a comparison of the two sets of efficiency curves.

The matter of power factor is of great moment to central stations; since a low power factor means a larger investment in apparatus, on account of the increased capacity required, hence larger interest charges, and larger line and transformer losses. We found all the American motors, with a single exception, inferior to the foreign ones in power factor. It is our opinion, however, that the two three-phasers tested on the monocyclic circuit would have a higher power factor if run on a balanced system.

The evidence on this point is not conclusive, and the matter will be investigated further. Until power factors of alternating-current motors are improved central stations may well hesitate about using such motors except for long distance service.

Of the six motors tested by us, only two could be started under load without seriously affecting the lights of the system. Both of these motors are of American make and could be thrown on or off with the armatures blocked without visibly affecting the lights. Voltmeter measurements showed practically no unbal-

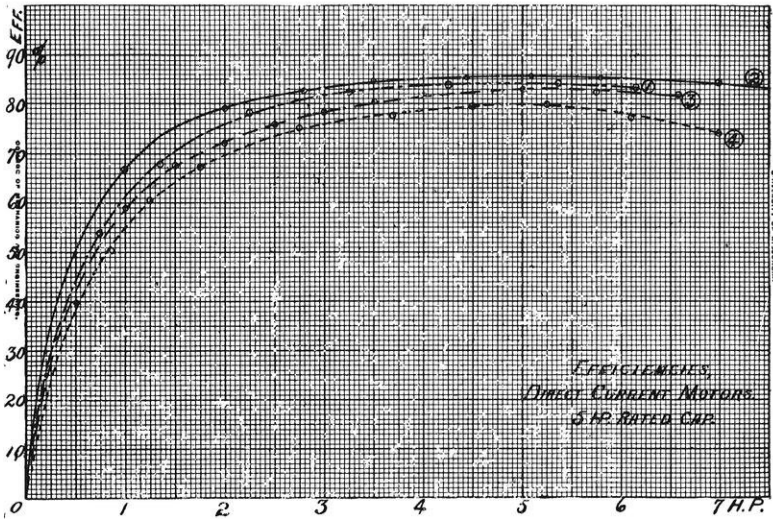


FIG. IX.—Efficiency curves, direct current motors.

ancing of the line pressures. None of the others could be used on commercial lighting circuits where good regulation and the satisfaction of the customers are considered of importance. (It should be noted here that the generators used in these tests were of 75 to 300 K. W. capacity). As evidence of what proper design of motors may accomplish in this respect, the performances of (1) and (5) may be considered. Both were tested on a monocyclic generator of 300 K. W. capacity, running on about one-third load. When started under load a very perceptible winking of all the station lights was caused by (1), while the effect produced by (5) was barely measurable by a sensitive voltmeter.

We noticed also that the line pressures were most seriously

RECAPITULATION — COMPARATIVE QUALITIES.

Number.	Class.	Rated capacity, H. P.	Rating at voltage used, H. P.	TORQUE, IN PER CENT. OF FULL LOAD.			Starting current, full load, per cent. of full load.	Drop in speed, in per cent. at full load.	EFFICIENCIES—PER CENT.					POWER FACTORS — PER CENT.					
				Max. running.	Static.	Starting.			Maximum.	¼ load.	½ load.	¾ load.	Full load.	Maximum.	0 load.	¼ load.	½ load.	¾ load.	Full load.
1	3-P.	5	5	140	131	77	157	3	77.8	55.2	70.6	77	76.6	76.4	13	37.5	50	62.3	71.5
2	Syn.	5	5	100	45	44	153	.....	83.8	54.5	72.5	80.5	83.8	67.5	10.5	25.5	58	67.3	64
3	2-P.	5	6.26	104	90	85	114	9.7	79	52	71.9	78.9	77	84	74	81.6	83.3	83.7	84
4	2-P.	5	5	186.5	136	39.4	262	7	79.5	62.2	77.2	79.5	77.8	82.6	15.5	44.7	62.5	73.7	80.3
5	3-P.	5	6.55	171	138.5	86.6	156	3.7	88	75.2	85	87.7	88	78.5	6.8	27.5	45.5	59.8	70.3
6	2-P.	10	10	>147	142	137	194	4.5	82	67	78.4	81.9	81.1	79	15	40.4	59.1	69	73.4
7	3-P.	4.5	4.5	>163	232	.....	357	3.7	79.1	61	73.8	78.4	79.1	88.4	22.2	51.3	69.4	80.3	85.2
8	2-P.	5	5	.....	.....	.....	.....	4.6	83.8	65.5	80.2	83.8	82	89	.....	52	71.5	81.7	87.2

NOTE.—6, 7, and 8 were not run up to maximum load, on test. 1 and 5 were tested on a circuit badly unbalanced and their power factors have later been found to be larger on commercially balanced circuits.

affected by the induction motors where the generator had a very peaked, irregular electro-motive force curve; and least affected where the curve was practically of the sine form. Our experiments upon this point, however, were not sufficiently extended to make our results conclusive, but we believe they are in harmony with recent theoretical conclusions. An irregular curve of e. m. f. gives rise to harmonics which distort the motor field, thus rendering the motor more of a disturbing element on the line, and also increasing the losses. In two-phase circuits, for instance, the third harmonic, which is the strongest, sets up a rotary field in opposition to the main one, thus also reducing the torque. With a sine curve, all these irregularities and extra losses are eliminated; consequently a generator having a sine curve of e. m. f. should give the most satisfactory service where induction motors are used.

Another fact emphasized by our tests is that central station generators from which induction motors and lights are to be operated should have the smallest possible armature reactions; otherwise when the generator load is light the starting of a motor is sure to affect the lights disastrously.

The reduction of the wattless current and the consequent improvement of the power factor by means of condensers in parallel with each phase of the primary is clearly shown in Fig. IV.

For purposes of comparison, the efficiency curves of several of the latest type direct current motors are also here given.

We believe the following conclusions are justified:

First: Induction motors give as good regulation and efficiency as direct-current motors.

Second: They can be made to have, and some of them do have, as good starting torque as direct-current motors.

Third: Their starting torque may be made as high as necessary to suit service conditions without using an excessive current at starting; and only such motors as are guaranteed to do this should be used on commercial lighting circuits.

Fourth: Only generators having small armature reactions, and approximately sine curves of e. m. f. should be used to operate both lights and induction motors for commercial service.

Fifth: Such motors and generators are now furnished by at

least two American manufacturers, and therefore it is now possible for central stations to furnish both light and power from the same generators with economy to themselves and satisfaction to their customers.

Sixth: For power distribution the polyphase motor is the ideal motor on account of its simplicity of construction, mechanical stability, sparkless running, and constancy of speed in addition to other desirable qualities already mentioned.

INTERNAL COMBUSTION ENGINES.*

By C. W. HART, B. S., '96, AND C. H. PARR, B. S., '96.

I.

The first man to propose the use of explosion to obtain power was the Abbe Hautefeuille, the son of a baker at Orleans. To him belongs the honor of designing the first motor in which heat was used for the generation of power.

In 1678, he planned to explode powder in a vessel in communication with water and utilize the vacuum thus produced to lift the water. Other powder machines were designed and built, but during the next 100 years the attention of engineers was turned to steam and the first to design and construct an actual gas engine was John Barber, who took out a patent for one in 1791. His engine consisted of a pump which forced gas with air into a receptacle where it was ignited and from which, combined with steam, it issued through a nozzle against the blades of a paddle-wheel.

A great improvement in the practical application of gas engines was made by Phillippe Lebon, a French engineer who obtained a patent in 1799 on the production of gas from coal, and a second in 1801 in which he proposed to utilize this gas to drive a piston in an engine very similar to that designed by Lenoir sixty years later. The inflammable gas and a sufficient quantity of air to make it ignite were introduced separately into the cylinder on both sides of the piston, and the inventor proposed to fire the mixture by an electric spark. The machine was double acting,

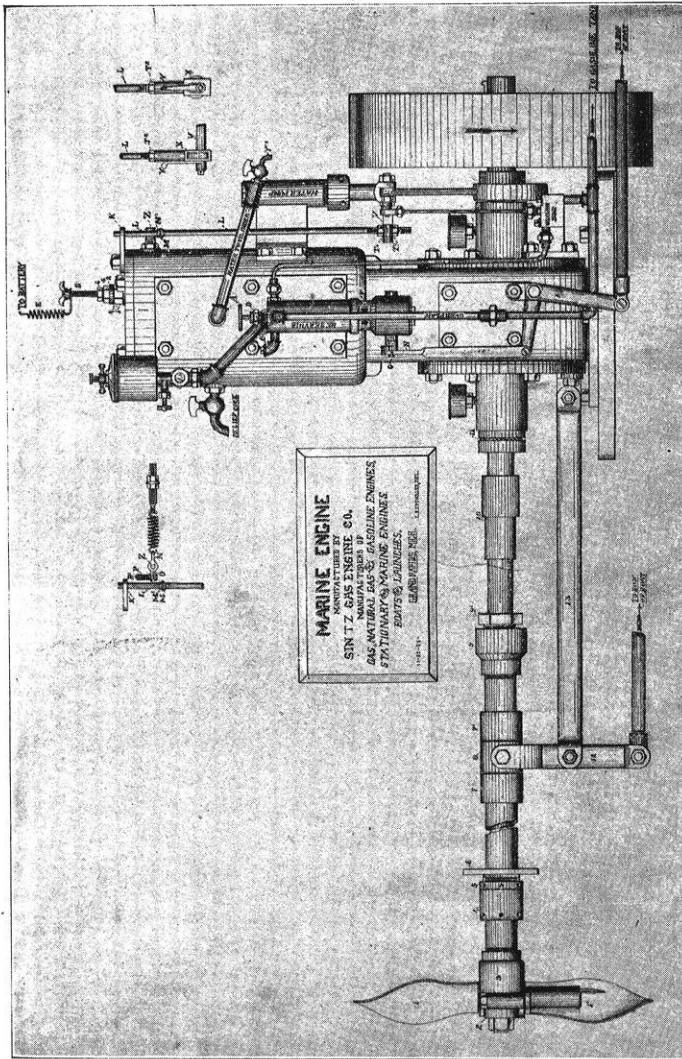
* A thesis submitted for the degree of B. S. in mechanical engineering; received special honors.

and the explosions of gas took place alternately on each side of the piston. The piston rod worked not only the motor shaft but through it the two pumps in which the gas and air were compressed before they entered the motor cylinder. Lebon also suggested that the machine generating the electric spark should be driven from the motor shaft. The excellent theoretical principles on which this machine was designed were striking at that early period, and marked a new era in gas engines; but more than sixty years elapsed before the great advantages Lebon had so clearly understood, of compressing the gas and air before ignition, were fully realized.

The next engine of note was that of Barnett, patents for which were taken out in 1838. The first had one working cylinder, single acting. Gas and air were drawn in and compressed by two pumps, and passed into a receiver below the motor cylinder where they were mixed. During the down stroke of the pumps, while the charge was being compressed into the receiver at a pressure of about 25 lbs. per square inch, the return stroke of the motor piston was discharging the burnt gases through the exhaust. All three pistons moved simultaneously up and down. As the motor piston reached the bottom of its stroke, a valve at the side opened communication with the receiver. At the same time a revolving ignition cock immediately above the exhaust fired the charge issuing from the receiver, and, as the crank passed the dead point, the burning gases entered the motor cylinder through the admission port and impelled the piston upward. Barnett may justly claim the honor of having been the first to introduce compression of the gas and air in a practical shape as now used in gas engines.

Up to 1860, the designs for engines were numerous and many were built. Certain conditions came to be recognized. The heat generated was so great that it had to be carried off as quickly as possible, and even with water jackets on the cylinder, parts of the engine sometimes became red hot. It was also impossible, in a double acting engine, to compress the gas and air before ignition, and expansion of the gases was also greatly limited. It was some time before inventors came to know that the discharge of the products of combustion at high temperatures was a great loss of energy.

Barsanti and Matteucci, in England, sought to overcome this



Sintz Gasoline Engine adapted for boat propulsion.

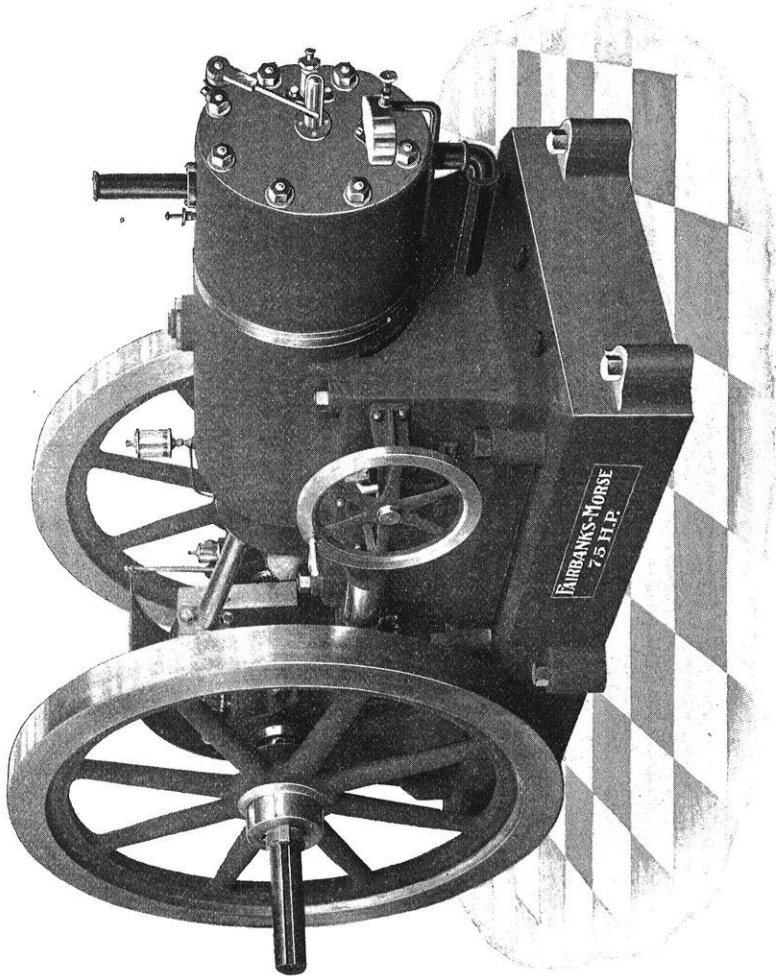
difficulty by their vacuum engine. A long cylinder was provided in which was a piston free to move out, but which clutched the shaft by means of a ratchet and gear on its return. During the early part of the out stroke the mixture was drawn in. At a certain point it was fired by an electric spark and the piston pushed rapidly out until the atmosphere without and the vacuum within stopped it. The vacuum was further increased by the cooling of

the gases and the piston, in consequence of this and of its own weight, was drawn forcefully in, doing work on the shaft. While this motor was not a success owing to its mechanical construction, its cycle was good as it utilized to the fullest extent the expansion of the gases.

We have now gone over in brief the purely experimental period of the gas engine and come now to the period of application, which began about 1860. Great as was the perfection to which steam engines had been brought, it was felt that they did not and could not supply all the various requirements for an economical motor. The necessity for some other kind of engine had already been pointed out by Chevarton in 1826. In a letter to the *Mechanic's Magazine*, he says: "It has long been a desideratum in practical mechanics to possess a power engine which shall be ready for use at any time, capable of being put in motion without any extra consumption of means, and without a loss of time in its preparation. These qualities would make it applicable in cases where but a small power is wanted, and that only occasionally required. They are so numerous, and the consequent saving of human strength would be so great, that the advantages accruing to society would be immense, even if the current expense were much greater than that of steam." No words could better describe the present advantages of the gas engine.

In 1860, much had been achieved by mechanical ingenuity in the construction of the gas engine. All the parts had been designed and the details thought out. Scarcely a single improvement has been suggested in modern engines, which may not be found in the drawings of Lebon, Barber, Street, Barnett, and others. In the words of Professor Witz: "The gas motor had been invented; the problem was how to make it a working success." It is here that we enter on the second period of application.

The first practical working engine was that of Lenoir. It resembled in construction a double acting horizontal steam engine, and the gas was fired electrically. Gas and air were admitted at both ends, drawn in by the piston during the first part of the stroke, and then fired and expanded. Admission of the charge was cut off either at half stroke or a little later. The cylinder, both covers, and the chamber into which the gas was admitted were water-



Fairbanks-Morse 7.5 H. P. Gasoline Engine.

jacketed, and the circulating water was used over and over again.

Hugon, in 1862, introduced the flame ignition and forced a jet of water into the cylinder in order to keep it cool, lubricate it, and increase the efficiency. The injection of water has since been proven to be of no advantage.

At this time very little scientific work had been done on the gas engine. Those experimenting with the motors recognized the great waste of energy without being able to better their work. They could not tell why one engine worked better than another. Any one who has experimented with the gas engine is able to ap-

preciate their position. About this time (1862) a remarkable patent appeared in France by Beau de Rochas. He pointed out that the reasons for the extravagant working of these engines were incomplete expansion, lack of compression, and loss of heat through the walls. He laid down as conditions essential to good efficiency:

I. The largest cylindrical volume with the smallest circumferential surface.

II. Maximum speed of the piston.

III. Greatest possible expansion.

IV. Highest pressure at the beginning of expansion.

These rules have not been improved upon even to this day; and the intelligent inventor has, since these conclusions were brought out, worked to produce mechanism which would best fulfill these essential conditions. Large cylinders were used instead of multiple cylinders as the cylindrical volume increases as the cube of linear dimensions, while the surface of walls increases as the square. The wall surface exposed being smaller, less heat passes through it. As the absorption of heat by the walls is a function of the time, a higher piston speed is desirable. In order to avoid great waste through the exhaust the expansion should be utilized to the fullest extent. In order to obtain a good range of expansion, and for the best combustion, a high pressure at the beginning of expansion is desirable. This cannot be obtained without previously compressing the charge. Beau de Rochas not only put forth the conditions but proposed a cycle of operations for realizing their accomplishment. He proposed a single cylinder in which was to be carried out in four consecutive strokes:

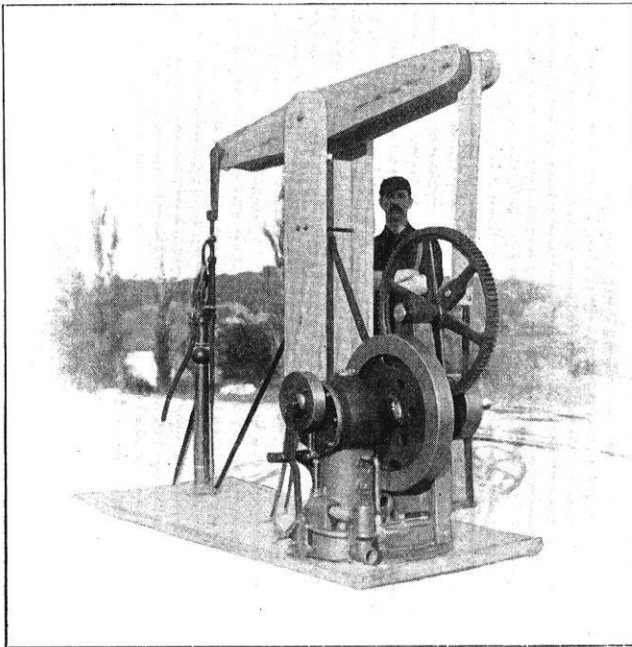
1. Drawing in the charge of gas and air.
2. Compression of the same.
3. Ignition at dead point, with explosion and expansion.
4. Discharge of the products of combustion from cylinder.

This is the cycle upon which the best modern gas and oil engines are founded.

In 1866, Otto and Langen brought out an engine somewhat along the lines of Barsanti and Matteucci. In an earlier patent they say: "Experience has shown that the interval of time between the heating and consequent expanding of the gases, and the subsequent cooling with consequent contraction, is but a very short one, and therefore, in applying the expansive force of such

heated gases as motive power, unless they are allowed to expand very rapidly—immediately after combustion has taken place—a great portion of the heat which should have produced such expansion will be absorbed by the cylinder walls of the engine, and consequently, a great part of the motive power will be lost.”

The principle of their engine was to obtain the most rapid and complete expansion possible. In theory their premises were true and their engine realized an economy, 26 cu. ft. of gas per H. P.



Gasoline Engine attached to ordinary windmill pump.

hour, in excess of any engine up to that time, and which compares favorably with engines of the present day. About 5,000 of these motors were built. They were not a mechanical success, but they approached more nearly to being such than did the motors of Barsanti and Matteucci where the principle employed was the same.

In 1872, Brayton introduced at Philadelphia a motor which promised well. He was the first to employ ordinary heavy oil and kerosene. His engine employed the principle of combustion at constant pressure instead of at constant volume. The charge

of gas and air was ignited before its admission into the cylinder, entered in a state of flame, and drove the piston forward without any rise in pressure. A steady combustion was maintained during one-third of the forward stroke, and then expansion took place. The return stroke expelled the products of combustion. A gauze diaphragm prevented the flame from igniting the supplied gas too soon. Two pumps supplied the oil and air at the pressure of explosion. The system of breaking up the petroleum by a blast of air forced into it, rendered possible the use of heavy oil. Brayton was therefore the inventor of the first safe and practical oil engine.

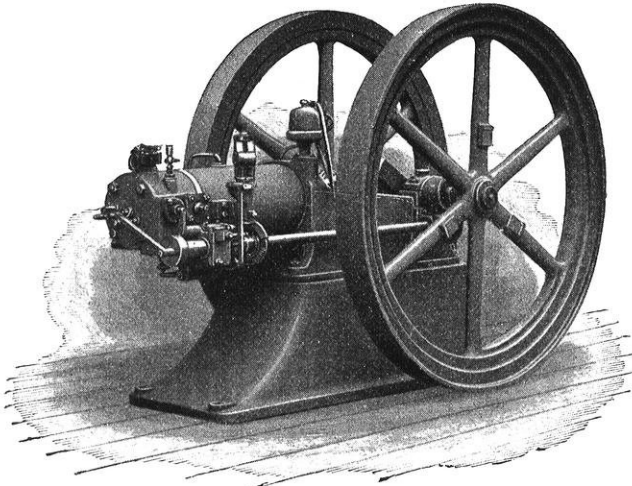
Until 1876, no engine had been constructed which carried out completely the cycle outlined by Beau de Rochas. During this year Otto brought out a motor working according to this cycle and with it obtained results of economy never before realized. The exact reasons for increased economy were not known to the maker of this engine. He attributed the good results to a stratification of the charge.

This engine was single acting. A clearance space equal to about 40 per cent. of the stroke was left in the cylinder into which the piston never entered. The out stroke of the piston sucked in the charge; the return stroke compressed it; ignition took place at the dead point; expansion existed during the entire out stroke; and the next back stroke drove out the exhaust, leaving, of course, the clearance space full at atmospheric pressure. His distributing valve was so arranged that pure air was admitted first, then a weak dilution of gas, and finally pure gas, into which the ignition flame passed. He thought thus to propagate the combustion by degrees and obtain a cushioning from shocks. He supposed that next to the piston existed a charge of the exhaust; then a weak layer of gas and air, and further back in the admission port a rich charge easy to ignite, and attributed his success to this arrangement. His conclusions were faulty, however, as experiments have been instituted which showed no such arrangement. A glass cylinder containing a piston was provided with an admission port at the same point as in the Otto cylinder, and smoke was drawn in during the out stroke of the piston. It was found that at the beginning of the stroke the smoke entered in a stream which contin-

ued to the piston where it was reflected back and mixed completely with all the contents of the cylinder.

Otto's success was due, however, to the introduction of compression, and, as recommended by Beau de Rochas, carrying out the entire cycle in one cylinder. His success was also no doubt due largely to his good mechanical design and construction.

Few engines more ingeniously constructed than the Otto have yet appeared, and even now, when so many later motors have been brought out, it is still one of the most economical. The German firm had, up to 1892, constructed 35,000 engines, while many other firms in Europe and America have been putting them on the mar-



Otto Gasoline Engine.

ket in large numbers. Many changes in detail have been made. Hot tube and electric ignition have been introduced and in most modern engines, including the Otto, makers have discontinued the use of the slide valve, and use in its place lift valves. In general, the proportions of the cylinder have not been changed; the ratio of stroke to diameter being 2 : 1.

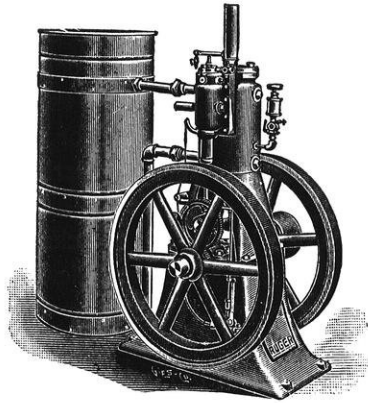
It is now generally recognized that the cycle of Beau de Rochas should be carried out to obtain a good engine, but the mechanism which is to do it is a subject for much study. The Otto engine is open to the objection that it gives only one impulse for four strokes of the piston. This causes some irregularity of motion and necessitates a heavy and cumbrous construction. In order

to remedy these defects, Clerk brought out in 1880 an engine giving an impulse for every two strokes. Of the four operations of the cycle, Clerk proposed to transfer the first to an auxillary cylinder called the displacer. The gas and air were drawn into the displacer and slightly compressed. The action of the engine was as follows: The charge being compressed in the cylinder and the engine at the dead point, it was fired. Expansion took place during most of the out stroke when the piston uncovered holes in the cylinder through which the products of combustion passed. Soon after the uncovering of these holes, and before the expansion stroke had ended, communication with the displacer was opened and the charge of gas and air, already slightly compressed in the displacer, rushed in and cleaned the remaining burned gases out through the exhaust ports. As soon as the piston returned sufficiently to cover the exhaust holes, compression began and continued during the back stroke, and at the end of this ignition was effected. Of course some mixture of the incoming charge and the burned products took place, and Clerk endeavored to overcome this by the shape of the cylinder. He made the clearance space conical in form and introduced the charge at the small end, hoping to push the contents of the cylinder before the incoming charge without much mixture. Great care was used in determining the volume of the displacer so that as little as possible of the new charge would pass out of the exhaust, and so that the greatest part of the burned gases might pass out. This engine, it is said, worked with some economy, the consumption of gas of a rich quality being a little over 20 cu. ft. per I. H. P. hour in a 12 H. P. engine. It was not, however, a perfect success and its manufacture was discontinued.

Some experimenters thought that the burned gases remaining in the cylinder to be mixed with the new mixture caused a loss of economy, and engines with six strokes in the cycle were built. The best example is the Griffin. Its cycle was, 1st. admission of charge; 2nd. compression; 3rd. explosion and expansion; 4th. expelling the products of combustion; 5th. drawing in air; 6th. expulsion of charge of air. The defects of this cycle are: the want of regularity in the speed, and the loss of power due to the small number of ignitions, there being only one motor stroke in six. This fault was in part overcome in the Griffin by using both

sides of the piston. No greater economy was secured by the scavenger charge of air as what was gained by the increased purity of the charge was lost in the increased friction of moving the engine through another revolution per explosion. It was also found that the cooling influence of the piston rod lowered the pressure on that side of the piston by taking away heat.

Another engine which is worthy of note is that of Atkinson. By an ingenious toggle connection between the piston and the crank he succeeded in securing four strokes of the piston to one revolution of the crank, and in varying the length of stroke so as to obtain undoubtedly the most perfect cycle ever invented for a gas engine. The cycle was a short out stroke of the piston, from



A Ruger 5 H. P. Gasoline Engine.

a very small clearance space, which sucked in the charge; then a still shorter back stroke of compression, at the end of which the charge was ignited and expanded through a long out stroke of the piston, securing the full benefit of the expansive force; the return stroke brought the piston back nearly to the head, completely expelling the burned products. This engine on trial gave a small consumption of gas, yet it was not a successful engine as it was large for the power developed. The speed was low as the parts could not be balanced for high speed.

Another engine whose simplicity is noticeable is that invented by Day of England, and which goes by the name of the Sintz type in America. Its cycle of operation is accomplished in the same order as the Clerk, but instead of a displacer cylinder the crank end of the cylinder is surrounded by an air tight case in which the

crank revolves. The only valve on the engine is an automatic lift valve operated by the suction of the mixture into the crank case. The operations are performed as follows: The piston being at the top of the stroke with a compressed charge above it, ignition takes place and expansion forces the piston down doing work on the crank and compressing slightly the charge in the crank case. Near the end of the stroke the piston uncovers a port in one side of the cylinder and exhaust takes place. Still nearer the end of the stroke a port in the other side of the cylinder, which leads to the base, is uncovered and the mixture there slightly compressed rushes in, driving before it the exhaust. Soon after the piston returns covering the ports, compressing the charge above it, and sucking in a new charge below, completing the cycle at the dead point.

We now have before us in the preceding pages the most important work which has been done in developing the internal combustion engine. After perusing all the publications on the subject which we could secure, we selected the motors which we have for description because each was the chief representative of its class. The designs which have been gotten out and which have been tried number into the thousands.

(To be continued.)

ELECTRIC MOTORS IN FACTORIES.

By C. M. CONRADSON, '83; M. E., '85.

In machine shops and factories electric motor driving has in many cases displaced belt and shaft transmissions, sometimes with very favorable results and many times with doubtful economy. In many instances the receipt for making an electrical transmission is as follows: "Leave as much of the line shafting, belting and gearing as possible. Belt a large motor to the line shaft, being careful to set it on the floor where it will be as much in the way as possible. Turn on the current and trust to luck." Contrary to common opinion it is very easy to make an electrical transmission very uneconomical. The writer is a believer in direct connected motors wherever possible even on the smallest tools and ma-

chines. In existing plants of course it is frequently impossible to direct connect but it should be done in every new plant. Many engineers have other views, however. Quoting from "The Iron Age" of May 28:

First: "When the tool requires only a fraction of a horse power for its operation, it is not the best practice to drive it by means of a motor, the first cost of which would, perhaps, more than counterbalance the benefits arising from its use. To put this more broadly, the tools found in the usual shops, and which vary largely in the power they need, cannot all be driven economically by individual motors, or single units, for each machine."

There may be some truth in the above statement at the present time due to the fact that suitable mechanisms have not yet been developed for connecting the motor to the tool in an economical and efficient manner. This difficulty will rapidly disappear, however, as soon as machine shop proprietors (naturally the most conservative of men) appreciate the enormous advantages to be gained by direct electric driving of each tool, and competent engineers take hold of the problem of designing such connections. There is an enormous amount of new work to be done by machine tool designers, however, before it will be possible to apply motors directly in a thoroughly satisfactory manner.

Many of the combined motors and machine tools that have been brought out so far are very crude. Quoting from a letter received from a distinguished mechanical engineer ("They look as if the designers have just come out of the backwoods and ought to return there.") Some of the most pretentious attempts at combining electric motors and machine tools show the worst engineering. The machine tool to be driven must be harmonized with the driving motor. The method of connection must be simple, effective, durable, efficient and cheap. The requirements of each kind of machine tool must be specially studied and the necessary modifications made both in the machine tool and motor. The arrangement required for an engine lathe will not answer for a planing machine or an automatic screw machine. As soon as it is possible to secure motor driven tools properly designed for the work they have to do there is not the slightest doubt that they will displace shaft and belt driven tools. This is equally true both in the instal-

lation of new plants and in adding new tools in an old plant because the motor driven tool can be set anywhere without being forced to fit itself to existing lines of shafting. It is a fact well known to every works manager that it is impossible to arrange belt-driven tools in such a manner as to cover a given floor space to the best advantage. Frequently a line shaft becomes so filled up with pulleys that it is impossible to find room for the necessary driving pulleys for the new machine, while at the same time there may be ample vacant floor space. It then becomes necessary to put up another short line shaft or else locate the machine in some other (perhaps much less desirable) point where it is possible to belt to countershaft. It is generally forgotten in comparing belt driving with motor driving that the machine tool must be charged with its share of the cost of the building in which it is located, as well as its share of the cost of the entire transmission plant. In the first case the total amount of space utilized for machine tools must be charged pro rata to the various tools, including all waste space; as for instance that directly under the line shaft, which is generally unavailable. The cost of the transmission plant should be pro rated proportionally among the various tools according to the amount of power required by each. To obtain the running expense, interest, and all expense for the power plant, depreciation, taxes, insurance, repairs, etc., must be charged proportionally to each tool. When the total first cost of installing a tool is figured out on this basis it will be seen that the first cost of the tool itself is not the only item to consider in installing the tool. There may be considerable space wasted directly due to the fact that the tool is belt driven and that its location is therefore fixed by other considerations than those of economy of manufacture. It is safe to say that motor driven tools will not occupy more than sixty per cent. of the floor space of corresponding belt driven tools; hence a large saving in the cost of the shop chargeable directly to the tool. This percentage will vary with different shops, but the above figure has been obtained by actually comparing an existing modern shop with a proposed plant of the same tools motor driven and arranged in better shape for economical work. In the motor and line shaft driven shop there is no advantage obtained over the ordinary belt and line-shafting transmission. In the motor driven shop there

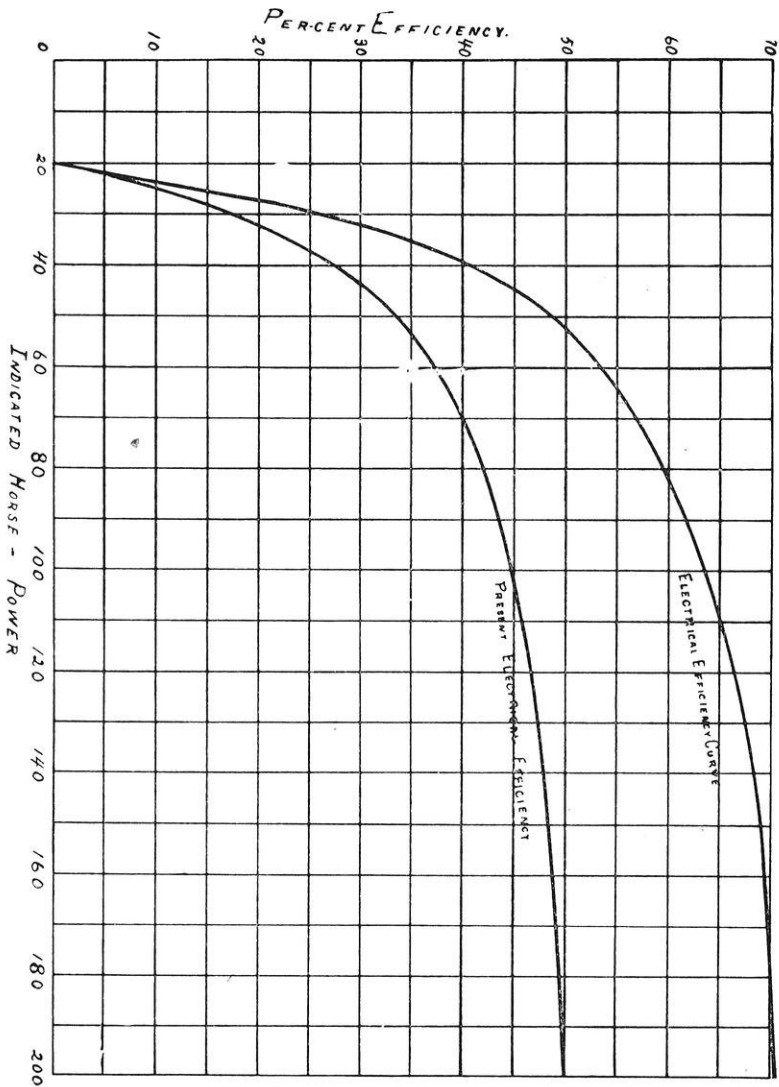


FIG. I.

will be no main belting, jack shaft, main and secondary line shafts, pulleys, hangers, etc., the net cost of which will be saved and which can be applied for the purchase of motors and the necessary electrical equipment. Furthermore in a new plant a large saving can be made in the cost of the shop itself due to the fact that the framing can be made much lighter, as there are no line shafts or countershafts to support and the sole function of the framing will be to

support the roof. In a line shaft driven shop the friction load in the shaft transmission is practically constant and it is not diminished materially even if all of the tools are stopped. In the motor driven shop under like conditions there is no power being used chargeable to the transmission excepting enough to overcome the friction in the generator. In an all electric transmission the efficiency from the engine shaft to the machine tool will not be less than seventy per cent. (at fair loads with scarcely any loss when the driven machinery is shut down.) The best that can be done with line shafts driven by electric motors gives an efficiency of from 20 per cent. to 30 per cent. less, depending upon the condition of the shafting and amount of load.

The writer has just completed a power test of about two hundred machines in a large factory to determine if electrical motor driving can be profitably substituted for the present belt, shafting and gearing transmission. A test of a new electrical transmission recently installed in another factory owned by the same firm has also been made to determine the efficiency actually obtained and to secure such further data as might be available in making the new installation. The curves shown on Fig. I. represents the actual electrical efficiency of the present plant and the expected electrical efficiency of the best possible plant that can be installed to do the work.

Fig II. shows the efficiency of the belt transmission of the old plant and also shows the electrical efficiency expected from an electrical transmission where as many as possible of the motors are direct connected. In this case the old engines will be retained, which reduces the efficiency somewhat. To operate the 249 machines a total of 124 motors is recommended. About 80 of the machines will be direct connected. It will be readily seen that the electrical transmission as at present running does not show any economy over belt transmission. It is about 17 per cent. less than would be obtained by a rope transmission accomplishing the same purpose, i. e., driving a line shaft 150 feet long at a distance from the engine room. The specific reasons for the poor economy shown by the electrical transmission are as follows:

- 1st. The generator is driven by a countershaft belted to the engine by a nearly vertical belt.

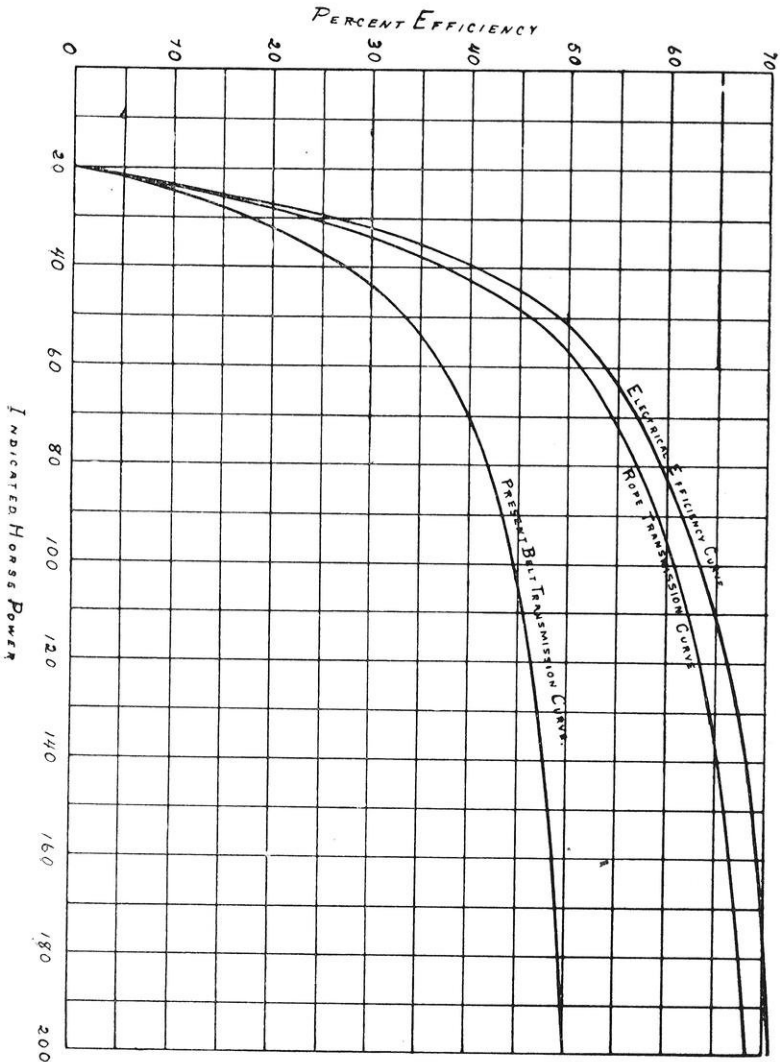


FIG. II.

2nd. The belt from the countershaft of the generator is also nearly vertical.

3rd. The motor installed for driving the line shaft is so large that it is only loaded from 30 to 35 per cent. of its rated capacity.

4th. The motor is belted to a line shaft, causing considerable friction.

5th. The line shaft is out of alignment.

6th. The belt transmissions from the line shaft and counter-shaft to driven machines causes further unnecessary loss.

Leaving efficiency out of consideration, motors should be direct connected because it was shown in the test referred to above that on the average but 55 per cent. of the machinery was in operation at one time and this at a time when every foreman was specially instructed to put on as much load as possible. There is every reason to believe that under average running but 30 to 40 per cent. of the machinery will be in operation at any one time.

In the factory operated by line shafts and large motors the motors will necessarily be running all the time unless the entire department is shut down, consequently large losses will result if there is a breakdown in the motor. In a factory of the kind tested operated by direct driven machinery the motors will last much longer as they will be in actual operation but one third to one half of the time. A breakdown in a single motor will cause no more delay than is caused by the failure of a belt lacing.

Quoting further from the *Iron Age*: "Grouping these tools and operating them from a short length of counter shafting, possesses decided advantages. In this method the aggregate power required is less than would be the case of individual motors and the first cost of the plant is greatly reduced." All other conditions being equal there is but one reason for greater aggregate power being required in the case of individually driven tools than in the case of shaft driven tools, and that reason arises from the fact that very small motors cannot be made so efficient as the larger sizes. As a matter of fact, however, the loss from this source will be comparatively slight, especially when the large net saving of power that arises from individually driven tools is taken into account. From the very fact that it rarely happens that the power required is the sum total of the maximum required for each tool, arises the chief economical advantage of the individually driven tool as compared with the shaft driven tool with the direct electric motor drive. Absolutely no power is being used except when the tool is doing useful work. It seems that this writer has confused the maximum power required by an individual tool with the total aggregate power required to drive a complete plant. It is true the cost of the electric motors for an individually driven plant will be much more

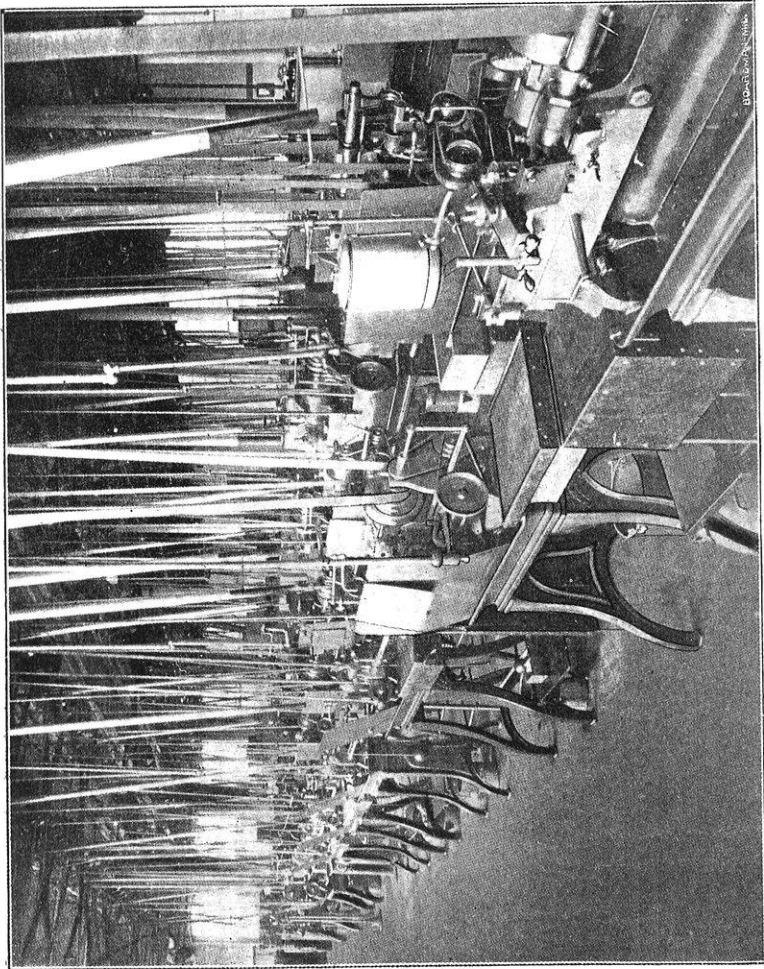


FIG. III.

than the cost of motors for driving by short lengths of shafting. It is not true that the aggregate power required to drive a whole plant will be greater. On the contrary, there is every reason to suppose that it will be much less. It is almost impossible to give accurate figures in this branch of engineering, as very few reliable tests have been made of the power required for operating tools. Some of the tests that are on record are peculiarly amusing. An electrical engineer of high standing naively states that a "small lathe operating on a light cut," requires at 110 volts, 1.14 amperes, equivalent to 1.68 HP. The volts, amperes and HP. re-

quired are accurate to the second decimal place. Such comparatively unimportant details as the size of the lathe, the diameter of the work being operated on, the kind of metal, cutting speed, rate of feed, kind of cutting tool, etc., are passed by. The reason why motors are being put in to operate short lengths of shafting at the present time is because the manufacturers of machine tools and electrical motors are in this particular very much behind the times. The writer does not pretend to have any prophetic instinct but will venture the assertion that all ordinary machine shop tools will be electrically driven in less than five years. There are other considerations besides economy of operation, which will be apparent from an inspection of the machine shop interior shown. This photograph is from probably the best arranged manufacturing plant in the world and certainly shows some of the disadvantages of belt driven machines without much argument.

The following conclusions seem to be true:

1st. The most efficient means of transmitting power to machine tools is by means of electric motors directly connected to each tool.

2d. The cost of the necessary electric motors for such a transmission is considerably more than if the line shaft method is used but the total cost of plant need not and probably will not be as large.

3d. The efficiency of the direct connected plant will be at least 10 per cent. higher than of the line shaft driven plant.

4th. The cost of maintenance of the transmission plant as a whole will be about the same in each case.

5th. Motor driven machine tools can be arranged in any way desired and frequently with considerable economy in floor space over belt driven tools.

6th. There is no loss of power and no wear and tear of loose pulleys and shafting when the machinery is not employed.

7th. A motor driven shop would be much cleaner, as there would be no overhead countershafts and belts to throw oil.

8th. The light in the motor driven shop will not be obstructed by vertical belts.

9th. The cost of a machine shop building for motor driven tools will be materially less than necessary for the line shaft driven shop.

10th. There is nothing to obstruct the free movement of either jib or traveling cranes in the motor driven shop.

11th. Properly designed motor driven tools will be much more efficient than ordinary belt driven tools.

12th. The direct motor driven plant will be more durable; break-downs will not be so likely to occur and will cause less loss when they do occur; furthermore repairs can be easily effected without shutting down.

A COMPARATIVE TEST OF STEAM INJECTORS.*

By G. H. TRAUTMANN, B. S., '96.

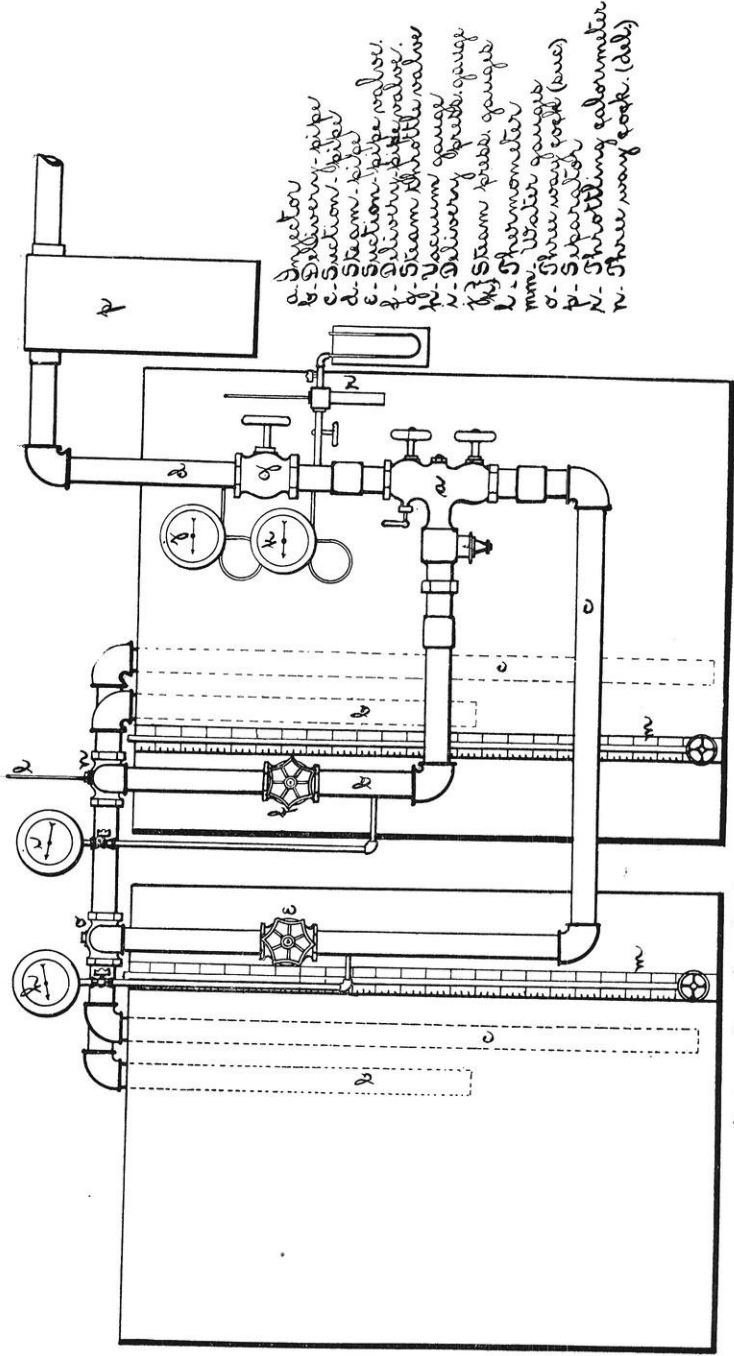
This test was made in the Engineering Laboratory of the University of Wisconsin and extended over a period of several months. The object of the work was to test each of the eight injectors according to a definite system so that they could be compared exactly in every detail carried out. The plan of the apparatus used explains itself. (See page 52.)

The steam is supplied from the boiler-house, passes through a separator before entering the injector and is regulated by means of a throttle-valve (g). The feed water is drawn from one of the tanks and is conveyed to the injector by means of the suction pipe (c) into which is placed a valve (e) which regulates the lift. The suction is measured by the vacuum gauge (h). The water, after passing through the injector is conveyed to the other tank by means of the delivery pipe (b) into which is placed a valve (f) for regulating the delivery pressure. This pressure is registered by the pressure gauge (i). The steam gauges (j) and (k) register the pressures at injector. Temperatures of water, steam, and the room are taken by means of accurate thermometers, and the weight of water is measured by means of water gauges (m) attached to the tanks.

In making out the log of the injector test the following readings were observed:

Duration of run; pressure at injector; delivery pressure; suc-

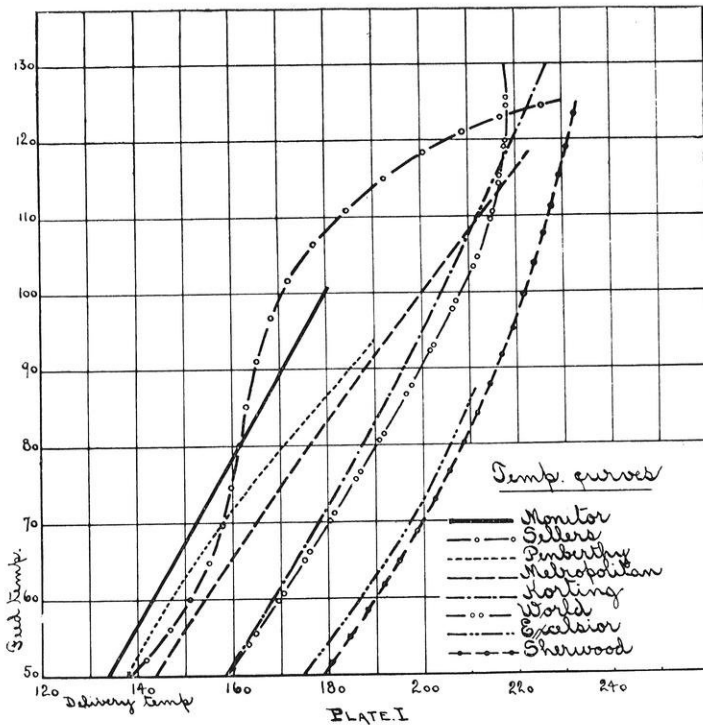
* Abstract of a thesis for the degree of B. S., in mechanical engineering. Received special honors.



- a. Injector
- b. Delivery-pipe
- c. Suction-pipe
- d. Steam-pipe
- e. Suction-pipe valve
- f. Delivery-pipe valve
- g. Steam throttle valve
- h. Vacuum gauge
- i. Delivery gauge
- j. Steam pipe gauge
- k. Thermometer
- l. Water gauge
- m. Three way cock (aux)
- n. Separator
- o. Throttling calorimeter
- p. Three way cock (del)

Apparatus for testing injectors.

tion in inches of Hg. from which is obtained the lift in feet; delivery in feet, calculated from the delivery pressure and lift; temperatures of supply and delivery water; barometer; quality of steam, calculated from the throttling calorimeter readings; pounds of water supplied and delivered; pounds of steam used, obtained by subtracting the number of pounds of water supplied from the number of pounds of water delivered; water per pound of steam by experiment; and the same by calculation.



The formula for this last value was the following:

$$y = \frac{x_1 r_1 + q_1 - q_3}{q_4 - q_3} \text{ in which}$$

y = the number of pounds of water per pound steam;

x_1 = quality of steam as found;

r_1 = heat of vaporization corresponding to the steam pressure at injector;

q_1 = heat of the liquid corresponding to the steam pressure at injector;

q_4 = heat of the liquid corresponding to the temperature of water delivered.

q_3 = heat of the liquid corresponding to temperature of feed water.

The efficiencies of each test were worked out according to the formula—

$$\text{Efficiency} = \frac{\frac{W}{w} (q_2 - q_1) + q_2 + \frac{(W + w) h}{w 772}}{q + rx} \text{ in which}$$

W = weight of water supplied;

w = weight of steam used.

q₂ = the heat of liquid corresponding to delivery temperature;

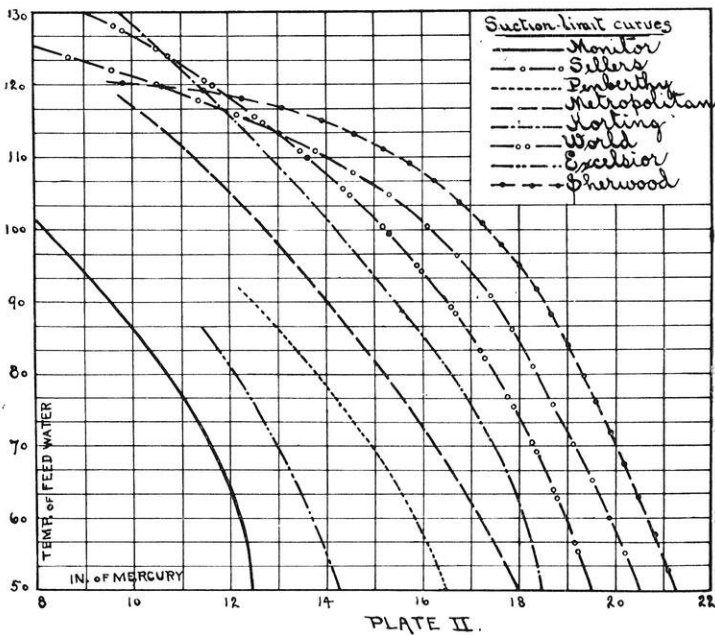
q₁ = the heat of liquid corresponding to the feed water temperature;

q = the heat of liquid corresponding to pressure at injector;

h = lift in feet;

(r) and (x) the same as in preceding formula;

$\frac{1}{772}$ = number of foot-pounds in one heat unit.



The results given by this formula are all very nearly equal. With hardly a single exception the first three figures in the expression for efficiency are 9's, thus showing that the efficiency of the injectors is nearly 100 per cent.

The following injectors were tested:

Penberthy—Scott Valve Co., Chicago, Ill.

Korting—Made at Hanover, Germany.

Sellers—Wm. Sellers Co., Philadelphia.

World—American Injector Co., Detroit, Mich.

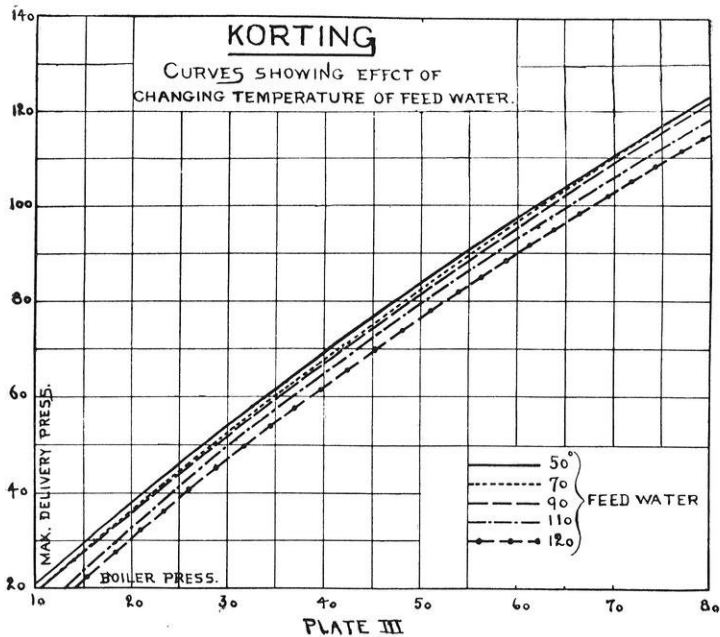
Sherwood—Sherwood Injector Co., Buffalo, N. Y.

Monitor—Nathan M'fg Co., N. Y. City, 92--94 Liberty St.

Excelsior—N. A. Watson, Erie, Pa.

Metropolitan—The Hayden & Derby M'fg Co., N. Y. City, 111 Liberty St.

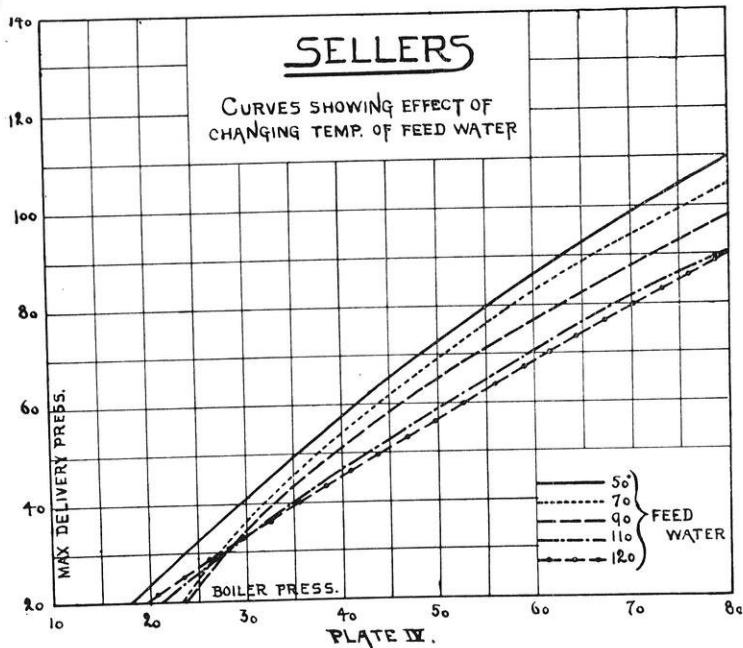
All injectors in this test were lifting injectors. The Korting, World, Metropolitan, and Sherwood are double tube, and the Sellers, Monitor, Penberthy and Excelsior are single tube injectors.



The system used to compare the injectors was as follows:

The pressure at injector was always kept at 80 pounds. The lift was always kept constant at 8" of Hg. The discharge pressures were taken at 20, 40, 60, 80, 100, 120, etc., to the limit. For each one of these pressures a run of a certain number of minutes was made keeping all values constant during the run. Temperatures of feed water were 50°, 70°, 90°, 110°, 120° F., etc., to the limit. For each change of feed water temperature a complete series of tests was made using the discharge pressures as given

above. The limits were also determined after each series of tests. In order to determine the limit of delivery, the pressure at injector being kept constant at 80 pounds and the vacuum gauge at 8", the discharge pressure was carefully increased until the injector would stop working. This highest pressure being the limit of discharge for 80 pounds boiler pressure and a lift of 8" of Hg. for each certain temperature of feed-water used. This series of discharge-limit tests was carried out for boiler pressures at 80, 60, 40, 20, etc., to the lowest limit at which the injector would work.

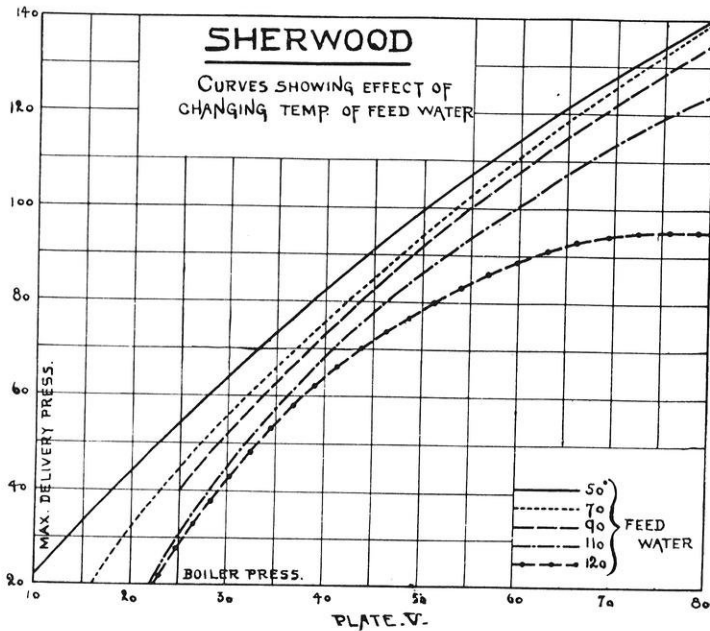


Suction limit tests were also made for each change of feed-water temperature. This was done by keeping the boiler-pressure constant always at 80 pounds, and finding the limit of suction for varying pressures of discharge, i e., at 20, 40, 60, 80, 100, etc.

Several curves were drawn in order to compare the workings of the injectors more easily. The curves on Plate I. are temperature curves. The feed-water temperatures are taken as ordinates and the delivery temperatures as abscissas. The different injectors are shown by lines drawn according to the key at the bottom of the plate. This plate shows that the Sherwood heats the water

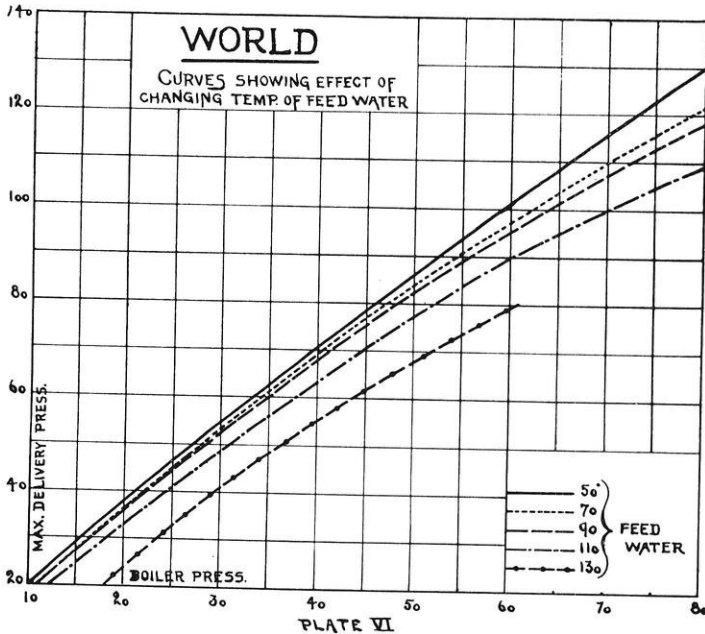
to a higher temperature than any other but the following table shows that the number of pounds of water per pound of steam (7.83) is much less than the others. This is a natural consequence as a smaller amount of water would be heated to a higher temperature:

No.	Name.	Gall'ns per hour.	Temperature of feed water.	Size of steam pipe.	Average water per lb. of steam.	Temp. of delivery.	Suction limit.	Limit of feed Temp.
1	Sellers.....	615	50	1½ in.	12.17	137	20.5 in.	125
2	Sherwood.....	579	50	1 in.	7.83	179	21.25 in.	122
3	Metropolitan.....	645	50	1 in.	11.07	144	17.75 in.	118
4	Monitor.....	511	50	1 in.	12.37	175	12.5 in.	102
5	Penberthy.....	478	50	¾ in.	12.03	137	16.5 in.	94
6	Korting.....	508	50	1½ in.	9.47	159	18.5 in.	130
7	World.....	370	50	¾ in.	9.22	160	19.5 in.	130
8	Excelsior.....	286	50	¾ in.	7.95	175	14 25 in.	87



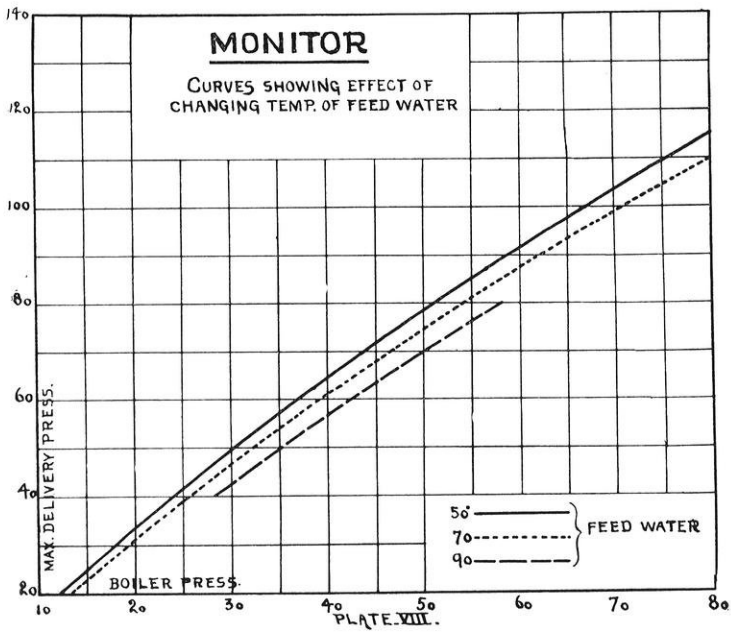
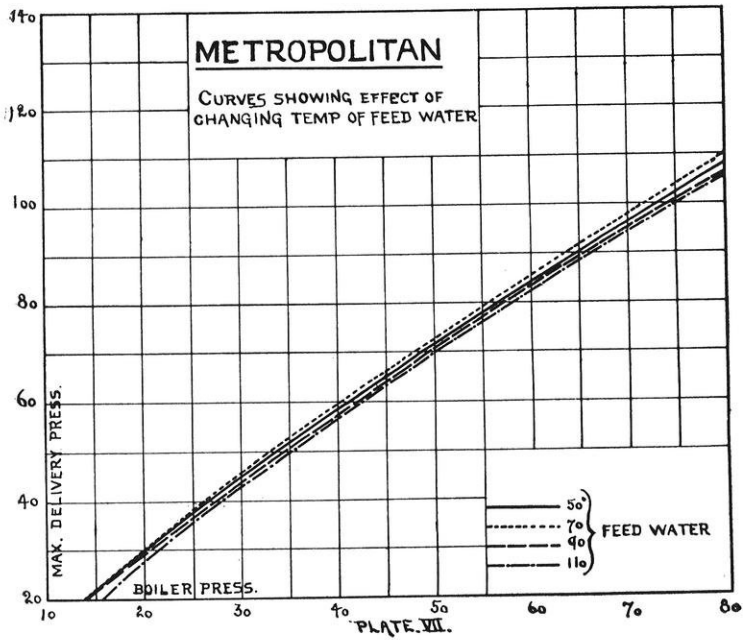
This same table shows that the Monitor delivers the greatest number of pounds of water per pound of steam (12.37), but in plate I. it ranks last in heating capacity. The World and Korting are

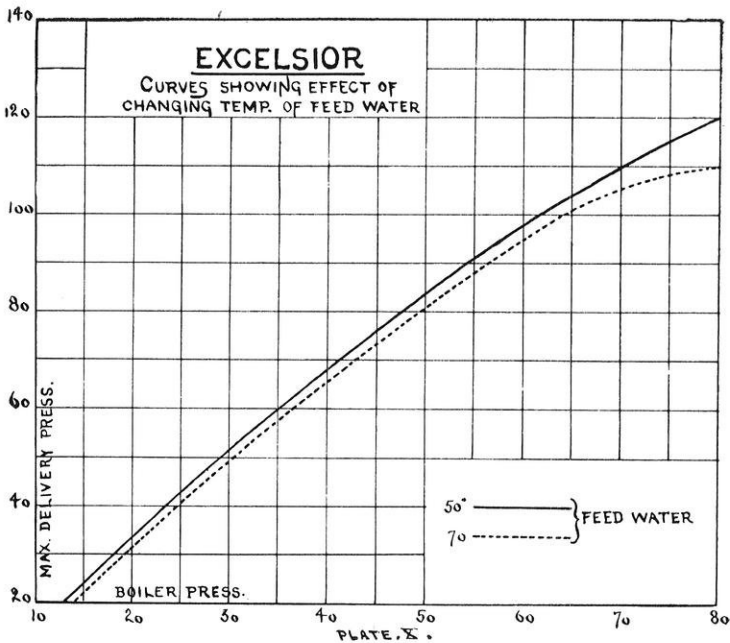
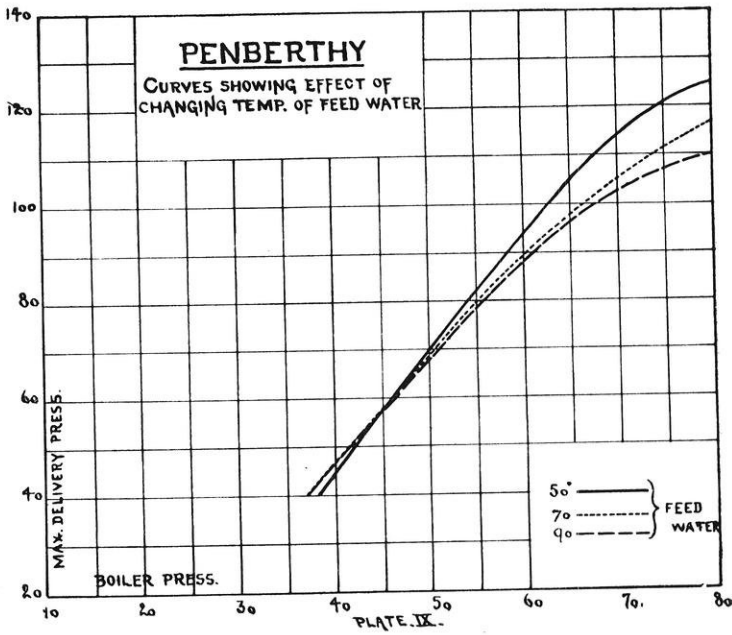
nearly the same in plate I. They are a little above the average in heating capacity and are nearly up to the average in the table for the number of pounds of water per pound steam, the World being (9.22) and the Korting (9.47). The table as well as plate I. shows that they are higher than all the others in the range of feed-water temperature, being equal at the limit (130°). The Sellers averages up well, the limit of feed-water temperature being 125°, the number of pounds water per pound of steam, 12.17 (ranking second) but the heating capacity is quite low, ranking about sixth in plate I.

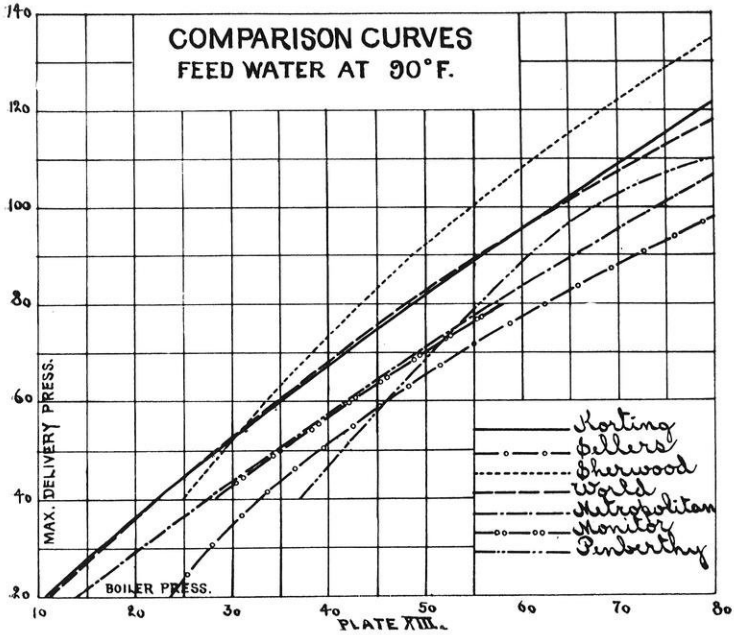
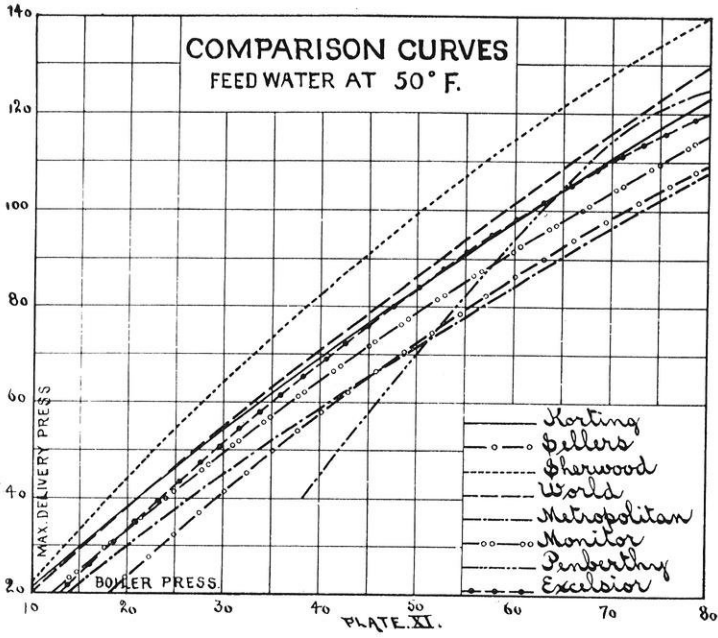


The Metropolitan is fifth in rank on plate I., being the lowest of the double-tube injectors for the limit of feed-water temperature (118°), and next to the lowest in heating capacity. It ranks fourth in the above table, the number of pounds water per pound steam being (11.07). Plate I. shows clearly that the double-tube injectors are best suited for hot water. The heating capacity of the single-tube injectors are all much lower than the double.

Plate II. shows that the order of highest suction limit is as follows:







- | | |
|-------------------------|-----------------------------|
| 1. Sherwood.....double. | 5. Metropolitan.....double. |
| 2. Sellers.....single. | 6. Penberthy.....single. |
| 3. World.....double. | 7. Excelsior.....single. |
| 4. Korting.....double. | 8. Monitor.....single. |

Plates III. to X. show the effects of changing the feed-water temperature. Each is for a separate injector. In these curves the maximum delivery pressures are taken as ordinates and the boiler pressures as abscissas. In these curves it is shown that the Korting and Metropolitan are the least affected by change of feed-water temperature, the curves for different temperatures being nearly identical. The Sellers and World vary quite a little, while the Sherwood changes considerably. On plates XI. and XIII. will be found comparison curves for feed-water at 50° and 90° F. Plate XI. is made up by transferring the 50° curve for each injector to the same plate, the object being to make a plate of curves where the injectors could be directly compared. Plate XIII. is made up in the same manner with 90° curves.

It is difficult to draw definite conclusions from these tests since injectors may be used under so many different conditions. Probably the most important property of an injector is its ability to use hot feed-water, and next its lifting power. The other properties do not figure so much since the efficiencies are all nearly 100 per cent.

NEW U. W. PUBLICATIONS.

The two following publications have recently appeared. Their origin is distinctly U. W. and Wisconsin may well feel proud of the authors. Mr. Ford took his second degree last June. He is a very young man and we hope he will live to realize the bright future his past work has indicated. Professor D. C. Jackson is also a young man, when his reputation is considered, and it will be a long time before his sun shall have risen to its zenith.

BULLETIN OF THE UNIVERSITY OF WISCONSIN.

ENGINEERING SERIES, VOL. 2, NO. 1.

A COMPLETE TEST OF MODERN AMERICAN TRANSFORMERS OF MODERATE CAPACITIES.

ARTHUR HILLYER FORD, Fellow in Electrical Engineering.

The publication begins with an introductory note by Prof. D. C. Jackson, addressed particularly to central station managers, containing in condensed form a method for making tests and some guarantees which should be required for transformers.

These guarantees are as follows: Iron loss from 30 watts to 150 watts, and exciting current from .055 amperes to .2 amperes for sizes from 1,000 watts to 10,000 watts output, with primary pressure 1,000 volts and at a frequency of 100 cycles per second. Pressure drop in secondary 3 per cent. between no load and full load. Maximum rise in temperature 70° F. Disruptive strength of insulation between primary coil and core to be 10 times the primary pressure. Testing all transformers on the line at least once a year is also advised.

The body of the publication is taken up with the results of the tests on 21 different transformers, ranging in size from 1,000 watts to 10,000 watts capacity, representing all the American makers except two. Most of the tests were made during the year 1895, but others have since been made on new types of transformers so that the tests show the practice up to July, 1896.

The points tested are copper loss, core loss, exciting current, regulation and heating. The methods used in the tests are then given, after which follow the results of the tests in the form of tables and curves, showing losses and efficiencies. Following this is the discussion of results. *Instruments*—Even the best instruments for the measurement of alternating currents are unreliable. *Methods*—The method devised by Dr. Sumpner for determining the losses was found to be the best. The iron losses are measured with a wattmeter by connecting the low pressure coil of the transformer to a source of alternating current, having the pressure at which the coil is designed to work, through the wattmeter, the primary being open. The copper loss is measured by short circuiting the secondary through an amperemeter and supplying an alternating current to the primary through a wattmeter; the pres-

sure being just sufficient to force the desired current through the secondary. The wattmeter gives the copper loss in the transformer plus that in the ammeter, which can be easily calculated. *Losses and efficiencies*—The iron losses are all reduced to the loss per cubic centimeter and the hysteresis factor is calculated so that the quality of the iron used in the different transformers can be compared. Measurements of the Foucault current losses are attempted but were not satisfactory. *Exciting current*—The presence of butt joints increases the exciting current. *Regulation*—Transformers with coils having the greater dimension of their cross section parallel to the axis have better regulation than those with square cross section. Transformers for giving constant current with primaries at constant pressure which depend on the magnetic leakage, for their regulation will work at only one frequency. *Conclusions*—It pays to make a careful selection of transformers and even to throw away those on the line which do not come up to the standard. Transformers which are permanently connected to the line and which have the load on for only a small portion of the time should be built with the maximum efficiency at about quarter load even at the expense of regulation, instead of at or above full load, as is now done in most cases.

ALTERNATING CURRENTS AND ALTERNATING CURRENT
MACHINERY.

BEING VOLUME II OF THE TEXT-BOOK ON ELECTRO-MAGNETISM AND THE CONSTRUCTION OF DYNAMOS.

By DUGALD C. JACKSON, C. E., and JOHN PRICE JACKSON, M. E.

The Macmillan Company, New York.

This book is based mainly on the lectures of Professor D. C. Jackson to seniors and graduate students in the University of Wisconsin, but the manuscript was carefully revised and extended by Professor J. P. Jackson of Pennsylvania State College. The book contains over seven hundred pages and deals with the subject in a very thorough manner. There are a number of original demonstrations which help to clear up the somewhat difficult problems in alternating currents. A great many words are saved by the free use of diagrams and all the illustrations have been selected for their clearness. An important change in nomenclature has been introduced: the term *active* to represent the component

of electromotive force in phase with current, and to represent the working component of current. This removes the inconvenience caused by the use of the term *effective* as formally adopted to mean $\sqrt{\text{mean.}}$ A number of the laboratory tests referred to were worked out by students at U. W. In most cases foot-notes acknowledge the authors' indebtedness.

Following is a review of the contents:

- Chapter I. Electric Pressure Developed by Alternators.
- Chapter II. Armature Windings for Alternators.
- Chapter III. Self-Induction and Capacity.
- Chapter IV. Graphical and Analytical Methods of Solving Problems in Alternating Current Circuits.
- Chapter V. The Magnetic Circuit of Alternators.
- Chapter VI. Characteristics, Regulation, etc.
- Chapter VII. Regulation and Combined Output.
- Chapter VIII. Efficiencies, etc.
- Chapter IX. Mutual Induction.
- Chapter X. Operation of Ideal Transformer and Effect of Iron and Copper Losses.
- Chapter XI. Efficiency and Losses in Transformers.
- Chapter XII. Design of Transformers.
- Chapter XIII. Polyphase Conducting Systems and the Measurement of Power in Polyphase Circuits.
- Chapter XIV. Alternating Current Motors.
- Chapter XV. Polyphase Transformers.

APPENDICES.

- A. The Application of Fourier's Series to Alternating Current Curves.
- B. The Characteristic Features of Alternating Current Curves.
- C. Oscillatory Discharges.
- D. Electrical Resonance.

Index.

As the essence of the book is taken from lectures to college classes, its chief function will be that of a text-book, and for this reason it is so designed that it may be used for either a long or a short course. In the latter case, chapters IV., X., XI., XII., XIII., XIV., XV., and the appendices may be omitted. An abbreviated course is not, however, advised by the authors, for students in Electrical Engineering.

Descriptions of commercial machinery are avoided as the student is expected to get his working knowledge from the laboratories and by reading the numerous references.

The practical engineer will find in this volume an excellent reference book. There is no padding, the tables are modern, theory is simple and the mathematics are not such as would stagger a person. These good points, however, would be of little avail to the busy engineer, were it not for the index which was compiled for use.

COLLEGE TECHNICAL JOURNALS.

The Technograph for 1896, published annually by the Association of Engineering Societies of the University of Illinois issued in May, contains several interesting articles on technical subjects. It also contains a descriptive index of central stations giving a brief description of situation and equipment of the principal central stations in the United States, as described in the leading technical journals.

The Minnesota Year Book, issued annually by the technical students of the University of Minnesota, contains several valuable articles of interest to scientific men and engineers. The articles are contributed by professors and students and many of them are the result of extensive research in their respective lines.

EDITORIAL.

The marked success which attended the first appearance of the *ENGINEER* was gratifying not alone to the editors, but to all the professors, students and alumni of the University. This success was due in no small part to the active interest taken by all in the new magazine. The immense amount of work required in its edition was gladly given by those who were able to assist.

Naturally it is to be expected that many things in the new magazine can be bettered. But time and experience will soon show what is best. Beginning with this number, the *ENGINEER* appears in a permanent cover. This, we think, will greatly improve its external appearance. Some changes have been made in the magazine itself. Smaller type has been used in the index, making it much more compact, and it has been improved by the addition of index letters, making it more convenient for use.

The senior engineers and several of the engineering faculty are indebted to the Western Society of Engineers for a very pleasant and instructive trip to Louisville. The party, consisting of members of The Western Society with their wives and friends, left Chicago Thursday evening, October 15th, on a special train consisting of five Pullman sleepers on the Monon route. Thursday morning the party found themselves at Bloomington, Indiana, where, after partaking of breakfast as guests of the Stone Quarry companies, they proceeded to inspect the quarries at Bloomington and Bedford. In the afternoon the train proceeded to Louisville, arriving in time for supper. On Saturday morning the party became the guests of the Louisville Cement company and were taken from the depot to the Louisville Hotel in a special train of five electric cars. From there the party took a train on the Pan-handle road to the quarries of the Louisville Cement company, where the complete process of the manufacture of cement was seen. The works of the Black Diamond company were also visited. Here a large blast was exploded for the benefit of the party. After dinner a steamer was boarded and a trip was taken up the Ohio river to the Louisville waterworks, where the large pumping engine and the filters for purifying the river water were inspected.

It was expected that the party could go on to the Mammoth

Wisconsin Engineer Index

To Current Engineering Periodicals.

Explanation:—W, words. M. Jan., W. Jan. 4, or P. Jan. at the end of the reference, indicates that a description or digest of the article may be found in the index of the Engineering Magazine of January, in The Electrical World digest of January 4, or in the Electric Power digest for January.

List of periodicals from which articles are indexed:

- American Architect, The. *w.* \$6. Boston.
Am. Engineer and Railroad Jour. *m.* \$2. New York.
Am. Chemical Journal. *b-m.* \$4. Baltimore.
Am. Gas Light Journal. *m.* \$3. New York.
Am. Journal of Science. *m.* \$6. New Haven.
American Machinist. *w.* \$3. New York.
Am. Manufacturer and Iron World. *w.* \$4. Pittsburgh.
American Miller. *m.* \$2. Chicago.
American Shipbuilder. *w.* \$2. New York.
Am. Soc. of Irrigation Engineers. *qr.* \$4. Denver.
Annual Report of Illinois Society of Engineers and Surveyors. New York.
Architectural Record. *qr.* \$1. New York.
Architect, The. *w.* 26s. London.
Architecture and Building. *w.* \$6. New York.
Architectural Review. *qr.* \$5. Boston.
Australian Mining Standard. *w.* 30s. Sidney.
Boston Journal of Commerce. *w.* \$3. Boston.
Brick. *m.* \$1. Chicago.
Brick Builder, The. *m.* \$2.50. Boston.
British Architect, The. *w.* 23s. 8d. London.
Builder, The. *w.* 26s. London.
Bulletin Am. Iron and Steel Assn. *w.* \$4. Phila.
Bulletin of Univ. of Wisconsin. Madison.
California Architect. *m.* \$3. San Francisco.
Canadian Architect. *m.* \$2. Toronto.
Canadian Engineer. *m.* \$1. Montreal.
Canadian Mining Review. *m.* \$1.50. Ottawa.
Cassier's Magazine. *m.* \$3. New York.
Clay Records. *m.* \$1. Chicago.
Colliery Engineer. *m.* \$2. Scranton.
Colliery Guardian. *w.* 27s. 6d. London.
Domestic Engineering. *m.* \$2. Chicago.
Electric Power. *m.* \$2. New York.
Electric Railway Gazette. *w.* \$3. New York.
Electrical Age. *w.* \$3. New York.
Electrical Engineer. *w.* 19s. 6d. London.
Electrical Engineer. *w.* \$3. New York.
Electrical Engineering. *m.* \$1. Chicago.
Electrical Industries. *m.* \$1. Chicago.
Electrical Journal. *m.* Chicago.
Electrical Plant. *m.* 6s. London.
Electrical Review. *w.* 21s. 8d. London.
Electrical Review. *w.* \$3. New York.
Electrical World. *w.* \$3. New York.
Electrician (Electn.). *w.* 24s. London.
Electricity, (Elec. Lond.). *w.* 7s. 6d. London.
Electricity (Elec.). *w.* \$2.50. New York.
Electrochemische Zeitschrift. *m.* Ger.
Electrotechnische Zeitschrift. *m.* Ger.
Engineer, The (Eng.). *s-m.* \$2.50. New York.
Engineer, The (Eng. Lond.). *w.* 36s. London.
Engineer and Contractor. *w.* \$1. San Francisco.
Engineer's Gazette. *m.* 8s. London.
Engineering (Engng.). *w.* 36s. London.
Engineering and Mining Jour. *w.* \$5. N. Y.
Engineering Magazine. *m.* \$3. New York.
Engineering-Mechanics. *m.* \$2. Phila.
Engineering News. *w.* \$5. New York.
Engineering Record. *w.* \$5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Pennsylvania. *m.* \$7. Pittsburgh.
Foundry, The. *m.* \$1. Detroit.
Gas Engineers' Magazine. *m.* 6s. 6d. Birmingham.
Heating and Ventilation. *m.* \$1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8d. London.
India Rubber World. *m.* \$3. New York.
Gas World, The. *w.* 13s. London.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineer. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* \$5. Chicago.
Inventive Age. *s-m.* \$1. Washington.
Iron Age. *w.* \$4.50. New York.
Iron and Coal Trade Review. *w.* 70s. 4d. London.
Iron and Steel Trades Jour. *w.* 25s. London.
Iron Industries Gazette. *m.* \$1.50. Buffalo.
Iron Trade Review. *w.* \$3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* \$5. Washington.
Jour. Assn. Eng. Societies. *m.* \$3. St. Louis.
Journal of Electricity, The. *m.* \$1. San Francisco.
Jour. Franklin Institute. *m.* \$5. Phila.
Journal of Gas Lighting. *w.* London.
Journ. of Inst. of Elect. Engineers. London.
Jour. New England Waterw. Assn. *qr.* \$2. New York.
Jour. of Royal Inst. of British Arch. *s-qr.* 6s. London.
Journal of Society of Arts. *w.* London.
L'Eclairage Electrique. *w.* France.
L'Electricien. *w.* France.
L'Energie Electrique. France.
L'Industrie Electrique. *b-m.*
Locomotive Engineering. *m.* \$2. New York.
Machinery. *m.* \$1. New York.
Machinery (Mach. Lond.). *m.* 9s. London.
Manufacturer and Builder. *m.* \$1.50. New York.
Manufacturer's Record. *w.* \$4. Baltimore.
Marine Engineer. *m.* 7s. 6d. London.
Master Steam Fitter. *m.* \$1. Chicago.
Mechanical World. *w.* 8s. 8d. London.
Metal Worker. *w.* \$2. New York.
Mining and Sci. Press. *w.* \$3. San Francisco.
Mining Industry and Review. *w.* \$3. Denver.
Mining Journal, The. *w.* £1. 8s. London.
Mining World, The. *w.* 21s. London.
National Builder. *m.* \$3. Chicago.
Nature. *w.* \$7. London.
New Science Review, The. *qr.* \$2. New York.
Paving and Municipal Engng. *m.* \$2. Indianapolis.
Physical Review. *b-m.*
Plumber and Decorator. *m.* 6s. 6d. London.
Popular Science Monthly. *m.* \$5. New York.
Power. *m.* \$1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineers' Club. *qr.* \$2. Philadelphia.
Progressive Age. *s-m.* \$3. New York.
Railroad Car Journal, The. *m.* \$1. New York.

cave, but owing to the short notice plans could not be perfected; so Saturday evening the party left Louisville, arriving in Chicago Sunday morning. After returning to Chicago the seniors divided into their respective courses and made their regular inspection trips among the various works of interest in the city. As guests of the Western Society and the Cement and Stone companies, the seniors speak most highly of their entertainment and are exceedingly grateful for the opportunity from which they were able to derive so much pleasure and benefit.

A word about our index may not be amiss. It has received many compliments and has also been severely criticised by some whom we believe do not understand our intentions. The primary object in view on starting the index was to continue the work of the Associated Societies which had been discontinued on account of the heavy expenses involved. It was decided that to start an index with a digest of each article would be impracticable on account of the immense amount of work required and also the space needed would make it prohibitive. It was then decided to publish an index that would give the name and length of every article, the periodical in which it might be found and, if reviewed in one of the large magazines, the fact was to be mentioned. In this the index becomes similar to Poole's Index. All American Technical Journals and the principal foreign journals are indexed. Thus if any one wishes to find what current literature there may be on any technical subject it is only necessary that he should look under its principal alphabetical heading and there will be found all that has been published in the last three months. To find a year's writings it is necessary to refer to but four numbers. In order to do this with the others it would require the examining of twelve different numbers and as many different headings. Another desirable feature is the printing of the index on one side of the paper only. This makes it convenient for clipping where engineers desire to clip titles to insert in their scrap books for future reference.

It is our desire to make the index as complete and convenient as possible, and any suggestions for its betterment will be gladly received.

- Railroad Gazette. *w.* \$4.20. New York.
 Railway Age. *w.* \$4. Chicago.
 Railway Master Mechanic. *m.* \$1. Chicago.
 Railway Press, The. *m.* 7s. London.
 Railway Review. *w.* \$4. Chicago.
 Railway World. *m.* 5s. London.
 Safety Valve. *m.* \$1. New York.
 Sanitarian. *m.* \$4. Brooklyn.
 Sanitary Plumber. *s-m.* \$2. New York.
 Sanitary Record. *m.* 10s. London.
 School of Mines Quarterly. \$2. New York.
 Science. *w.* \$5. Lancaster, Pa.
 Scientific American. *w.* \$3. New York.
 Scientific Am. Supplement. *w.* \$5. New York.
 Scientific Machinist. *s-m.* \$1.50. Cleveland.
 Sibley Jour. of Engineering. *m.* \$2. Ithaca, N. Y.
 Southern Architect. *m.* \$2. Atlanta.
 Stationary Engineer. *m.* \$1. Chicago.
- Stevens' Indicator. *gr.* \$1.50. Hoboken.
 Stone. *m.* \$2. Chicago.
 Street Railway Journal. *m.* \$4. New York.
 Street Railway Review. *m.* \$2. Chicago.
 Tradesman. *s-m.* \$2. Chattanooga, Tenn.
 Trans. Am. Inst. Elect. Engineers. *m.* \$5. New York.
 Trans. Am. Inst. Mining Engineers. New York.
 Trans. Am. Soc. Civil Engineers. *m.* \$10. New York.
 Trans. Am. Soc. Mechanical Engineers. New York.
 Transport. *w.* £1,5s. London.
 Technology Quarterly. \$3. Boston.
 Western Electrician. *w.* \$3. Chicago.
 Western Mining World. *m.* \$4. Butte, Mon.
 Wiedemann's Annalen.
 Zeitschrift für Beleuchtungswesen. Ger.
 Zeitschrift für Electrochemie. *s-m.* Ger.
- A**BBEY Dore (Ill.)—R. W. Paul, Builder.
 April 4. 4000 w. M. June.
 ABSORPTION Photography—See Roentgen Rays.
 ABUTMENT, To Ascertain the Best Angle for Wing Wall of Bridge—J. H. Sewiss, Ill. Soc. of Engrs. and Surv. 11 An. Rept.
 ACCIDENTS in April—R. R. Gaz. May 22. 2200 w.
 Accidents in May—R. R. Gaz. June 26. 500 w.
 Accidents in the United States in June, Train—R. R. Gaz. July 24. 2200 w.
 ACCUMULATOR—Elec. Jour. May 15. Lighting. June 11. W. July 18. L'Elec. July 11. W. Aug. 1. L'Eclair Elec. May 16. W. June 13.
 Accumulator Accessories—Elec. Lond. July 3. Serial. Part 1. 1000 w.
 Accumulator Jars—Electrotechn Zeit. June 11.
 Accumulator, Prize for—Electn. Apr. 10. W. May 2. Electrotechn Zeit. Aug. W. Aug. 22.
 Accumulator Traction—Elec. Eng. Lond. July 17. W. Aug. 8.
 Accumulator Traction at Birmingham—Elec. Eng. Lond. Apr. 10. W. May 2.
 Accumulators and Reserve in Installations—Massenbach, Elektrotechn Zeit. Apr. 23. W. May 16.
 Accumulators, Celluloid in—Elec. Rev. Lond. July 31. W. Aug. 22.
 Accumulators, Cellulose in—Elec. Rev. Lond. May 29. W. June 20.
 Accumulators for Lighting Railway Carriages, Experiments with—G. Klose, Eng. Lond. April 24. 600 w. M. June.
 Accumulators of the Future—Warren, Chem. News, Elektrochem Zeit. June 5. W. July 4.
 Accumulators, The Theory of—Lubenow, Zeit. f. Electrochem. June 20.
 Accumulators, Weight of Solution in—Fitzgerald, J. Inst. Elec. Eng. Mar. W. May 9.
 Accumulators with the Alternating Current Supply at Zurich, Use of—Jour. Inst. Elec. Eng. May. Elec. Rev. June 13.
 ACCURACY, The Evils of Fictitious—Eng. News. July 30. 1600 w. M. Sept.
 ACETYLENE, A Lecture upon—J. M. Crafts, Science. Mch. 13. 9000 w. M. May.
 Acetylene and Calcium Carbide, A Discussion of Certain Recent Data on the Cost of—W. H. Birchmore, Am. Gas Lgt. Jour. May 25. 3400 w. M. July.
 Acetylene and Car Lighting—P. Conradson, Ry. Rev. July 25. 1800 w.
 Acetylene Apparatus (Ill.)—T. O'Connor Sloane, Sci. Am. Sup. Apr. 4. 2800 w. M. May.
 Acetylene, Domestic Lighting with—L'Ind. Elec. Apr. 10.
 Acetylene Gas—G. Black, Can. Elec. News. July. 3800 w.
 Acetylene Gas as an Illuminant, Commercial Value of—T. A. Ferguson, Eng. News. May 14. 2000 w. M. July.
 Acetylene Gas as an Illuminant for Polaroscope Work, Note on the Use of—H. W. Wiley, Pro. Age. Mar. 16. 800 w. M. May.
 Acetylene, Practical Use of—W. W. Goodwin, Am. Gas Lgt. Jour. June 1. 2700 w.
 Acetylene Standard for Photometry, An.—Pro Age. Mch. 16. 500 w. M. May.
 Acetylene, The Fire Hazard of—Am. Gas Lgt. Jour. Apr. 27. 600 w. M. June.
 Acetylene—See Electric Energy.
 ADJUSTER, Brake Slack—R. R. Gaz. April 24. 1800 w. M. June.
 ADMIRALTY Officers, The New (Ill.)—Eng. Lond. July 31. 1600 w.
 AERIAL Navigation, Latest Inventions in (Ill.)—Rudolph Kosch, Sci. Am. Sup. May 30. 2800 w.
 Aerial Tramways—W. R. Shaw, Ind. and East Eng. July 11. 2200 w.
 Aerial Navigation—See Navigation.
 AFTERDAMP—T. Davies, Col. Guard. July 17. 2000 w.
 AGRICULTURAL MACHINERY—Sci. Am. July 25. 4200 w.
 AIR and Other Gases, The New Process for the Liquefaction of—Nature. April 2. 1000 w. M. June.
 Air as Used for Power Purposes, Compressed—Frederick C. Weber, Compressed Air. May. 2000 w.
 Air Brake Hose Dummy Coupling—R. R. Car Jour. April. 250 w. M. June.
 Air Brake Hose, Talks with Rubber Men—Ind. Rub. Wld. June 10. 2500 w.
 Air Brake Hose, The Inspection of—Ry. Mas. Mech. June. 1200 w.
 Air Brake Instruction Car No. 108, Southern Railway (Ill.)—Loc. Engng. June. 800 w.
 Air-Brake Instruction Plant, Central of Georgia R. R.—W. W. Elfe, Loc. Engng. May. 250 w.
 Air-Brake Men's Association Committee Reports—R. R. Gaz. Apr. 24. 600 w. M. June.
 Air-Brake Men's Association, The—R. R. Gaz. May 1. 6500 w.
 Air-Brake Piston Travel—R. R. Gaz. April 17. 4000 w. M. June.
 Air Brakes, Piston Travel of—Ry. Rev. April 25. 1100 w.
 Air-Brake Recorder, An Automatic—Ry. Rev. May 2. 1200 w.
 Air-Brake Rigging, Cost of—Ry. Rev. July 25. 1200 w.
 Air-Brake Testing and Inspecting Plants—Pro. West Ry. Club. May. 500 w. M. Aug.
 Air Brakes, Qualifications of a Superintendent of—F. B. Farmer, Paper N. W. Ry. Club. Ry. Rev. Apr. 18. 1800 w. M. June.
 Air, Compressed—W. L. Saunders, Compressed Air. Mch. Serial. Part 1. 1700 w. M. May.
 Air Compressor, Test of a Compound—Am. Mach. Apr. 16. 1000 w. M. June.
 Air Compressing at Drummond Colliery, N. S. Experience with—Charles Fergie, Can. Min. Rev. Mch. 1500 w. M. May.
 Air Compressors—P. Bjorling, Col. Guard. July 31. Serial. Part I. 2000 w.
 Air Compressors of the Pneumatic Gun Battery, High Pressure (Ill.)—B. C. Batcheller, Am. Mach. Apr. 23. 1800 w. M. June.
 Air Compressors, The Efficiency of—C. P. Paulding, Am. Mach. July 9. 1200 w. M. Aug.
 Air in Colliery Workings, Continuous and Automatic Sample—Taking of (Ill.)—Paul Petit, Col. Guard. Mch. 27. 2000 w. M. May.

A new scientific organization to be known as The Science Club of the University of Wisconsin, has recently been formed. Its existence is due to the energy of Professor George C. Comstock. In the past there have been a number of minor clubs devoted to special branches of science; but the experience has been that the interest taken in them, while very great at their inception, gradually dies out, leaving the major part of the work in the hands of a few over-taxed specialists. This is due to the decidedly technical character of the programs and for this reason a larger body of a less technical nature is desired. Such an organization will not encroach upon the ground of the smaller clubs devoted to special branches of science, but these will not be expected to have so large a membership.

The object of the organization is expressed in the preamble: "For the promotion, within the University of Wisconsin, of an interest in and knowledge of the physical and natural sciences and their useful application." * * * One of the by-laws reads: "The programme and discussion at regular meetings of the association shall be, so far as possible, of an untechnical character." Meetings will be held once a month.

The advantages of the club may be enumerated as follows:

1. The untechnical character of the program enables men of science to become acquainted in a general way with the branches of science in which they themselves have not specialized and to an extent which would otherwise require the expenditure of more time and study than the returns would warrant.
2. The research work in the University can be presented by the investigators, which is a great advantage.
3. The members become well acquainted with one another socially.

The present officers of the club are: President, Professor George C. Comstock; Vice President, Professor D. C. Jackson; Secretary and Treasurer, Dr. William S. Marshall. These three men constitute the executive committee.

The program committee consists of Professor Comstock, ex-officio chairman, Dr. Edward Kremers and Dr. Joseph Jastrow. There are about fifty charter members, consisting of members of the faculty and graduate students.

The Wisconsin Engineer wishes the club success and will publish a resumé of their proceedings in its future numbers.

- Air Lift, Handy (Ill.)—Loc. Engng. May. 60 w.
- Air Motor—See "Motor."
- Air Paradox, A Compressed—Frank Richards, Am. Mach. Apr. 16. 900 w. M. June.
- Air Splits, Useful Effects of—Am. Mfr. and Ir. Wld. July 3. 1600 w. M. Aug.
- ALGERIA—see Electricity.
- ALKALINE Chlorides—See Electrolysis.
- ALLOYS, Comparative Tests of Nickel Iron—David H. Browne, Eng. and Min. Jour. May 16. 1200 w. M. July.
- Alloys, Methods of Preparing—Moissau, L'Ind. Elec. June 25. W. July 18.
- Alloys of Iron and Nickel—M. Rudeloff, Ir. Age, Apr. 23. 800 w. M. June.
- ALTERNATE Current and Continuous Current System of Supply at Brighton, The Combined (Ill.)—Electn. May 8. 1100 w. M. July.
- Alternate Current Arc, Analytical Study of the—Fleming and Petavel, Phil. Mag. Apr.
- Alternate Current Electric Distribution—Ferraris and Arno's, Elec. Eng. June 3. 900 w. M. July.
- Alternate-Current Working, The Principles of—Alfred Hay, Elec. Eng. Lond. June 19. Serial. Part 1. 2400 w. M. Aug.
- Alternating Arcs and Wave Forms—Steinmetz, Electn. May 22. W. June 13.
- Alternating Arcs and Wave Forms—Blondel, Electn. June 5. W. June 27.
- Alternating Current Arc, Effect of Wave Form on the—Frith, Phil. Mag. June.
- Alternating Current Circuits, On Determination of Grounds on—R. O. Heinrich, Elec. May 6. 2000 w. M. June. W. May 23.
- Alternating Current Curves, Determining—Michalke, Elektrotechn Zeit. July 23. W. Aug.
- Alternating Current Curves, Determining—Behn-Eschenberg, Elektrotechn Zeit. July 30. W. Aug. 22.
- Alternating Current Curves, New Method of Drawing—Drexler, Elektrochem Zeit. Apr. 15. W. May 23.
- Alternating Current Curves, New Method of Tracing—Rodgers & Burnie, Elektrotechn Zeit. July 16. W. Aug. 8.
- Alternating Currents, Curve Tracer for (Ill.)—Drexler, Elektrotechn Zeit. June 18.
- Alternating Currents, Depositing Metals with—Roelsing, Elektrochem Zeit. Apr. 5. W. May 6.
- Alternating Currents, Focusing Tube for—Swinton, Electn. May 8. W. May 30.
- Alternating Currents, Measurement of Very Large and Very Small—Campbell, Elec. Eng. Lond. and Elec. Rev. June 19. W. July 11.
- Alternating-Current Machinery, Notes on General Electric (Ill.)—Elec. Wld. Apr. 4. Serial. Part 1. M. May.
- Alternating Currents, Resistance of Conductors to—Mascart, J. Inst. Elec. Eng. Apr.
- Alternating Currents, Resistance of Conductors to—Brylinski, L'Eclair. Elec. Apr. 11.
- Alternating Currents, Results Accomplished in Distribution of Light and Power by—W. L. R. Emmett, Elec. Rev. May 13. 5000 w. M. July.
- Alternating Current Rushes in Condensers—Scattergood, Serial. Elec. Rev. Lond. July 17. 2000 w. W. Aug. 8. Elec. Rev. Lond. July 24. W. Aug. 15. Elec. Rev. Lond. July 31. W. Aug. 22. Elec. Rev. Lond. Aug. 7. W. Aug. 29.
- Alternating-Current Stations and High Voltage Lamps—H. W. Couzens, Paper Mun. Elec. Assn. England. Elec. Rev. July 8. 2500 w. M. Aug.
- Alternating Current Systems of Electric Supply, Regulation of Pressure and Reduction of Light Load Losses in—Elec. Eng. Lond. Mar. 27. Elec. Rev. Lond. Mar. 27. Ind. and Ir. Mar. 27. 3000 w. P. June.
- Alternating Current Transformers—Fleming, Elec. Rev. Lond. July 31. Elec. Eng. Lond. July 31. W. Aug. 22.
- Alternating Currents, Transmission of Power by—Morris, Engng. Lond. July 17 and 24. M. Sept. W. Aug. 22.
- Alternating Currents—See Distributing.
- Alternator, Some Account of the Evolution of the Inductor (Ill)—John F. Kelly, Elec Rev, May 13. Serial Part 1. 700 w. M. July.
- Alternator, 24000 Volt—Elektrotechn Zeit, June 25. W. July 18.
- Alternators, Distributing Power and Light from Single Phase—Joseph N. Mahoney, Elec Eng, Mch 18. 900 w. P. May. M. May.
- Alternators Four Miles Apart, Paralleling—Elec Eng, May 27. W. June 13.
- Alternators, Parallel Coupling of—Laffargue, L'Ind Elec, July 25. W. Aug 29.
- Alternators, Paralleling of—Robert Hammond, Elec Eng, Lond, Mch 13. Serial Part 1. 4800 w. P. May. M. May.
- Alternators with Stationary Armatures and Fields (Ill)—L'Ind Elec, June 25.
- ALUMINA Factory, Description of an—J. Sutherland, Ind & Ir, July 31. 2400 w.
- Aluminum in Shipbuilding—M. Guilleumou, Ir Age, Apr 16. 500 w. M. June.
- ALUMINUM, Melting Points of—S. W. Holman, Tech Quar, March. 4800 w.
- Aluminum, Plating—Margot, Electn, May 20. W. June 20.
- Aluminum, The Electro-Metallurgy of (Ill)—J. W. Richards, J Fr Inst, May. W. May 23. 6200 w. M. June.
- Aluminum, The Metal of the Future—Prog of the Wld, June. 1500 w.
- Aluminum Works at Foyers, The British (Ill)—Elec Eng, Lond, Apr 24. Serial Part 1. 12000 w. W. May 16. M. June.
- Aluminum Works at Niagara Falls, Equipment of (Ill)—O. E. Dunlap, W Elec, July 11. 1800 w.
- AMALGAM on Copper Plates, The Accumulation of—Aust Min Stand, May 21. 1800 w. M. Aug.
- AMERICAN and English Permanent Way—Eng, Lond, July 10. 1500 w.
- American Surety Building, The (Ill)—Eng Rec, June 13. 1000 w. M. Aug.
- ANALYZERS in Arc Light Circuits—Desmond, W Elec, July 18. W. July 25.
- AMMONIA in Coke Manufacture, The Recovery of—Ir & Coal Trs Rev, May 1. 1000 w.
- Ammonia—See Tar.
- Ammonium Citrate Solution Used in the Analysis of Fertilizers, A Simple Method for Determining the Neutrality of the—N. W. Lord, Jour Am Chem Soc, May. 450 w.
- AMPERE, A Day with the Founders of (Ill)—T. C. Martin, Elec Eng, June 17. 6400 w. M. Aug.
- Ampere and Voltmeters (Ill)—Raps, Elektrotech Zeit, Apr 30.
- ANALYSIS of Ores, Pig Iron and Steel by the Carnegie Steel Co., Methods in Use for the—Eng News, July 9. 4000 w.
- Analysis, The Introduction of Standard Methods of—Baron Hauns Jüptner von Jonstorff, Ir & St Trs Jour, May 16. 5800 w. M. July.
- ANGULAR Advance—Loc Engng, April. 1200 w. M. May.
- ANTHRACITE Cullm Heaps in the Production of Power, The Utilization of—N. W. Perry, J Fr Inst, July. 6500 w. M. Aug.
- ANTIMONY, Commercial Electric—Electn, Apr 10. W. May 2.
- APPRENTICES, The Training of—Engng, July 17. 1100 w. M. Sept.
- AQUEDUCT, The Claim of the Contractors for the New Croton—Eng News, Apr 24. 1700 w. M. June.
- ARBITRATION Cases, M. C. B. A.—R R Car Jour, Apr.
- ARC and Sunlight, Shadow Pictures from the (Ill)—W. H. Freedman, Elec Eng, Mch 11. 500 w. M. May.
- Arc, Can an Electric Current be Opened without an—A. J. Wurts, Elec Eng, Mch 18. 1000 w. P. May. M. May.
- Arc, Counter E. M. F. of the—Arno, L'Eclair Elec, May 2.
- Arc Lamp (Ill)—L'Elec, May 9. W. June 6.
- Arc Lamp, Experiments with the Jandus—Koerling and Mathiesen, Elektrotechn Zeit, June 4. W. June 27, Aug 6. W. Sept 12.

Messrs. Williams and Perkins in their article of this number, have used the terms static torque and starting torque in connection with their tests on alternating current motors. The static torque was found by clamping the band of their brake tightly and balancing the pull of the rotor*; the starting torque by loading the brake to the maximum value at which the machine would start, and come up to speed. This distinction is a good one. Some manufacturers have been calling static torque the starting torque, and this is misleading. Static torque is of no use whatever except to show what limit the starting torque can be made to approach by the use of finely divided resistances in the armature† circuit, as pointed out by the writers.

Messrs. Williams and Perkins found loads between the starting torque and the static torque under which the rotor would revolve but would not come up to speed. This seems to indicate that the starting torque is a variable quantity, depending on the kind of load to which the motor is subjected; i. e., a line of heavy shafting with a large static resistance to turning and a small running friction, could be brought up to speed by a certain motor, and perhaps this same machine would fail on a piece of machinery intended to be driven at the same speed and having the same static resisting moment, but a larger running friction than the shafting. The starting torque of Williams and Perkins' tests holds for light machinery with small moment of inertia. It would be interesting to know just how much this quantity can vary with different classes of loads.

One of the special advantages which the students in engineering at the University of Wisconsin enjoy is the Special Lecture System. Successful men in practical life are invited to talk to the different departments of the University and the engineering lectures are quite frequent. These lectures are given on Friday afternoons, the work in the class rooms and laboratories being suspended that all may take advantage of the treat. It is a good thing for young engineers to listen to older men of experience in the profession, for their talks are always profitable and of a practical nature. The observing student not only gets in-

* Part which revolves.

† Part in which current is induced.

- Arc Lamp, Pilsen (III)—*L'Elec* June 6. W June 27.
- Arc Lamp, The Evolution of the—L. H. Rogers, *Elec Rev*, May 20. 5500 w. M July.
- Arc Lamp with Inclined Carbons—Zeit f Be-leucht, May 10. W June 6.
- Arc Lamps, A New Method of Studying the Light of Alternating—W. L. Puffer, Abs Paper A I E E, *Elec* Apr 1. *Elec Eng*, April 1. *Elec Rev*, Apr 15. 600 w. M May.
- Arc Lighting from Alternating Current Stations—F. Lewis, *Elec Rev*, Lond, July 3. 1100 w.
- Arc Lighting from Railway Circuits—*L'Ind Elec*, Apr 10. W May 9.
- Arc Lighting on Motor-Generator and Converter Systems, Public—*Elec Rev*, Lond, June 19.
- Arc Lighting on Motor-Generator and Converter Systems, Public—*Elec Eng*, July 15.
- Arc Lighting Practice—Alex Dow, *Elec Engng*, Apr. 3400 w. M June.
- Arc, Mercury—*Electn*, June 12. W July 12.
- Arc, On the Alternate Current—*Elec Rev*, Lond, May 1. 1300 w. M July.
- Arc Spectra, Photographic, Study of the—Baldwin, *Phys Rev*, May, June. W May 30.
- Arc, The True Resistance of the—Frith and Rogers, *Electn*, May 15. W June 6.
- Arc—See Thermo Electric.
- ARCHES, The Austrian Tests of (III)—*Eng News*, April 9. 2200 w. M June.
- ARCHINGS, Brick—*Br Build*, Mch., 1000 w. M May.
- ARCHITECT and Contractor, The—Thomas A. Fox, Serial Part 1. *Br Builder*, Mch. 800 w. M May.
- Architect's Use of Color, The—H. R. Ricardo and Christopher Whall, Paper R 1 of B A. Jour of Roy Inst of Brit Archs, Apr 23. 14000 w. M July.
- Architecture and Decorative Art Institute at Chicago—P. B. Wright, *Arch*, July. 2000 w.
- Architecture and Engineering—A. D. Hamlin, *Eng Rec*, Mch 21. Serial aPrt 1. 3000 w. M May.
- Architecture at the Royal Academy, the Present Position of—F. Masey, *Arch*, Lond, May 1. 3500 w. M July.
- Architecture, Domestic—Grant Helliwell, *Can Arch*, Mch. 3000 w. M May.
- Architecture in Australia—*Arch*, Lond, April 17. 2200 w. M June.
- Architecture in Scotland During the Past Century, Church—John Honeyman, *Brit Arch*, Mch 20. 1100 w. M May.
- Architecture in India—Nanaje Narayan Waslekar, *So Arch*, May. 2000 w. M July.
- Architecture in Washington City, Domestic (III)—Glenn Brown, *Eng Mag*, June. 3600 w. M July.
- Architecture, Japanese (III)—C. T. Mathews, *Arch Rec*, Apr. 5000 w. M June.
- Architecture of China, Notes upon the—F. M. Gratton, *Arch & Build*, May 9. Serial Part 1. 3500 w. M June.
- Architecture of Holland, The Brick (III)—R. C. Sturgis, *Br Build*, Mch. 1200 w. M May.
- Architecture of the Teutonic Order, The—C. Fitz Roy Doll, *Builder*, Mch 28. 8000 w. M May.
- Architecture, Restraints upon the Practice of—J. B. Robinson, *Eng Mag*, May. 2100 w. M June.
- Architecture, Romanesque—Prof. Aitchison, *Builder*, Mch 7. 5000 w. M May. *Builder*, Mch 14. 4000 w. M May.
- Architecture, Truth in—W. E. Doran, *Can Arch*, May. Serial Part 1. 2000 w. M July.
- Architecture—See Græco-Phœnician.
- Architectural Aberrations—*Arch Rec*, July—Sept. 1200 w.
- Architectural Club, Ninth Annual Exhibition of the Chicago—Peter B. Wight, *In Arch*, Apr. 2000 w. M July.
- Architectural Competitions—John A. Fox, *Am Arch*, June 20. 8500 w. M Aug.
- Architectural Drawing at Columbia College, The Instruction in (III)—William R. Ware, *Sch of Mines Quar*, Apr. Serial Part 1. 4500 w. M July.
- Architectural Design, Authority in—J. B. Robinson, *Arch Rec*, July—Sept. 3500 w.
- Architectural Rendering in Pen and Ink (III)—D. A. Gregg, *Brickbuilder*, April. 1600 w. M June.
- Architectural Tour in England and France, Notes on—W. A. Langton, *Can Arch*, April. 2100 w. M June.
- ARGON and Helium When Submitted to the Electric Discharge, Behavior of—Collie and Ramsey, *Elec*, Apr 24. W May 16.
- ARID Belt, Our Sub—E. V. Smalley, *Forum*, June. 3800 w. M July.
- ARMATURE Currents in Electrical Machines—O. T. Blathy, *Electn*, July 17.
- Armature—See Motor, Telegraph, Coils.
- Armatures, How to Insulate Grooved—Wm. Baxter, Jr., *Am Mach*, June 11. 1700 w. M Aug.
- Armatures, Self Induction in Alternating—Breslau, *Electrotechn Zeit*, July 16. W Aug 8.
- Armatures, The Advantages of Grooved—Wm. Baxter, Jr., *Am Mach*, Apr 16. 2300 w. M June.
- ARMOR, Formulæ of Calculating the Perforation of—Capt. Tressider, *Eng*, Lond, Apr 24. 1800 w. M June.
- ARRESTER, Automatic Potential—Johnson & Steel System, *Elec Rev*, July 29.
- ARTESIAN Well, A Novel Test on the Flow of an—W. Pence, III *Soc of Eng & Surv*, 11 An Rept. 2200 w.
- ASBESTOS—G. Heil, *Arch & Bld*, July 11. 1800 w.
- Asbestos—G. H. Guy, *Elec Eng*, June 10. 3400 w. M Aug.
- ASPHALT and Brick, From Cobblestones to—N. P. Lewis, *Pav & Mun Engng*, Apr. 2800 w. M May.
- Asphalt—See "Reservoir Linings."
- Asphaltum, The Chemical Relations of—S. F. Peckham, *Pav & Mun Engng*, May. 1500 w. M June.
- ASTRONOMICAL Telescope in Fifty Years, The Development of the—*Sci Am*, July 25. 240 w.
- ASTURIAS Spain, Mining in—*Min Jour*, July 18. 1100 w.
- ATMOSPHERIC Electricity—Chree, *Electn*, July 24. W Aug 15.
- Atmospheric Temperature and Humidity on Melting Iron in a Cupola, The Effect of—A. Sorge, Jr., *Foundry*, April. 600 w. M June.
- AURIFEROUS Beach Sands on the North Coast, The—J. E. Crane, *Aust Min Stand*, Mar 12. Serial Part 1. 5200 w. M June.
- AURIFEROUS Ores and Gravels by Means of Amalgamation and Blowpipe, The Assay by Prospectors of—W. H. Merritt, *Tr Am Inst Min Eng*, Apr. 1500 w. W June.
- AUSTIN Friars and Its Cloister—A. S. Walker, *Builder*, Apr 4. 2800 w. M June.
- AUSTRALIA as a Field for Electric Supply—Dawson, *Electn*, June 12. *Elec Eng*, July 8.
- Australia, The Scientific Exploration of Central—W. A. Horn, *Aust Min Stand*, Mar 26. 3600 w. M June.
- Austrian Electric Railway Statistics—*Elektrotechn Zeit*, June 15.
- AUTOCARS, Electrical—*Elec Rev*, Lond, July 24. W Aug 15.
- AZIMUTH, Longitude and Time, Approximate Methods for Rapid Determination of—Geo. C. Comstock, *Wis Eng*, June. 1500 w.
- BACTERIA in Milk—H. W. Coon, *Sci Am*, May 2. 1800 w. M June.
- Bacteria, Influence of Induced Currents on—Lortet, *L'Ind Elec*, May 10. W June 6.
- BACTERIOLOGICAL Researches, The Practical Results of—George M. Sternberg, *Pop Sci* M. Apr. 6500 w. M May.
- BAKER and Its Oil Industry—W. Hume, *Nature*, July 9. 2400 w. M Sept.
- BALATA and the Supply, The Demand for—*Ind Rub Wld*, July 10. 900 w.
- BAND Saw, The Making of a (III)—*Ir Age*, July 20. 2000 w.
- BANK Building, The Heating and Ventilating of a (III)—*Eng Rec*, July 11. 1100 w.

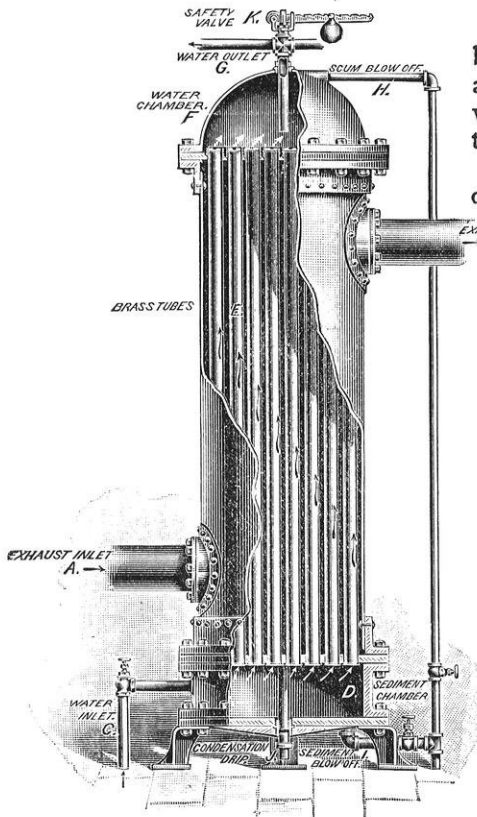
formation from the substance of such a lecture but learns something of the successful man's method of thinking. This is well shown when the lecturer recites some of his experiences with difficulties and his methods of overcoming them. Many of our lecturers are men of national reputation and their talks are often published as University bulletins. Following are names of some of the lecturers and their subjects:

1894-95.—Bell, Alexander Graham—Radiophony. Gray, Elisha—Early Reminiscences. Abbott, Arthur V., C. E., Chief Engineer—Electric Transmission of Power. Baker, W. E., C. E. Chief Engineer—Electric Equipment of Elevated Railroads Benzenberg, George H., C. E., City Engineer—Water Supply Tunnel. Brownell, H. G., B. S., Designer—The Operation of Galvanoplasty. Cooley, L. E., C. E., Trustee—Deep Waterway from the Great Lakes to the Atlantic. Ferguson, Louis A., B. S. Electrical Engineer—Modern Electric Power Stations. Grafton, W. McC., Signal Engineer—Interlocking Signal System. Johnson, J. B., C. E., Professor Civil Engineering—The United States Timber Tests. Lewis, F. H., C. E., Consulting Engineer—Specifications and Tests for Structural Steel; Specifications and Tests for Cements. Lindemann, August, M. E., Superintendent—Presses and the Die and Tool Work connected therewith. Loree, L. F., M. Am. Soc. C. E., Superintendent—Emergencies Arising in the Operation of Railroads. Mead, Daniel W., B. C. E., Consulting Engineer—Water Supply Engineering. Peck, S. B., M. E., Consulting Engineer—Conveying Machinery. Sweet, John E., M. E.—The Modern Steam Engine.

1895-96.—Baker, W. E., C. E.—Electric Equipment of Elevated Railroads. Brown, Charles C., C. E., Consulting Engineer—Sanitary Engineering. Gannett, Henry, Chief Topographer U. S. Geological Survey—Topographical Methods of the Geological Survey. Gregg, J. H.—The Prevention of Scale in Steam Boilers. Johnston, Thomas T., C. E., Assistant Chief Engineer—Construction of the Canal. Lundie, John, C. E.—Motorcycle Tests. Pierce, R. H.—Electrical Storage Batteries. Summers, E. E.—Motorcycle Tests. Swenson, Magnus, M. E.—Economical Evaporating Machinery. Van Ornum, John L., C. E.—Topography.

- BARODA Palace—R. F. Chisholm, J Roy Inst Brit Archs, May 21. 10000 w. M Aug.
- BARIS, Graphics of Truck Arch—Soc Engng, May. 1100 w.
- Bars of Any Section by Extrusion at High Temperatures, The Production of Metallic (III)—Perry F. Nursey, Eng, Lond, May 8. 2400 w. M. July.
- BASIC Open Hearth Plants, Cost of—Ir & Coal Tr Rev, June 4. 1400 w.
- Basic Open Hearth Process at Granite City, (III), The—Ir Age, April 16. 900 w. M June.
- BATHS, Public Rain—M. Morris, San, July. 5600 w.
- BATTERY During Electrolysis, Energy of a—Elec Rev, May 8. W May 30.
- Battery, Electrodynamic Theory of the Gas—Quincke, Elektrochem Zeit, Apr 1.
- Battery, Evolution of the Storage, Electn, May 15.
- Battery, Jacques Carbon—Elec, June 3. W June 13.
- Battery, Small Electric Light (III)—L'Elec, May 30. W June 27.
- Battery, The Evolution of the Storage—Maurice Barnett, Jour Fr Inst, Apr. 8800 w. M May.
- Battery Traction at Birmingham—Ry Wid, Apr. 800 w. M June.
- Battery, Velvo-Carbon Primary—Allingham, Elec Rev, Lond, July 24. W Aug 15.
- Batteries, Advances in the Theory and Construction of Secondary—F. Zacharias, Electn, Apr 17. P June.
- Batteries, Carbon Consuming (III)—Elec Eng, May 13. W May 23.
- Batteries, Commutator for Storage (III)—Stine, Elec, May. W May 23.
- Batteries, Construction and Theory of Lead—Loeb, Electn, Apr 17.
- Batteries, Experiments with Air—Zettel, Elektrochem Zeit, Apr 5. W May 16.
- Batteries for Electrical Locomotion, On Secondary—Desmond D. Fitzgerald, Elec Rev, Lond, Mch 20. Serial Part 1. 2500 w. M May.
- Batteries, On the Charging of Car Lighting—Elec Anz, Apr 16.
- Batteries, Storage (III)—Charles Blizard, Elec Pow, May. 5300 w. W May 22. M July.
- Batteries, Theory and Construction of Secondary—Zacharias, Electn, Apr 17.
- BATTLESHIP "Juasigniberry," The French—Engng, July 3. 800 w. M Sept.
- Battleship Massachusetts, Contract Trial of the United States Coast Line (III)—C. H. Hayes, Jour Am Soc of Nav Engs, May 8500 w. M July.
- Battleships, Queen of—Sea, April 30. 1700 w. M June.
- Battleship "Yashima," The Japanese (III)—Engng, Mch 6. 2600 w. M May.
- BEAM or Girder from Irregular Loading, A Method of Determining the Size of a—Robert D. Kinney, Power, Apr. 1200 w. M May.
- Beams, Strength of—Walter Ferris, Am Mach, Apr 16. 1500 w. M June.
- Beams, The Transverse Strength of—M. Lewinson, Tr Am Soc of Civ Eng, Mch. 2500 w. M May.
- BEAR Trap Type, Dams, Sluices and Lock Gates of (III)—A. Powell, Jour Assn of Engng Soc, June. 11500 w.
- BEARINGS, Machinery—J. Dewrance, Ind & Ir, July 17. 3800 w.
- Bearings, Side Pressure Ball—Ry Wid, May. 1400 w.
- BELFAST and Its Industries (III)—Eng, Lond, July 10. 1800 w. M Sept.
- BELT Laciings, Odd (III)—B. F. Fells, Am Mach, May 28. 500 w.
- Belting, Laying Out (III)—Thomas Hawley, Bos Jour of Com, May 2. 2200 w. M June.
- Belts and Their Use, Notes on Conveying—Thos. Robins, Jr., Col Guard, May 15. 3000 w. M July.
- BERGEN County Traction Company (III)—St Ry Jour, June.
- BERLINER Controversy, The—W. Clyde Jones, Elec Engng, July. 3800 w.
- Berliner—See Microphone.
- BESSEMER Process, The Invention of the—Ir & St Trs J, Mch 21. 5000 w. M May. Engng, Mch 27. 3000 w. M May.
- Bessemer Process, The Invention of the—Jos. D. Weeks, Am Mfr & Ir Wid, May 29. 2500 w.
- Bessemer Process, The Inventor of the—Ry Age, Apr 11. 1400 w. M June.
- BESSEMERIZING, Nickel, Matte—H. W. Noyes, Eng & Min Jour, May 2. 1500 w. M June.
- BICYCLES AND TIRES, The Export of American—Ind Rub Wid, July 10. 1600 w. M Aug.
- Bicycle, The (III)—Sci Am, July 25. 1800 w. M Sept.
- BIRDS, The Sailing Flight of—Engng, May 29. 1000 w.
- RISMTII—See Resistance.
- BLACK Diamond Express, The—R R Car Jour, June. 450 w.
- BLAST-Furnace Gases, The Economical Use of—A. S. Keith, Ir & Coal Trs Rev, Apr 17. 2500 w. M June.
- Blast-Furnace Shut without Brickwork, A—F. Büttgenbach, Ir & Coal Trs Rev, Apr 3. 900 w. M June.
- Blast Furnace Practice, American—J. L. Stephenson, Eng, Lond, July 10. Serial Part 1. 3000 w.
- Blast Furnace Stack, A Sketch of a Modern—A. P. Gaines, Eng Assn of the South, April. 3400 w.
- Blast Furnaces and Their Value, Standard Physical Tests for the Product of the (III)—T. D. West, Trans Am Inst of Min Engs, Apr.
- Blast Furnaces, Lighting of—F. Brickeraux, Col Guard, April 2. Serial Part 1. 2600 w. M June.
- Blast Furnaces, Past and Present—Ir & St Trds Jour, July 4. 1000 w.
- Blast in Cupolas, The Action of—T. West, Engng, July 31. 2700 w.
- Blast Meter Tell the Truth? Does the—H. Hansen, Foundry, Apr. 1200 w. M June.
- Blast Penetration and Improvements in Center Blast, Power of—T. D. West, West Found Assn. Ir Tr Rev, June 25. 5300 w. M Aug.
- Blasting in Pole Line Construction—I. J. Macomber, Sib Jour of Engng, April. 500 w. M June.
- Blasting Operations in Collieries, Improvements in—M. C. Ibseng, Am Mfr & Ir Wid, June 26. 2800 w. M Aug.
- BOATS, Inclined Planes for (III)—Sci Am Sup, April 18. 3500 w. M June.
- BOARD of Trade, The Reconstruction of the Plant of the Chicago (III)—Bions J. Arnold, Elec Eng, May 27. 2000 w. M July.
- Boiler, Circulation in Water-Tube—W. H. Watkinson, Paper Inst of Naval Architects, Engng, April 3. 3800 w. M June.
- Boiler Coverings, Experiments with—Can Eng, June. 1200 w. M Aug.
- Boiler Explosion at Bridgeport, Ala (III)—R R Gas, April 24. 150 w. M June.
- Boiler Explosions, Does High Steam Pressure Increase the Danger of—Loc Engng, May. 1400 w.
- Boiler Firing, Smokeless Combustion and—W. Hempel, Col Guard, July 24. 700 w. M Sept.
- Boiler Inspection—Ind Engng, June 20. 2500 w.
- Boiler Making Contrasted with Old Methods, Modern—H. J. Hartley, Paper Am Boiler Mfrs Assn, Ir Age, July 2. 2500 w. M Aug.
- Boiler Plates, New Rules for Testing—Eng News, April 9. 1100 w. M June.
- Boiler Room, The—L. H. Tullen, Elec Wid, April 11.
- Boiler Seals, The Conductivity of (III)—Power, May. 1500 w. M June.
- Boiler, Tests of Two Systems of Firing on a Water-Tube—G. H. Barrus, Eng Rec, July 18. 600 w. M Sept.
- Boiler, The Covering—G. Hartley, Min & Sci Pv, July 18. 600 w. M Sept.
- Boiler, The Efficiency of a Steam. What is

BUNDY FEED WATER HEATER.



A New Feed Water Heater has been brought out called the BUNDY, a rather peculiar name, although quite well known on account of the radiator made bearing the same name.

The Bundy Feed Water Heater is of the cylindrical tubular type having an outer shell of wrought iron, containing a series of 2 inch brass tubing. The exhaust enters the wrought iron shell at A and passes out at B, heating in transit the water that enters at C, passes through the pipe E and out at G. D is a sediment chamber and F a water chamber, each supplied with blow off connections, I for sediment discharge and H for scum blow off. K is a safety valve and J the condensation drip.

The exhaust steam inlet and outlet may be changed to different parts of the cylinder or be reversed, the steam entering at B and leaving at A, or both may be on the same side.

It will be observed that the exhaust steam acts on the exterior of the brass pipes and this the manufacturers claim heats the water to a higher temperature than it is possible to secure with a heater in which the exhaust steam passes through the pipe having the water on the outside. Then again the friction in passing the exhaust through the pipes is liable to induce a back pressure on the engine which the makers of the Bundy guarantee cannot occur with this heater.

It will also be observed that the water outlet pipe G enters the water chamber several inches drawing the water that is pure while the scum rises to the top and is removed by occasionally opening the valve in the water blow off.

The water outlet pipe G may be connected to a return trap setting on the boiler three feet above the water line of the boiler and so the water be put into the boiler without cost for running a pump.

The Bundy is the product of the A. A. Griffin Iron Co., 66-68 Center St., N. Y. City, with offices at 177-179 Fort Hill Square, Boston, and 702 Arch St., Philadelphia, and works at Jersey City, N. J. Printed matter may be had of them for the asking, giving further particulars and prices.

- it?—Wm. Kent, *Tr Am Inst Mech Eng*, Vol XVII, 2800 w. M June.
- Boilers, Circulation in Water-Tube—A. C. Elliott, *Engng*, May 1. Serial Part 1. 2200 w.
- Boilers, Compound Marine—N. Soliani, *Paper Inst Nav Arch. Engng*, Apr 3. 1400 w. M June.
- Boilers and Engines, Efficiency of—T. F. Scheffer Jr, *Mach Mag. Serial Part 1*. 1800 w. M June.
- Boilers, Efficiency of—J. C. McMynn, *Elec Engng*, Apr. 1900 w. M June.
- Boilers, Formulae for the Strength of Seams, Stays and Braces for Cylindrical (II) *Jour Am Soc of Nav Eng*s. May. 2800 w. M July.
- Boilers, Marine—Abst Paper N E Coast Inst Eng and Shipbuilders. *Ind & Ir*, June 26. 2400 w. M Aug.
- Boilers, Mineral Oil in Marine—*Engng*, May 22. 3000 w. M July.
- Boilers on H. M. S. "Sharpshooter, The Belleville—A. Dodgson, *Engng*, Mch 6. 400 w. M May.
- Boilers, The Commercial Efficiency of Steam—A. Haussen, *Engng*, July 17. 3200 w. M Sept.
- Boilers, The Efficiency of Steam—*Eng News*, June 11. 1800 w. M Aug.
- Boilers, The Maintenance and Repair of Marine—J. F. Walliker, *Prac Eng*, July 10. 1800 w. M Sept.
- Boilers, Their Equipment and Management: Steam—Albert A. Cary, *Elec Rev*, May 20. Serial Part 1. 1500 w.
- Boilers, Water-Tube—J. Watt, *Eng. Lond*, Mch 27. 2800 w. M May.
- Boilers see Corrosion.
- BOLSTER 70,000 lb. Car, Body—*Ry Rev*, May 9. 800 w.
- BORDER, The Harpy Plant—E. F. Canning, *Gar & For*, July 29. 1200 w.
- BRAKE Cylinders, Economical Oiling—*R R Car Jour*, June. 3000 w. M Aug.
- Brake Gear, Efficiency of Foundation—R. A. Parke, *R R Car Jour*, June. 1200 w. M Aug.
- Braking Cars (II)—*Elek Anz*, Apr 19. W May 16.
- Brakes, Continuous Railway—*Engng*, June 26. 800 w.
- Brakes for Goods Trains, Automatic—*Ind & East Eng*, Feb 22. 1500 w. M May.
- Brakes, Maintenance of Passenger and Freight—*R R Car Jour*, June. 4000 w. M Aug.
- Brakes on Street Cars, Hand or Air—*Die Elek*, Apr 18.
- Brakes on Railways in India, The Working of Automatic—*Ind Engng*, Mch 21. 800 w.
- BRAZIL, Minerals and Mining of—*Cons Rept*, July. 1600 w.
- Brazil Railways and Shipping—*Trans*, July 17. 500 w.
- Brazing Rail Bonds (III)—Payne system, *St Ry Rev*, July 15. W Aug 1.
- BRICKS, AGES, An Increasing Problem in Knuckle—*Ry Mas Mech*, May. 1400 w.
- BREMEN, Free Port of—*Consular Reports*, Feb. 4800 w. M June.
- BRICK Buildings, Notes on the Design of—G. F. Newton, *Br Build*, Apr. 2300 w. M June.
- Brick Paving—See "Paving."
- BRICKMAKING in Tuskegee Ala. Industrial School (III)—V. E. Matthews, *Brick*, Apr. 1200 w. M May.
- Brickwork Tests, (III)—W. C. Street, *Jour Roy Inst of Brit Arch*, April 2. 1000 w. M June.
- Brickwork Tests, A Further Note on—H. H. Statham, *Builder*, April 11. 1800 w. M June.
- Brickwork, Tests of Canadian and English—C. H. Wright, *Can Arch & Build*, July.
- Brickwork, The Resistance of—C. A. Blackall, *Brickbuilder*, May, 2800 w. M July.
- BRIDGE, Accident to Rochester (II)—*Engng*, Mch 20. 1200 w. M May.
- Bridge, A Concrete Foot—A. N. Talbot, *III Soc Eng & Surv*, 11th An Rept. 3500 w.
- Bridge, Adjustment of the Kelvin—*Appleyard*, *Phil Mag*, June.
- Bridge at Knoxville, Tenn, The New Tennessee River (III)—*Eng News*, May 7. 400 w. M June.
- Bridge at Niagara, The New Railway—*R R Gaz*, Apr 24. 2000 w. M June.
- Bridge at Paris, New Cantilever—*Eng, Lond*, May 15. 900 w. M July.
- Bridge-Building, Architecture of (III)—E. C. Gardner, *Eng Mag*, Aug. 2000 w.
- Bridge, Calibration of Slide-Wire (III)—Becke *Elec*, July 8. W July 18.
- Bridge Construction in New South Wales Timber (III)—Percy Allen, *Eng, Lond*, May 22. 4500 w. M July.
- Bridge Construction on the "Big Four" *R R*, Emergency—*Ry Rev*, July 11. 1500 w.
- Bridge, Counterweighed Arch (III)—*R R Gaz*, July 24. 1000 w.
- Bridge Disaster at Victoria B. C.—*Eng News*, June 18. 3000 w. M Aug.
- Bridge, East Coast Railway India, The Kistna (II)—F. J. E. Spring, *Engng*, July 3. Serial Part 1. 2700 w.
- Bridge, Erection of a Long Plate-Girder Railroad—*Eng Rec*, Mch 28. 400 w. M May.
- Bridge, Gate for the Wallabout Draw, Brooklyn (II) *Eng News*, Mch 26. 900 w. M May.
- Bridge, Melan Concrete and Stone Arch, Topoka Kan. (III)—*Eng News*, Apr 2. 2800 w. M May.
- Bridge, Modified Wheatstone—Lacoiné, *L'Elec*, May 15. W June 6.
- Bridge over Harlem River, N Y C & H R R R, Four-Track Swing (II)—*Eng News*, April 30. 1000 w. M June.
- Bridge over the Hudson River at New York, The New (III)—*Sci Am*, May 2. 1300 w. M June.
- Bridge over the River Inverness, The New Waterloo (III)—*Eng, Lond*, Apr 10. 2400 w. M June.
- Bridge Problems of the Greater New York, The—*Eng Rec*, May 23. 900 w. M July.
- Bridge, Permeability—Chittcock, *Electn*, May 15. W June 6.
- Bridge, Raising a Highway—*Ry Rev*, May 9. 900 w. M July.
- Bridge, The Adopted Plans of East River (III)—*Eng News*, July 30. 400 w.
- Bridge, Widening a Swiss Arch (III)—*Eng Rec*, May 23. 150 w. M July.
- Bridge, Widening of Iron Truss (III)—*Eng Rec*, July 25. 800 w.
- Bridge, see Abutment, Arch, South Rocky River, Pratt Truss, North River, Merrimac, Rock River, Seine.
- Bridges, Cantilever—*Ry Rev*, Apr 25. 900 w. M June.
- Bridges, Cantilever (III)—E. Marburg, *Pro Eng Club of Phila*, July. 5000 w.
- Bridges for Branch Lines, Railway—M. A. Pollard—*Urquhart. Paper Soc of Eng*s, *Lond Arch*, June 5. 2500 w. M June.
- Bridges for Electric Railroads—C. Stowell, *R R Gaz*, July 10. 1500 w.
- Bridges, Highway—C. Gaylor, *Jour Assn of Eng*s Soc, June. 2800 w.
- Bridges in England, Cast Iron Railroad—*R R Gaz*, May 8. 1000 w.
- Bridges in the Port of Marseilles, Swing—*Engng*, May 29. 1200 w. M July.
- Bridges, Low Level—A. Brady, *Eng News*, July 16. 2200 w.
- Bridges of Short Span—F. W. Wilson, *Eng News*, May 7. 1600 w.
- Bridges, Opening—George Wilson, *Prac Eng*, May 1. 2200 w. M July.
- Bridges, Some Curious—*III Car & Build*, May 15. 2800 w. M July.
- Bridges, The Influence of Braked Trains on the Superstructure of Metallic—F. Jasinski, *Ry Rev*, April 11. 900 w. M June.
- Bridges see Railroads.
- BRIGHTON—*Lond Elec Eng*, June 26.
- BRONZE Casting in Europe, The Art of—Geo. Simonds, *J Soc of Arts*, June 19. 13. 500 w.
- BROM CYAN, Some Experiments with—H. C. Cutter, *Eng's Yr Book*, Univ of Minn. 800 w. M July.

SIX MONTHS OF ELECTRICAL JOURNALISM.

The ELECTRICAL REVIEW has just completed its twenty-eighth volume, which contains some of the best newspaper work ever done by a technical journal. In addition to giving thoroughly reliable news of the progress of electrical work in all its branches, the ELECTRICAL REVIEW has secured in the past six months a large number of unusually valuable and exclusive articles on important subjects. It printed the first official interview with Professor Roentgen and the only interview with Professor Salvioni, of the University of Perugia, Italy, who made some very interesting and remarkable discoveries on the Roentgen ray.

The REVIEW was also the first to give an illustrated description of the new Westinghouse-Baldwin electric locomotive, and obtained the first official interview with Thomas A. Edison on his new fluorescent lamp. This interview was illustrated with a sketch of the lamp made by Mr. Edison for the REVIEW. The greatest honor that this journal has attained is that it was selected exclusively by Nikola Tesla for giving to the world the remarkable series of articles written by him, describing his wonderful progress in X-ray photography and in vacuum-tube lighting.

The electrical field is rapidly broadening and the class of people interested in its progress is as rapidly widening; the progress made from week to week is faithfully delineated for their benefit in the ELECTRICAL REVIEW, of New York City.

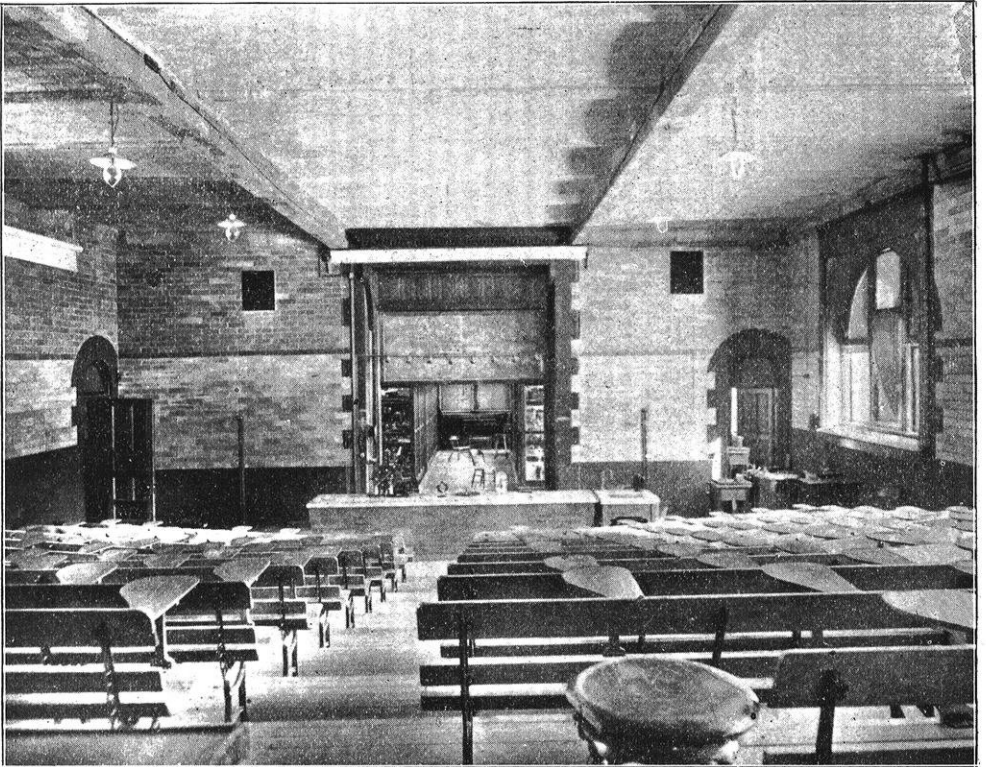
THE STREET RAILWAY REVIEW, commencing with January, 1897, will begin the publication of a foreign edition of their magazine.

The new publication will be similar in appearance to the home edition, which will continue as a quarterly. It will contain descriptions of the principal street railway plants outside of the United States, and also a resumé of the best and latest appliances and ideas which have been brought out in this country.

As this new edition can not help but boom American interests, we all unite in the hope that it will be a success.

- BRUGES (III)—George S. Morris, *Am Arch*, June 6. 1:00 w. M July.
- BUDA-PEST Millennium Exhibition Alternating Current Machinery (III)—*Elec Eng*, July 22. Serial Part 1. 1800 w.
- BUDA-PEST Conference—*Elec Rev*, Lond, July 10.
- BUILDING Artistically Considered, The Tall Office—Louis H. Sullivan, *In Arch*, May. 3500 w. M July.
- Building Bill, Discussion of the High—*Arch & Build*, May 23. 2500 w. M July.
- Building, New Library; University of the City of New York (III)—*Eng Rec*, Mch 28. 200 w. M May.
- Building, Some Observations on Ancient and Modern—Arthur Dixon, *J Roy Inst of Brit Arch*, Mch 5. 2800 w. M May.
- Building Stones of Eastern Ontario—Andrew Bell, *Can Arch*, Mch. 3000 w. M May.
- Building, The Commercial Cable—*R R Gaz*, June 5. 1000 w. M July.
- Building, The Westfield Bank, N. J. (III)—*Eng Rec*, Mch 4. 800 w. M May.
- Building Without Walls, A (III)—*In Arch*, May. 4500 w. M July.
- Building see Electricity.
- Buildings Commission, United States Public—A. F. Tennile, *Arch & Build*, Mch 21. 2700 w. M May.
- Buildings, Failure of—Roger Smith, *Arch*, Lond, Mch 27. Serial Part 1. 5500 w. M May.
- Buildings in the Hungarian Millennium Exhibition, The Historical (III)—*Arch Lond*, Mch 13. 1100 w. M May.
- Buildings, New Municipal; Croydon—*Brit Arch*, May 22. 6000 w. M July.
- Buildings, Stafford County Council—*Brit Arch*, May 1. 3000 w. M July.
- BULLETS see Electric Currents.
- Burgundy, Notes on some Remnants of Medieval—P. S. Worthington, *J Roy Inst of Brit Arch*, Mch 5. 4300 w. M May.
- CABLE, A New French Trans-Atlantic—*Elec Rev*, Lond, Apr 10. Serial Part 1. 1880 w. M June.
- Cable Communication and the Projected Pacific Cable, Colonial—*Elec Rev*, Lond, Apr 3. Serial Part 1. 5000 w. M June.
- Cable Coupling, High Pressure (III)—*Electn*, May 22. W June 13.
- Cable Laying on the Amazon River—Siemens, *Electn*, May 22. *Elec Rev*, Lond, May 22. 3500 w. M July. W *Elec*, July 18.
- Cable Specifications and Tests—J. A. Jechell, *Electn*, July 17. 3000 w. *Elec Eng*, Lond, June 12.
- Cable Steamer, Gear for Japanese—*Electn*, Apr 17. *Elec Rev*, Lond, Apr 17. *Elec Eng*, Lond, Apr 17.
- Cable, The Submarine (III)—*Sci Am*, July 25. 1700 w.
- Cable vs Electric Traction—*Elec Ry Gaz*, Apr 10. 2000 w. M June.
- Cable Working, Duplex—*Electn*, May 15.
- Cables and their Accessories, High Pressure—Hetherington, *Cas Mag*, Sept. W Sept 12.
- Cables, Concentric—*Elec Rev*, Lond, Apr 10. 1400 w. M June.
- Cables, Insulation of Underground—E. J. Spencer, *St Ry Jour*, May. 1000 w.
- Cables in War Time, Submarine—*Elec Rev*, Lond, July 3. 5800 w.
- Cables see Inductance Mines.
- Cabling and Serving Machine, Combined (III)—*Eng Lond*, April 24. --- w. M June.
- CALCIUM Carbide and Acetylene—Jacquin, *L'Elclair Elec*, Apr 18.
- Calcium Carbide in Agriculture—*Cosmos*, June 13. W July 18.
- Calcium Carbide, Manufacture of—Dunlap, W *Elec*, May 16. 2000 w. W May 23.
- Calcium Carbide, Manufacture of—*Electn*, June 26.
- Calcium Carbide Plant at Niagara—Dunlap, *Elec Eng*, May 20.
- Calcium Carbide, The Cost of—Hutchinson, *Elec*, May 6. W May 23.
- Calcium Carbide, The Manufacture of—J. I. Morehead and G. de Chalmot, *J Am Chem Soc*, April. 5800 w. M May.
- CALIFORNIA Will be a Leader—*Min & Sci Pr*, April 18. 3000 w. M June.
- CALORIMETER, New Form of Steam (III)—R. C. Carpenter, *Trans Am Inst of Mech Eng*, Vol XVII. 1800 w. M June.
- Calorimetry: Methods of Correction for Cooling—Silas W. Holman, *Tech Quar*, Dec. 2500 w.
- CANADIAN Electrical Association—*Elec News*, July.
- CANAL Boat Towing by Electricity (III)—*Lightning*, Apr 30.
- Canal for Connecting the Bristol and English Channels, Proposed Ship—W. O. E. Meade-King, *Eng*, Lond, Mch 13. Serial Part 1. 1800 w. M May.
- Canal in Wyoming and Colorado, The West Side Irrigation and Mining (III) E. Meade, *Eng News*, July 30.
- Canal, Methods of Work and Special Plant on Chicago Drainage (III)—*Eng Rec*, Apr 4. Serial Part 1. 3800 w. M May.
- Canal, The Crinan Ship—*Eng*, Lond, May 15. 1000 w. M July.
- Canal, The Manchester Ship; and Canal and River Hydraulics—*Eng*, Lond, May 15. 2800 w. M July.
- Canal, The Report on the Nicaragua—*R R Gaz*, Mch 13. 3500 w. M May. *R R Gaz*, Mch 20. 1800 w. M May.
- CANDLE Power and Luminosity—W. D. Birchmore, *Pro Age*, April 15. 4000 w. M June. W May 16.
- Candle Power of Arc Lamp or other Luminous Sources, An instrument for Directly Measuring Mean Spherical—*Elec Wld*, May 9. 1500 w. M June.
- CANTERBURY Cathedral—*Arch*, Lond, July 10. 2000 w.
- CAPACITY—See Self-Induction.
- CAPITOL, The Ventilating of the National—J. G. Dudley, Designed by Gen. Meiggs, *Heat & Vent*, July 15. 2000 w.
- CAR and Line Tests—Pond and Curtiss, *Sib Jour*, May. W June 27.
- Car, Budapest Underground Railway—*Elec Eng*, May 27.
- Car Builders' Convention, The Master—*R R Gaz*, June 19. 10000 w. M Aug.
- Car Building, Art in (III)—D Doty, *R R Car Jour*, June. 3000 w. M Aug.
- Car, Chicago, Great Western Ry, 60000 lb Furniture—Ry Mas Mech, June. 1400 w. M Aug.
- Car Construction, The Progress of American—H. S. Haines, *Ry Rev*, June 20. 3200 w. M Aug.
- Car, Ditching (III)—*Eng News*, May 7. 1500 w.
- Car, Erie Railroad, Postal (III)—*Loc Engng*, July. 700 w.
- Car for the Erie R R, 80,000 lb Ore—*R R Gaz*, June 12. 1400 w.
- Car Hire and Movements—W. W. Wheatly, *R R Car Jour*, June. 2000 w. M Aug.
- Car House Construction in Boston (III)—*St Ry Jour*, Apr. 1100 w. M May.
- Car Inspectors, Examination of—*R R Car Jour*, Apr. 1800 w. M June.
- Car Law, Supreme Court on the Separate—*R R Gaz*, June 19. 1100 w.
- Car of 60,000 Pounds Capacity, Hopper Gondola—*Am Eng & R R Jour*, May. 500 w.
- Car Owner's Responsibility—F. H. Stark, *R R Car Jour*, June. 2000 w. M Aug.
- Car Owner's Stampout, The Rules of Interchange from the—Maurice, *R R Car Jour*, May. 1600 w.
- Car Service Reforms—Ry Age, May 23. 3000 w.
- Car Shops, Piece Work in—G. L. Potter, *Ry Rev*, Mch 28. 2000 w. M May.
- Car Specifications—*St Ry Jour*, Aug. 1800 w.
- Car, the Construction of Steel—*Eng News*, July 2. 2400 w. M Aug.
- Car, The Question of the Big—*R R Gaz*, Apr 10. 1700 w. M May.
- CARBIDE—Acetylene Patents, The—*Gas Wld*, Apr 11. 2500 w. M June.
- CARBIDE of Calcium and Acetylene—*Pro Age*, Apr 15. W May 2.

University Views.

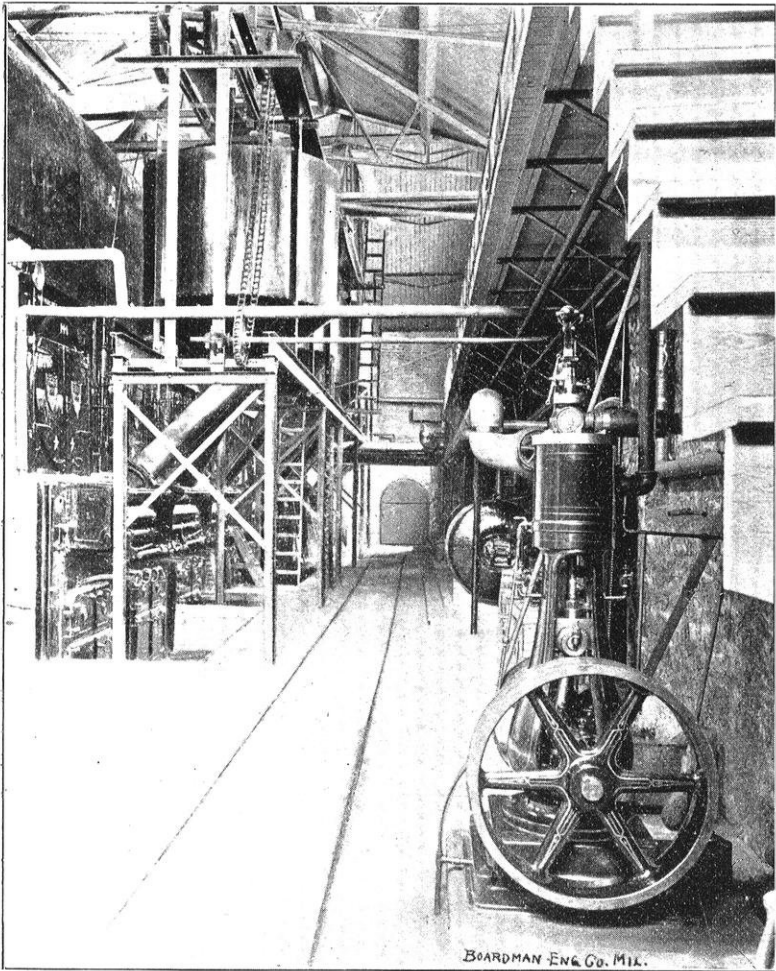


PHYSICAL LECTURE ROOM.

The Physical Lecture Room contains seats for 200. Its equipment is the most modern. The lights are connected with a stage dimmer by the use of which they can be regulated to any desired degree of illumination. By means of curtains controlled by a hydraulic device the room can be darkened on turning a valve.

There are two stereopticons, the screens for which can be raised or lowered at pleasure. The lecturer's table is fitted with a small Pelton-wheel for operating light machinery. There are numerous other conveniences, all of which help to make this an ideal lecture room.

- Carbide of Calcium and Acetylene and Their Application—Ed. Hospitalier, *Pro Age*, May 1. 1200 w. M June.
- Carbide of Calcium, Cost of—*Pro Age*, July 15. 3000 w.
- CARBON as Resistance, On the Use of—Max Zimmer, *Die Elek*, Apr 18.
- Carbon, Electrolytic Solution of—Coehn, *Zeit f Electrochem*, May 20. June 13.
- Carbon, Electrolytic Solution of—Vogel, *Elektrochem Zeit*, Apr 20. W May 16.
- Carbon Generator—Fitzgerald, *Elec Rev*, Lond, July 3. W July 25.
- Carbon in Rhodium, Indium and Palladium, Solubility of—Moissan, *L'Ind Elec*, July 25. *L'Eclair Elec*, July 25.
- Carbon in the Arc, The Temperature of the—La Nature, Aug 1. W Sept. 12.
- Carbon into Electrical Energy, Direct Conversion of (III)—W Elec, May 23. 1400 w. M July.
- Carbon Irons—*Elektrochem Zeit*, June 5. W July 4.
- Carbon Monoxide Poisoning—F. Clowes, *Jour of Gas Lgt*, July 14. 2200 w.
- Carbon, The Electrolytic Dissolution and Deposition of—Edit. *Electn*, June 12. 1600 w. W July 4. M Aug.
- Carbonic Acid in Flue Gases, The Estimation of—A. H. Sexton, *Col Guard*, Mch 20. 1200 w. M May.
- Carbons of the Arc, Temperature of the—Wilson and Gray, *Am J of Sc*, May. W May 16.
- Carbons, Some Faults in Arc-Lamp—W. M. Stine, *Elec Wld*, July 11. 1200 w. M Aug.
- CARRIAGE Competition, Road—*Elec Rev*, May 1.
- Carriage, Great Western Railway of England, Passenger.
- Carriage Trials, Official Report on the American Horseless—Eng, Lond, Mch 13. 7000 w. M May.
- CARS are Cleaned by the Wagner Palace Car Co., How—*Loc Engng*, June. 700 w.
- Cars, Axle and Journal Box for 80,000 lb.—R R Gaz, June 26. 5200 w. M Aug.
- Cars, Economical Use of Large Freight—R R Gaz, June 12. 1200 w. M Aug.
- Cars, Electric Lighting of Passenger—Eng News, June 11. W June 20.
- Cars for Interchange Service, The Size and Capacity of Freight—Eng News, Mch 12. 1800 w. M May.
- Cars for the B. & O. R. R., New Freight—Eng News, June 11. 1100 w. M Aug.
- Cars, New York, New Haven & Hartford 60,000 Pound Coal (III)—*Loc Engng*, June. 800 w.
- Cars, Regulation of Motor—E. G. Fischinger, *Elektrotechn Zeit*, Apr 2. P June.
- Cars, Report of the Committee on Large—Pro N Y R R Club, Feb 20. 22000 w. M May.
- Cars, Weight of Passenger—R R Car Jour, May. 1300 w.
- Cars—See Gas Motor.
- CARTAGE Decision, A Free—R R Gaz, Apr 24. 1:00 w. M June.
- CATHODE in a Crooks Tube, The Darkening of—Birchmore, *Elec Eng*, July 8.
- Cathode Rays—Puluj, *Electn*, Mar 20. P June.
- Cathode Rays, Absorption of—Lenard, *Proc Lond Phy Soc*, June. W July 18.
- Cathode Rays and Continuous Discharges Through Gases—Lehmann, *L'Eclair Elec*, May 22.
- Cathode Rays and Kinetic Theories—Leray, *Cosmos*, June.
- Cathode Rays and Their Transformation into Röntgen Rays—Puluj, *Zeit f Elek*, July 1. W June 6.
- Cathode Rays and X-Rays—S. P. Thompson, *Lond Elec*, June 26. W July 18.
- Cathode Rays, Electrostatic Deflection of—G. Jaumann, *Electn*, July 10. 3500 w.
- Cathode Rays, Its Character and Effects—A. W. Wright, *Forum*, April. 2200 w. M May.
- Cathode Rays, Manifold by (III)—Elihu Thomson, *Elec Eng*, Mch 11. 400 w. P May. M May.
- CATHODE RAYS, The New Photography (III)—John Trowbridge, *Scrib Mag*, Apr. 2400 w. M May.
- Cathode Rays Under the Influence of Strong Magnetic Forces (III)—*Elec Rev*, Lond, June 12. Serial Part 1. 2000 w. M Aug. W July 4.
- Cathode Rays—See Photometry. Roentgen. Rays.
- CATHOGRAPHY, On Apparatus for—Nikola Tesla, *Min & Sci Pr*, May 9. 1400 w.
- CAST IRON, How to Gain a Knowledge of—Foundry, July. Serial Part 1. 1800 w.
- Cast Iron, The Mobility of Molecules—A. E. Outerbridge, *Trans Am Inst of Min Eng*, April. 3300 w. M June.
- Cast Iron, The Physics of—*Trans Am Inst of Min Eng*, July. 7500 w.
- Cast Iron—See Impressions.
- CASTING a Large Kettle in Loam (III)—*Foundry*, Mch. 700 w. M May.
- Castings by Hydrofluoric Acid, Cleaning—R. Moldenke, *Age of St*, Mch 28. 1800 w. M May.
- Castings, Making Large Brass—C. Vickers, *Am Mach*, Mch 12. 900 w. M May.
- Castings, The Sand Blast Apparatus for Cleaning—Fred C. Brooksbank, *Ir Age*, Mch 12. 5000 w. M May.
- CELL, A One-Volt Standard—Hibbert, *Electn*, July 3. W July 25.
- Cell, Clark Standard—J. Warren, *Elec*, Lond, July 3. 1800 w.
- Cell, E. M. F. of the Clarke—Limb, *Electn*, May 29.
- Cell of High E. M. F.—*Elec Rev*, Lond, May 1. W May 25.
- Cell, The Electric (III)—W. P. Jones, *Elec Pow*, April. 1000 w. M June.
- Cell, Improved Leclanche—*L'Energie Elec*, May 16. W June 20.
- Cells, Constant Galvanic—Heil, *Elektrochem*, p 245. *Proc Lond Phys Soc*, May. W June 6.
- Cells, Output of Galvanic—Zacharias, *Elektrochem Zeit*, Apr 20. W May 16.
- Cells, Testing Secondary—*Elec Plant*, Mch 1. 5000 w. M May.
- CEMENT, A Hypothetical New Hydraulic—A. D. Elbers, *Eng & Min J*, Apr 18. 2200 w. M June.
- Cement, A Proposed Standard Specifications for Portland—W. J. Donaldson, *Eng News*, July 4. 1400 w. M Aug.
- Cement in Germany, Slag—*Consular Reports*, Feb. 4000 w. M June.
- Cement Pipes with Metal Skeleton (III)—*Brick Jour*, June. 300 w.
- Cement Testing, Notes on—H. M. Morris, (III) *Car & Build*, April 10. 1800 w. M June.
- Cement, The Action of Heat on—J. S. Dobie, *Am Arch*, July 11. 2300 w.
- Cement, The Effect of Grinding Mixed Sand and—H. E. Reeves, *Tech*, May. 800 w. M Aug.
- Cement, The Manufacture and Use of Sand (III)—*Eng News*, Apr 16. 1800 w. M June.
- Cement Works, Some French (III)—H. K. Landis, *Pav & Mun Eng*, July. 1700 w.
- Cements, Relative Strength of Hydraulic—H. C. Estee, *Tech*, May. 1000 w. M Aug.
- Cements When Subject to Freezing, Effect of Magnesia on the Strength of—Frank Haas, J. A. McGraw, *Eng News*, Apr 30. 1000 w. M June.
- CENTRAL Station Accounts—*Elec Eng*, Lond, July 10. *Electn*, July 17. W Aug 8.
- Central Station, An Historical Electric—*Lieb*, *Cas Mag*, May.
- Central Station at Dusseldorf—*Elektrotechn Zeit*, Apr 2.
- Central Station at Graz (III)—*Pojatz*, *Zeit f Elek*, July 1. W July 25.
- Central Station Costs—*Electn*, Apr 17.
- Central Station, Distribution of Electrical Energy from a (III)—W. C. Eglin, *Proc Eng Club of Phila*, Apr. 4000 w. W May 30. M June.
- Central Station Economics—Abbott and Dommerque, *Elec Engng*, May.
- Central Station Economics, Some—P. G. Goss-



BOILER HOUSE.

The Boiler House of the University is situated back of Science Hall and is the best equipped boiler plant in the state. There are at present six tubular, two Heine boilers, a Root and a Standard boiler, but two more will be added, making the plant 1500 horse power. The new boilers are to provide for the heating of the new Library and also the old Library and Ladies' Hall are to be heated from the plant. When this is done all of the University buildings with the exception

of those of the College of Agriculture and the Washburn Observatory will be heated from this plant. At one end of the Boiler house is the coal pit, having a capacity of 1,000 tons. The boilers are stoked by the Roney stoker. The steam is conducted to the various buildings through pipes carried in underground tunnels. The water from the condensed steam is returned direct but the high pressure feed water is passed through the fuel economizer.

- ler, Abs Paper Can Elec Assn. Elec Eng, July 8. 3500 w. M Aug.
- Central Station, Local Development of—West Elec, Sept 12.
- Central Station in Paris (III)—Laffargue, L'Ind Elec, Apr 25. W May 30.
- Central Station Practice, Little Economies in—T. C. Grier, Elec Rev, May 6. Serial Part 1. 1400 w. M June.
- Central Station Statistics—Elec Rev, Lond, May 1. W May 23.
- Central Station Statistics for Germany—Elektrotechn Zeit, June 25. W July 18.
- Central Station, Test of Combined Electric Light and Railway—Jackson and Richter, Tr A S M E, 1895.
- Central Station Working XII—R. E. Richardson, Elec Wld, Mar 21. P May.
- Central Station Working XIII—H. E. Raymond, Elec Wld, Mar 28. P May.
- Central Station Working XV—C. R. Van Brunt, Elec Wld, Apr 18. P May.
- Central Station—See Current.
- Central Stations and Isolated Plants, Descriptive Index of Typical—Esty, Technograph, May. W June 20.
- Central Stations, Cost of Operating—Lightning, May 7. W June 20.
- Central Stations, Current Supply from—Lieb, Cas Mag, June. W June 27.
- Central Stations, Revenue Accounts of—Elec Eng, Lond, June 5.
- Central Stations, The Total Efficiency of Certain—E. A. Merrill, Elec Eng, June. 2400 w. M Aug. W July 4.
- CHAINS and Chain Iron—G. Shawcross, Prac Eng, July 31. 2500 w. M Sept.
- CHARGES, Electromagnetic Theory of Moving—Morton, Phil Mag, June.
- CHÂTEAU de Blois, The—Am Arch, July 18. Serial Part 1. 2000 w.
- CHEMICAL Change and the Conditions which Determine It, Nature of—Armstrong, Elec Eng, Lond, Apr 17.
- Chemical Effects on Electric Current—Gordon, Elec Pow, June.
- CHEMISTRY—Sci Am, July 25. 1500 w.
- CHESTER, Inaugural Address of William Reginald—Gas Wld, June 13. 10700 w. M Aug.
- CHICAGO Harbor Improvement, The Needs and Possibilities of—Eng News, July 16. 4000 w.
- Chicago Main Drainage Channel, Mechanical Methods of Rock Excavation Used on the (III)—W. G. Potter, Jour of W Soc of Eng, Apr. 14500 w. M July.
- CHIMNEYS, The Scientific Construction of—H. J. Palmer, Ind & East Eng, Apr 11. 1700 w. M June.
- CHINESE Railways and the British Trade—Ir & Coal Trds Rev, July 31. 1000 w.
- CHLORATE of Potash at Niagara Falls, Manufacture—Dunlap, Elec Eng, Sept 9. West Elec, Sept 12. W Sept 19.
- CHLORIDES, The Electrolysis of—E. Androli, Eng & Min J, June 13. Serial Part 1. 2500 w. M Aug.
- CHURCH, The Shepard Memorial (III)—Arch & Build, Apr 25. 500 w. M June.
- Churches of Perigueux and Angoulême (III)—M. G. Van Rensselaer, Cent Mag, Apr. 8500 w. M May.
- CIDER Making in France—Cons Repts. 3800 w.
- CIRCUIT CLOSER, Automatic (III)—L'Elec, July 11. W Aug 1.
- Circuit, Electrolytic Action of the Return—Bell, St Ry Jour, June. W June 20.
- Circuits, Ground Detection in Electric—H. M. Wheeler, Engineer's Year Book, Univ of Minn. 2000 w. M July.
- Circuit Rules and Regulations—Zeit f Elek, July 1.
- Circuit, The Return—Bell, St. Ry J, Apr. W May 16.
- CITY and Guilds of London Technical Institute—Elec Rev, Lond, July 31.
- CIVIL ENGINEERS, The New House for the American Society of (III)—Eng News, May 28. 500 w. M July.
- CLAY, Tests of Strength of Vitriified—Eng News, Mch 19. 600 w. M May.
- Clay Ware, Theory of Burning—M. A. Th. Boehnke, Brick, May. 3000 w.
- Clays, New Jersey Fire—Charles Ferry, Ir Age, Mch 19. 1200 w. M May.
- CLOCK, The Hayden Century (III)—M. H. Lockwood, Elec Eng, May 27. 600 w. M July.
- CLUTCH for Drill Presses, Walker's Magnetic (III)—Am Mach, July 30. 400 w. M Sept.
- Clutch for Electrically-Driven Punches and Shears, Slipping (III)—Am Mach, May 21. 900 w.
- COAL AND GAS in House Fires, The Combustion of—J. B. Cohen and G. H. Russell, Gas Wld, Apr 11. 3000 w. M June. J Gas Lgt, Mch 24. 2600 w. M May.
- Coal at Wirtatobel near Bergenz, Tertiary Pitch—Dr. Wilhelm von Gumbel, Col Guard, Mch 27. 1200 w. M May.
- Coal Beds of California, The—H. W. Fairbanks, Eng & Min J, July 4. 1100 w. M Aug.
- Coal Briquettes—N. G. Neare, Tradesman, July 1. 2000 w.
- Coal by Gravity at Whitewell, Tenn., Handling—Tyler Calhoun, Eng Assn of the South, April. 3400 w. M July.
- Coal Car, Southern Railway 60,000 lb—R R Gaz, Apr 17. 200 w. M June.
- Coals, Classification of Bituminous—Baird Halberstadt, Col Eng, June. 2100 w.
- Coal-Cutting by Machinery—Ir & Coal Trds Rev, June 5. 3500 w. M Aug.
- Coal Deposits of the Northwest Territories of Canada, The—W. Henry, Min Jour, May 23. 2500 w.
- Coal, Determining Moisture in—B. S. Hale, Tr A I M E, Vol XVII. 3000 w. M June.
- Coal Dust and Explosives—H. Hewitt, Col Guard, July 10. 2800 w.
- Coal Dust as an Explosive—D. Stuart, Trans Am Inst of Min Engrs, July. 9500 w.
- Coal Dust Fuel in the Brown Coal Briquette Industry—Dr. Kosmann, Col Guard, April 2. 1000 w. M June.
- Coal Dust, Notes on the Explosion of—W. Orsman, Min Jour, Aug 1. 1500 w.
- Coal Dust Question, The Position of the—Col Guard, June 3. 3500 w. M Aug.
- Coal, Early Use of Anthracite—William Griffith, Bul of Am Ir & St Assn, May 20. 1100 w.
- Coal-Field, Constitution of the Southern Portion of the Valenciennes—M. Chapuy, Col Guard, May 22. 4600 w. M July.
- Coal Field, Notes on the Cerrillos—John J. Stevenson, Science, Mch 13. 1800 w. M May.
- Coal Field, Notes on the South Wales—Col Guard, May 29. 1200 w.
- Coal Fields of Kent, The (III)—Mach, Lond, June 15. 3500 w. M Aug.
- Coal Fields of Labnan, The—Ind Engng, Apr 18. 900 w. M July.
- Coal Field of New Brunswick, Notes on the Grand Lake—R. G. E. Leckie, Can Min Rev, Apr. 1800 w. M June.
- Coal Fields, Probable Continuity of the Shropshire, South Staffordshire and Forest of Wyre—W. J. Clarke, Col Guard, May 15. 2500 w. M July.
- Coal Fields, Texas—R. S. Weitzell, Eng & Min Jour, May 16. 500 w.
- Coal Fields, The Lancashire—Col Guard, Apr 10. 1200 w. M June.
- Coalfield, Working Thin Seams in the Franco-Belgian—M. F. Cambessèdes, Col Guard, June 26. Serial Part 1. 3500 w. M Aug.
- Coal for Firing Steam Boilers—Bryan Donkin, Col Guard, June 12. 4200 w. M Aug.
- Coal Handling—J. J. Ormsbee, Col Eng, July. 1500 w. M Aug.
- Coal Handling Machinery, Recent Improvements in (II)—John D. Isaacs, Jour of Assn of Engng Soes, Apr. 4000 w.
- Coal Handling Plant at Pikeville, Tenn., (III)—J. J. Ormsbee, Eng Assn of the South, April. 1300 w.
- Coal, Heating Value of the Volatile Portion of Bituminous—William Kent, Stev In, Apr. 1600 w. M May.

①

6670

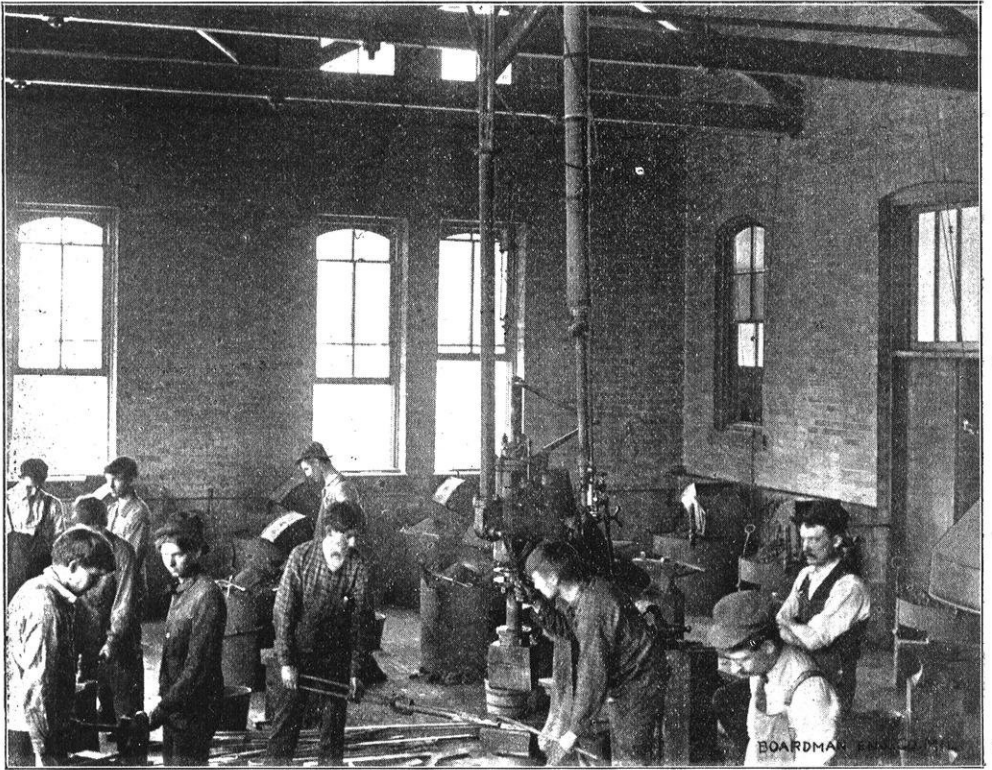


DRAUGHTING ROOM.

The above engraving shows the interior of the largest of our three draughting rooms. It is used by the senior, junior and sophomore mechanical and electrical engineers. The room is well lighted, having windows on three sides. The

photograph does not do justice to the size of this room as there are 150 individual desks besides cases for filing drawings, instrument cases and cases for models and specimens.

- Coal Hoppers on Standard Tenders—Ry Rev, May 9. 200 w.
- Coal, How it Occurs and What Causes it, The Metamorphism of—H. Bolton, Col Eng, June. 5500 w.
- Coal in Different Countries, The Cost of Producing—Ir & Coal Tr Rev, June 5. 1400 w. M Aug.
- Coal in France, British—Col Guard, Mch 27. 1590 w. M May.
- Coal Miners and Their Work—Ir & Coal Tr Rev, June 26. 1800 w. M Aug.
- Coal Mines, Haulage in—Ir & Coal Trds Rev, June 5. Serial Part 1. 2800 w. M Aug.
- Coal Mines, Methods of Opening and Working—Ir & Coal Trds Rev, June 5. 2000 w. M Aug.
- Coal Mines, Precautions Necessary in the Use of Electricity in—H. W. Ravenshaw, Electn, June 12. 2900 w. M Aug.
- Coal Production and Consumption, Statistics of—Col Guard, Mch 13. 2500 w. M May.
- Coal Mines, The Design of Top Work for—F. W. Rickart, Tech, May. 4400 w. M Aug.
- Coal Mining and the Coal Trade, Annals of—Robert L. Galloway, Col Guard, May 22. Serial Part 1. 4400 w.
- Coal Mining Puzzles—Eng, Lond, July 17. 1400 w.
- Coal, Nitrogen in—Wm. Foulis, Am Mfr & Ir Wld, July 17. 1400 w.
- Coal on Railways and Canals, The Carriage of—Col Guard, July 3. Serial Part 1. 3200 w. M. Sept.
- Coal Owners and Wages Question, The—T. Ellis, Col Guard, July 17. 2800 w.
- Coal, Railway Companies and the Carriage of—Col Guard, July 3. 600 w.
- Coal Supply of India, The—Ind & East Eng, March 28. 1800 w. M June.
- Coals, The Relative Value of Different—H. M. Chance, Eng Mag, Apr. 3300 w. M May.
- Coal, The Screening and Washing of—Ir & Coal Trds Rev, June 5. Serial Part 1. 1700 w.
- Coal Tipper, A Special Hydraulic (III)—Am Mfr & Ir Wld, July 17. 300 w.
- Coal Washing, Historical Notes on Early Plans for—F. J. Rowan, Am Mfr & Ir Wld, May 1. 1100 w. M June.
- Coal Working, Possible Economies in—Ir & Coal Trs Rev, June 26. 2400 w. M Aug.
- Coalging Station at Wabash (III)—Am Eng & R R Jour, May. 1200 w.
- Coals as Steam Producers, Nova Scotia—F. H. Mason, W. G. Matheson, Can Min Rev, April. 2200 w. M June.
- Coals, Report on Indian—Ind Engng, June 20. 3500 w.
- Coals, the Calorific Values of—Prac Eng, June 26. 700 w. M Aug.
- COIL, How to Make Use of a Tesla High Frequency (III)—Woods, Elec Rev, May 27. W June 6.
- Coil, Magnetic Field of a Cylindrical—Everett, Proc Lond Phys Soc, May.
- Coil, The Magnetic Field of a Cylindrical—Everett, Phil Mag, Apr.
- Coil Winding, Computations for—W. Slingo and A. Brooker, Elec Rev, Lond, June 5. Serial Part 1. 1800 w.
- Coils, Separable Armature (III)—William Baxter, Jr., Am Mach, Mch 19. 2300 w. M May.
- COKE and Its Selection for the Foundry, The Manufacture of—W. T. Rainey, Abst Paper Foundrymen's Assn, Ir Age, June 11. 1600 w. M Aug.
- Coke Drawer, A Mechanical (III)—R. Cook, Trans Am Inst of Min Eng, July. 1000 w.
- Coke Industry, The Vast Importance of (III)—John Fulton, Eng Mag, May. 5000 w. M June.
- Coke Oven Construction—R. M. Atwater, Col Eng, June. 2500 w. M July.
- Coke Production in 1895—J. D. Weeks, Am Mfr & Ir Wld, July 17. 1500 w.
- Coke, Some Considerations as to—Ir Tr Rev, April 23. 1200 w. M June.
- Coke, The Effect of Coke Oven Construction on—R. M. Atwater, Ir Tr Rev, Mch 26. 2500 w. M May.
- COLLEGE and School of Science, The Electrical and Engineering (III)—Elec, Lond, July 17. 2000 w.
- COLLIERIES by Electricity, The Lighting of—Can Min Rev, June. 2500 w.
- COLLIERY Catastrophe in New Zealand, The Terrible (II)—Aust Min Stand, April 2. 1000 w.
- Colliery Pumps and Pumping Operations—Ir & Coal Trds Rev, June 5. 2500 w. M Aug.
- Colliery Windings, Safety in—C. M. Percy, Col Guard, May 15. 3000 w. M July.
- COLLISION at Sea, Minimizing the Effects of—Admiral S. Makaroff, Eng, July 4. 1800 w. M Aug.
- Collision, The Logan—R R Gaz, July 31. 1600 w.
- Collision, The 109th Street—R R Gaz, May 15. 800 w.
- COLOMBIA; Region of Magdalena—Cons Rept, July. 4200 w.
- COLOR Testing—C. Williams, R R Gaz, July 31. 3800 w.
- Coloring Matters Produced by Electrolysis—Elec Rev, Lond, May 1. W May 23.
- COLUMBIA University, The Dedication of the New Site of (II)—Science, May 8. 1100 w. M July.
- COMBINE, The Electrical—Elec, Mch 18. 3000 w. M May.
- COMBUSTION of Coal and Gas in House Fires, The—J. B. Cohens and G. H. Russell, Jour Gas Lgt, Mch 24. 2600 w. M May.
- Combustion and Smoke Prevention, Economy in—C. F. Mabery, J Assn Engng Soc, May. 5800 w. M Aug.
- COMMERCE Act, The Effect of the Interstate—W. P. Clough, Ry Age, May 23. 3500 w.
- COMMUTATOR Construction, Modern (III)—Am Electn, July. 2000 w. W. Aug 1.
- Commutator Resistance, The Phenomena of—H. J. Eidsall and M. C. Korty, Sib J of Engng, June. 1100 w. M Aug. W July 11.
- Commutators, Machine Shop Practice in the Manufacture of—E. L. Hayward, Am Mach, July 2. Serial Part 1. 1500 w. M Aug.
- Commutators of Street Railway Motors, Care of—Walter C. Smith, St Ry Rev, May 15. 700 w.
- Commutators, The Care of—Chas. Wirt, Am Mach, June 25. 1000 w. W Aug 1. M Aug.
- COMPASS, Electrically Operated (III)—Elec Anz, June 28.
- Compass on Iron Ships, Deviation of the—Proc Lond Phys Soc, July.
- COMPETITIONS, Architectural, Should They be Abolished or Regulated—J. A. Fox, R. D. Andrews, H. Warren, Brit Arch, July 3. 1500 w.
- COMPRESSED Air at Sydney Mines, Cape Briton—R. H. Brown, Can Min Rev, Mch. 100 w. M May.
- Compressed Air for Elevators, Uses and Advantages of a Public Supply of—Frank Richards, Am Mach, Apr 23. 1100 w. M June.
- Compressed Air for Pumping or Raising Water, The Use and Advantages of a Public Supply of—Frank Richards, Am Mach, May 7. 1800 w. M June.
- Compressed Air for Street Car Motors—R. Lundell, Elec Eng, June 10. 2000 w. M Aug.
- Compressed Air for Street Car Motors—Haupt, Elec Eng, July 8. W July 18.
- Compressed Air Haulage—Col Eng, May. 5000 w. M June.
- Compressed Air in Car Shops—Wm. Apps, R R Car Jour, June. 1600 w.
- Compressed-Air Victims, Some—Frank Richards, Am Mach, June 18. 1800 w. M Aug.
- Compressed-Air—See Traction, Transmission, Compressors, Air on Santa Fé Ry.—Ry Rev, April 25. 400 w.
- COMPUTING Instrument, A New (III)—H. Schuermann, Eng Assn of the South, April. 2400 w.
- CONCRETE and Steel in Combination, Strength of—Frank H. Constant, Eng's Year Book, Univ of Minn. 2000 w. M July.
- CONDENSATION, A Study of Initial—A. L. Rice, Sib J Engng, June. 1000 w. M Aug.

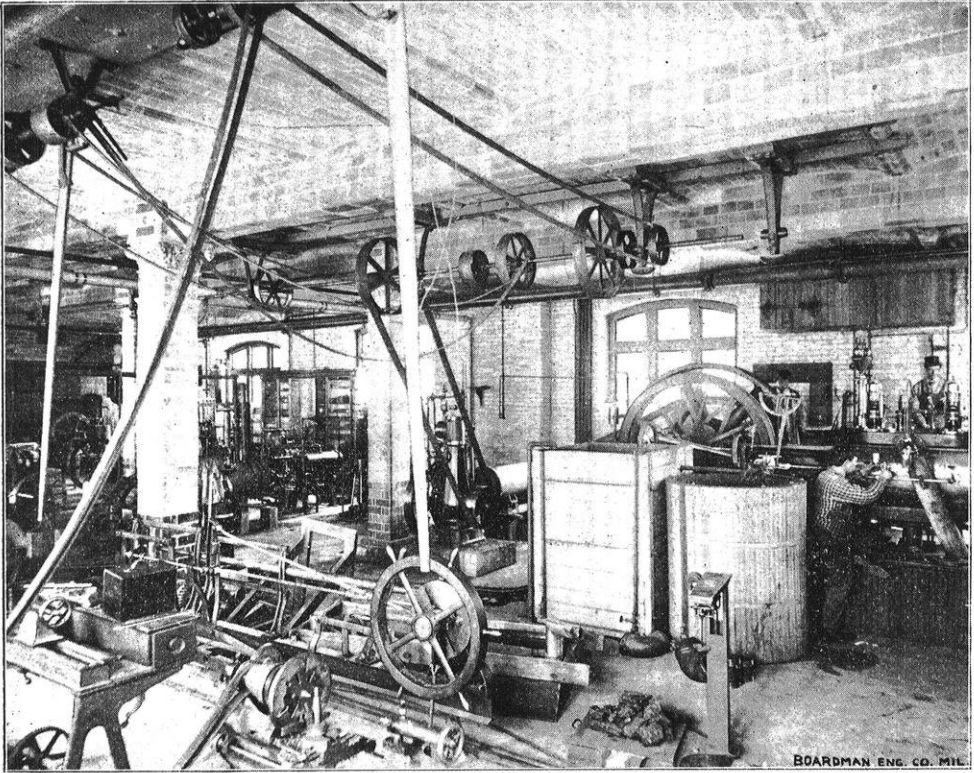


BLACKSMITH SHOP.

The Blacksmith-shop is located in the northeast wing of the machine shops. It contains forges and anvils for 50 students. The system was installed by the Buffalo Forge Co. All of the pipes (both suction and blast) are underground and the forges are provided with the anti-clinker, dumping tuyeres. The large cooling tank is also underground. The steam-hammer which plainly shows in the cut was designed and built by the

students in mechanical engineering. It is used in the heavier forgings and it makes possible the working of "scrap" into bars. The work consists of exercises in bending, upsetting, welding, etc., also forging and tempering such tools as chisels, punches and lathe tools. As in the other parts of the shop the exercises must be made according to the drawings on blue-print cards.

- Condensation, Initial—E. T. Adams, *Sib J Engng*, June. 900 w.
- CONDENSER, A Self-Cooling—L. R. Alberger, *Tr A I M E*, Vol XVIII. 4800 w. M June.
- Condenser for Steam Engines, The Evaporative (III)—Mach, *Lond*, July 15. Serial Part 1. 1500 w.
- Condenser Oscillations—Topler, *J Inst Elec Eng*, Apr. W May 9.
- CONDUCTIVITY of Cement and Concrete, On the—Dr. St. Lindeck, *Electn*, April 10. 1000 w. M June. P June. W May 2.
- Conductivity of Concentrated Sulphuric Acid—Guthe and Bangs, *J Inst Elec Eng*, July. W Sept 5.
- Conductivity of Mixtures of Electrolytes, Calculations of the MacGregor, *Phil Mag*, Apr.
- CONDUCTORLESS Roads—St Ry Rev, Apr 15. 900 w. M June.
- CONDUCTORS, Calculation of—Bochet, *L'Eclair Elec*, June 13. W July 18.
- Conductors, Calculations of—Gosselin, *L'Eclair Elec*, July 11. W Aug 15.
- Conductors—See Telephone.
- CONDUITS, Cast Iron and Stoneware—*Electn*, Mar 27.
- Conduit Construction in Washington, Electric (II)—St Ry Jour, May. 1300 w.
- Conduits from the Electrical Standpoint, Evolution of Interior—Luther Stieringer, *Elec Rev*, May 13. 7500 w. M July.
- Conduits of the Rochester Water-Works, Comparison of the—*Eng Rec*, May 2. 3500 w. M June.
- Conduit Railway—*Eng News*, June 1.
- Conduit Road in Washington, Operating Expenses of the—St Ry J, Apr. W May 16.
- Conduit System (II)—Lachmann, *Elek Anz*, June 14 and 18.
- Conduit System in New York (III)—*Elec Ry Gaz*, May 25.
- Conduit System on Amsterdam Avenue, The Lore (III)—*Elec Ry Gaz*, May 25. 1000 w.
- Conduit, Tests of the Tightness of a Vitriified Earthenware Water—Dabney H. Maury, Jr., *Eng News*, May 21. 1600 w. Ill Soc of Eng & Surv. 11th An Rept. 4500 w.
- Conduit—See Railway.
- CONES, Segar—Brick, June. 1300 w.
- CONGRESS HALL, Philadelphia, Restoration of—G. C. Mason, Arch & Build, Mch 14. 4000 w. M May.
- Congress of Electricians at Geneva, International—*L'Ind Elec*, May 10. W June 6.
- CONNECTICUT River, Flow of—Dwight Porter, *Science*, Apr. 1000 w. M June.
- Connecticut Street Railways, Earnings and Operating Expenses of the—St Ry Rev, Apr 15. P June.
- CONNECTION for High Tension Currents, Service—*Elek Zeit*, May 21.
- Connections, Mechanical—Francis B. Crocker, *Elec Pow*, Mch 1. 480 w. M May. P May.
- CONSONANCE—See Electrical.
- CONSTRUCTION, Greek vs Roman—R. Guastavino, Arch, June 12. 1600 w. M Aug.
- CONSUMING Devices, The Control by Municipal Authorities of—C. H. Wordingham, Paper Mun Elec Assn. *Electn*, June 26. 5000 w. M Aug.
- CONTACT System, Surface (III)—*Elec Jour*, July 15.
- Contacts—See Railway.
- CONTRACTOR—See Architect.
- Contractor's Fair Profit, The—J. Burnham, Ill Soc of Eng & Surv, 11 An Rept. 4200 w.
- Contracts, A Paper on—T. M. Clark, *Am Arch*, April 1. 5800 w. M June.
- Contracts, The Baltimore and Ohio Equipment—*R R Gaz*, May 1. 1200 w.
- CONTROLLER for Four-Motor Equipments, The General Electric Series Parallel—Wm Baxter, *Elec Wld*, July 18. 3000 w.
- Controllers, Rheostat and Series Parallel—Decker, *Rose Tech*, June.
- CONVENTION and Exhibition, The New York—Mercein, *Elec*, July 29.
- CONVEYING-Belts and Their Use, Notes on—Thomas Robin, Jr., *Trans Am Inst of Min Eng*, April. 4000 w. M June.
- COPENHAGEN, Free Port of—Consular Reports, Feb. 9400 w. M June.
- COPPER Assay by the Iodide Method, The—A. H. Law, *J Am Chem Soc*, May. 1600 w. M June.
- Copper Alloy, Silicate—*Jour Inst Elec Eng*, May. W June 13.
- Copper Mines of Lake Superior, The—W. P. Kibbee, *Min Jour*, July 27. Serial Part 1. 1600 w. M Aug.
- Copper Standard—*Elektrotechn Zeit*, July 2. W July 25.
- Copper Ore at Tharsis, Spain, Mining and Treatment of—C. F. Courtney, *Ind & Ir*, Mch 20. 1200 w. M May.
- Copper Ores in the Peronium of Texas—E. J. Schmitz, *Trans Am Inst of Mining Eng*, July. 2800 w.
- Copper Plates, The Formation of Amalgam—R. Bayliss, *Trans Am Inst of Min Eng*, July. 3500 w.
- CORDBITE—*Eng*, Lond, Mch 13. 2000 w. M May.
- CORE with Eccentric Conductor, Capacity and Resistance of a—*Elec Rev*, Lond, Apr 17.
- CORLISS High-Service Low-Duty Pumping Engine of the Providence Water Works, The (III)—*Eng Rec*, Mch 14. 200 w. M May.
- CORROSION of Marine Boilers, Unusual—H. Maccoll, *Engng*, July 31. 1600 w.
- COTTON—H. Hester, *Mfrs Rec*, July 17. 4000 w.
- Cotton is Bought and Sold, How—*Mfn Rec*, July 17. 1100 w.
- Cotton Mills of Japan—Consular Report, Mar. 1000 w. M June.
- COUNTERWEIGHT System of Providence, R. I.—M. H. Bronsdon, *St Ry Rev*, April 15. 700 w. M June.
- COUPLER Attachments, M. C. B.—*Ry Mas Mech*, June. 1100 w.
- Coupler Case, Decision of the United States Supreme Court of Appeals in the Gould-Trojan—*Ry Rev*, May 30. 3000 w.
- Coupler Tests, Some Recent—*Ry Age*, May 9. 200 w.
- Coupler, Thermoelectric—Mewer, *Electrochem Zeit*, June.
- Coupling, Sharps Shaft—*Ind & East Eng*, July 4. 800 w.
- Couplers—See Safety Appliance.
- CRANE, Power Calculation for a Traveling—C. I. Griffin, *Am Mach*, Apr 2. 1300 w. M May.
- Cranes, Foundry—A. E. Outerbridge, Jr., *Ir Age*, May 14. 1600 w.
- Cranes, Foundry—*Elec Rev*, Lond, July 10. W Aug 1.
- Cranes, Traveling—Adamson, *Elec Rev*, Lond, July 17. W Aug 8.
- CRANK Pins, A Device for Turning Worn—*Loc Engng*, May. 200 w.
- CRIPPLE Creek Gold Field—*Aust Min Stand*, June 11. 2000 w.
- Cripple Creek, History of (III)—*Min Invest*, June 20. 4200 w. M Aug.
- Cripple Creek Gold Production—E. Skewes, *Eng & Min J*, July 4. 1500 w.
- CROOKES Tube Analogous to the Photographic Action Discovered by Roentgen, On a Mechanical Action Emanating from the—*Sci Am Sup*, Apr 11. 800 w. M May.
- Crookes Apparatus, On a—H. Pfloum, *Electn*, April 24. 800 w. *L'Eclair Elec*, July 18.
- Crookes Tube, Charges and Electric Figures on the Surface of a—Villari, *Electn*, July 17. W Aug 8.
- Crookes Tubes, Concerning—C. C. Hutchins and F. C. Robinson, *Am Jour of Sci*, June. 1300 w. W June 27.
- Crookes Tube, Conditions of Maximum Power of—*L'Eclair Elec*, Apr 7. W May 9.
- Crookes Tubes, Electric Images without (III)—R. K. Duncan, *Elec Eng*, Mch 11. 200 w. P May. M May.
- Crookes Tube for Roentgen Rays—Colordeau, *L'Eclair Elec*, June 27. W July 18.
- Crookes Tube, Mechanical Action from—Rydberg, *L'Ind Elec*, Apr 10.
- Crookes Tube, On a Rotational Motion of

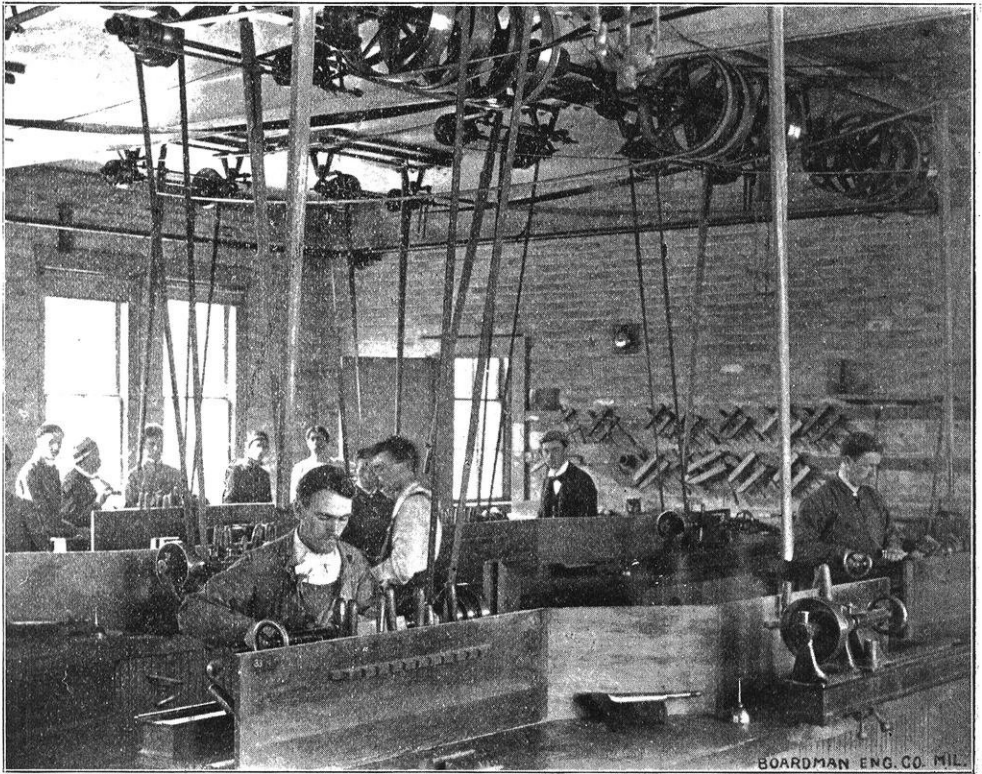


STEAM ENGINEERING LABORATORY.

The Steam Engineering Laboratory is located in the basement of Science Hall. It contains a hot-air engine, a gas engine and several steam engines of various types. The most important of these is a fifty horse-power, compound, experimental engine, so arranged that either cylinder can be supplied with live steam and run as a simple engine. The condenser and pumps can be disconnected so that the engine may be run as a non-condensing one. Both cylinders and receiver are provided with steam-jackets which may be used at will. By means of a Proell governor the revolutions can be varied from 50 to 125. The cylinders each have four poppet valves, and the cut-off, con-

trolled by the governor, may vary from zero to nine-tenths of the stroke. A Root boiler placed in the boiler house, furnishes the steam for this engine. The laboratory is supplied with friction brakes, dynamometers, and means for testing steam, vacuum, and other gauges; there are also the necessary tanks, weighing apparatus, pyrometers, calorimeters, indicators, counters, etc., for making complete engine and boiler tests. An engine of the type used in creameries has been placed in the laboratory by the Dairy department to enable the dairy students to become familiar with the type of engine they are apt to meet with in practice.

- the Cathode Disk in the—Elec Rev, May 27. 800 w. W June 6.
- Crookes Tube Phenomena—Smith, W Elec, June 13. W June 20.
- Crookes Tube Phenomenon and a Method of Preparing Tubes—Sestini, Elec Rev, Lond, May 1. W May 23.
- Crookes Tubes, Photographs in the Interior of—Metz, L'Ind Elec, May 10. W June 6.
- Crookes Tubes, The Snake of (III)—Elec Eng, June 24. 500 w.
- CROSSINGS—See Railway.
- CROSSING "Buenos Ayres," The Argentine (II)—Engng, May 29. 900 w. M July.
- Cruiser "Garibaldi" (II)—Engng, July 10. 400 w.
- Cruiser Kherson, The Russian Auxiliary—Engng, May 22. 2500 w. M July.
- Cruisers, Our New (II)—Engng, June 12. Serial Part 1. 3300 w. M Aug.
- CUDA, The Mineral Resources and Railways of—Ir & Coal Trs Rev, Mch 27. 1300 w. M May.
- CULM, The Utilization of Anthracite (III)—E. H. Williams, Jr., Eng Mag, July. 3700 w. M Aug.
- CUPOLAS, Management of—E. Grindrod, Foundry, April. 700 w. M June.
- Cupolas and Cupola Practice up to Date—Edward Kirk, Ir Tr Rev, May 28. 2000 w.
- CURRENT, A Simple Method for the Measurement of Electric—I Goto, Elec Wld, Mch 28. 300 w. M May.
- Current by an Edison Station, The Generation and Distribution of—J. W. Lieb, Jr., Elec Rev, Mch 11. 4700 w. P May. M May.
- Current, Charging for—Gilchrist, Elec Eng, July 1. W July 11.
- Current Density for Electric Light Mains, The Economical—James Whitchee, Electn, Mch 27. 2800 w. P June. M May.
- Current in an Alternating Arc, A Direct—Gold, Zeit f Elek, July 15. W Sept 19.
- Current is Generated, How the Electric—Sydney F. Walker, Am Gas Lgt J, Mch 23. 1800 w. M May.
- Current—See Pressure.
- Currents and Water Jets, High-Voltage—Electn, May 1. W May 23.
- Currents, Continuous Generation of High-Frequency—d'Arsonval, L'Ind Elec, July 25. L'Eclair Elec, July 25. W Aug 29.
- Currents in a Cheap and Simple Way for Experimental Work, How to Get Different Kinds of—F. J. Patten, Am Electn, June. 1400 w. W July 11. M Aug.
- Currents, Indicating and Measuring Open-Circuit—Nicolaieva, L'Eclair Elec, May 9.
- Currents, Measurement of High Frequency—Meylan, L'Eclair Elec, July 11. W Aug 15.
- Currents, Measuring High-Frequency (III)—Gailfe and Meylan, L'Ind Elec, May 25.
- Currents, Measuring Three-Phase—Dobrowolsky and Bauch, Elektrotech Zeit, Apr 2. W May 2.
- Currents, The Color of Water as Affected by Conventional—Science, May 8. 600 w.
- Currents, Thermal Instruments for Measuring—Friese, L'Eclair Elec, July 11.
- CURVATURE of Chords in Truss Bridges, A New Formula for the—Eng News, Mch 19. 1500 w. M May.
- CURVE, Degree of (III)—Wm. D. Pence, Tech, May. 1400 w. M Aug.
- Curves, New Method of Analyzing Periodic—Wedmore, J Inst Elec Eng, Apr. W May 9.
- Curves, Simple Method of Analyzing Periodic—Wedmore, Electn, June 5.
- CUT-OFF, How to Find the Point of—Power, May. 1500 w. M June.
- CYANIDE Processes—Elec Rev, Lond, Apr 17.
- Cyanide Process at the Mercur Mine, the—B. E. Ganes, Min & Sci Pr, May 23. 2400 w. M July.
- Cyanide Works, Charter Towers—Aust Min Stand, Mar 5. 700 w. M June.
- CYLINDER, Strength of Hydraulic—J. De D Telado, Mach, May. 1700 w. M June.
- AM, A Design for Movable—B. F. Thomas, Jur Assn of Engng Soc, June. 800 w.
- Dam, Lifting—A. Stickney, Jour Assn of Eng Soc, June. 1800 w.
- Dam, The Cold Spring N. Y. Concrete (III)—Eng Rec, July 11. 1300 w.
- Dam—See Kampsville.
- Dams, Marshall's Bear Trap (III)—W. L. Marshall, Jour Assn of Engng Soc, June. 7000 w.
- Dams, Masonry, Remscheid and Chemnitz Water Works (II)—Eng, Lond, July 31. 900 w.
- DAMASCUS Gun Barrels, Belgian—Consular Reports, March. 1500 w. M June.
- Damascus,—Its Architecture—So Arch, July. 2000 w.
- DANVILLE Gas, Electric Light and Street Railway Co.—Elec Ind, Apr.
- DAYTON—Miamisburg R. R. (III)—Elec Eng, July 15.
- Dayton, Tenn., Disaster, The—W. M. Gibson, Col Eng, May. 3000 w. M June.
- DEBTS, How to Minimize Bad—J. H. Penney, Gas Wld, May 2. 3400 w.
- DECISION, The Social Circle—Ry Age, April 11. 1000 w. M June.
- DEFENSE, Naval & Coast—Sci Am, July 25. 3800 w.
- DELANY System of Machine Telegraphy (III)—Jour Fr Inst, Aug. 2300 w.
- DELAVAL Turbine and Desrozier's Dynamo in the Edison Stations, New York, The—Elec Eng, Mar 18.
- DELAWARE and Schuylkill Rivers, The Improvement of—W. Atlee, R R Gaz, July 24. 5000 w.
- DEMURRAGE Legislation—Ry Rev, Apr 18. 1000 w. M June.
- DENTAL Surgery, Some Possibilities of Electricity in—Elec Rev, Lond, May 1. 800 w. M July.
- DEPEW Shops—N. Y. C. & H. R. R. R.—Ry Rev, June 13. 1000 w.
- DERRICKS, The Design of—B. F. La Rue, Stone, June. 2500 w. M Aug.
- DESIGN, A Question in Mechanical—F. King, Can Eng, July. 1000 w. M Sept.
- DESROZIER'S Dynamo—See De Laval.
- DETROIT Municipal Lighting Plant—Elec Eng, July 29. 1800 w. W Aug 8.
- DIAMONDS, Phosphorescent—Kunz, Elec Rev, June 3. W June 13.
- DIELECTRIC Constants, Determining—Small, L'Eclair Elec, May 30. W June 27.
- Dielectric Constants, Method of Determining—Nernst, L'Eclair Elec, May 23. W June 27.
- Dielectric Resistance—Drude, L'Eclair Elec, June 6.
- Dielectric—See Potential.
- Dielectrics—Appleyard, Electn, May 29. Elec Rev, Lond, May 29. Elec Eng, Lond, May 29. W June 20. Phil Mag, Aug. 18.
- Dielectrics—Duhem, L'Eclair Elec, July 18.
- Dielectrics, Viscosity of Polarized—Duff, Phys Rev, July—Aug.
- DIPHThERIA Toxine, Action of Alternating Current on—Tjurin, Elektrotech Zeit, May 17. W May 30.
- DIRECT-Feeding Systems—Bell, St Ry Jour, July.
- DIRECTORY of Engineering Societies—Power, Apr. 3700 w. M May.
- DISCHARGE of Electrified Bodies by Roentgen Rays—Perrin, L'Eclair Elec, June 20.
- Discharge Phenomena, in Barified Metallic Vapors—E. Wiedemann and G. C. Schmidt, Electn, Apr 24. P June. W May 16.
- Discharges Through Poor Vacuo, On Electrical—M. I. Pupin, Elec Age, Mch 28. Serial Part 1. 700 w. M May.
- DISCHARGING Liquids by Vapors—Schwalbe, Electn, July 24.
- DISCIPLINE Without Suspensions—Ry Age, July 17. 900 w.
- DISCOVERIES at Dahshur, M de Morgan's (II)—Sci Am Sup, Apr 11. 1900 w. M May.
- DISINFECTING Apparatus, Some Practical Ideas on—San Rec, Apr 3. 1700 w. M June.
- DISPERSION, The Electromagnetic Theory of—H. von Helmholtz, Electn, July 24.
- DISTRIBUTING Electrical Energy by Alter-



WOOD SHOP.

The Wood Shop is in the second story of the Machine Shop. There are thirty-two lathes all of which were built at the University. There are also the same number of benches so that sixty-four students may work at one time. The freshmen begin their shop practice here, the work

being elementary, consisting of carpenter work, turning and later some pattern work. Each is required to use his own patterns for the exercises in moulding. Blue prints of all the exercises are furnished and the students are required to follow the drawings.

- nating Currents, New System of—L'Ind Elec, May 10. W June 6.
- DISTRIBUTION of Energy, New System of Electric (III)—Ferraris and Arno, L'Eclair, July 4.
- Distribution Plant, Monocyclic (III)—Jour of Elec.
- Distribution System—Gutmann, Elec Eng, June 24.
- Distribution System, Alternating-Current (III)—Elec Eng, June 3.
- DISTRIBUTOR (III)—Electn, July 3. Elec Rev, July 3, 22. Elec Eng, July 3, 22. W July 25.
- DIVIDING Tools, Some (III)—A. H. Cleaver, Am Mach, May 7. 800 w. M June.
- DOCK on Lake Superior, A Great Coal—Sci Am, Mch 28. 400 w. M May.
- Docks and Docking Appliances, Recent Improvements in (II)—Eng, Lond, June 19. Serial Part 1. 2800 w. M Aug.
- DOVE, Plate Girder Construction for Large Church (III)—Eng Rec, July 25. 300 w.
- DOORS in Mines—Jas Blick, Col Eng, July. 2000 w. M Aug.
- Doors, Water-Tight (III)—N. Soliani Engng, Mch 27. 3000 w. M May.
- Doors, Water-Tight and Their Danger to Modern Fighting Ships—Charles Beresford, Engng, Mch 27. 3000 w. M May.
- DRAINAGE and Sanitary Equipment of the Hotel Cecil—Builder, May 9. 1800 w. M July.
- Drainage of Suburbs, Surface—Eng Rev, July 18. 1200 w.
- Drainage, Rural—Builder, July 4. Serial Part 1. 1300 w.
- DRAWING, see Electrical Engineering.
- DREDGE for the Mississippi River, The Mammoth (III)—Engng, July 17. 1400 w.
- Dredge for the Navigation Improvements of the Mississippi River, Hydraulic Suction (III)—Eng News, April 23. 3000 w. M June.
- DREDGING Machinery, The Evolution of—H. St. L. Coppee, Eng News, April 30. 1500 w. M June.
- Dredging Practice, English and American—A. W. Robinson, Eng News, Mch 19. 1900 w. M May.
- DRILL, A Portable Electric (III)—Am Mach, Apr 23.
- Drill, Exploring with the Govt. Diamond—Thos. W. Gibson, Can Min Jour, May. Serial Part 1. 2200 w. M July.
- Drill Haking and Other Operations at New Bedford, Twist (III)—Am Mach, June 4. 4400 w.
- DRIVING With the Aid of Congelation, Horizontal (III)—Col Guard, Mch 27. 1600 w. M May.
- DRY Dock at Kingston, Ont. (III)—H. F. Perley, Paper Can Soc Civ Eng. Can Eng, June. 2500 w. M Aug.
- Dry Dock, New Orleans and Algiers—Bradstreet's, Mch 14. 1200 w. M May.
- Dry Dock Company's Plant, The Detroit (III)—Sea, Mch 26. 1000 w. M May.
- Dry Docks in the Port of New York—Eng Rec Mch 21. 800 w. M May.
- DUODECIMAL System of Notation, Weights and Measures, Suggestions for—Elec Eng, Lond, April 17. 2800 w. M June.
- DWELLING, A Typical American (III)—Car & Build, April 24. 1200 w. M June.
- DYNAMITE, Manufacture, Use and Abuse of—H. A. Lee, Min & Sci Pr, June 6. 1800 w.
- DYNAMOMETER, A Hydraulic (III)—Jas. D. Hauffman, Paper A S M E, Tr Am Inst Mech Eng, Vol XVII. 1000 w. M June.
- Dynamometer, A New Transmission (III)—S. W. Robinson, Digest of Phys Tests, Apr. 2800 w. M June.
- Dynamometer for Measuring Power Absorbed in Driving Machinery (III)—Eng News, Apr 23. 700 w. M June.
- DYNAMO Machines, Parallel Coupling of Compound—Dubsky and Girault, L Ind Elec, July 25.
- Dynamo, On the Alternating Currents—W. E. Goldborough, Phys Rev, May-June. 1400 w. M July.
- Dynamo Regulation, System of—Elec Pow, Apr. 2000 w. M June. P May.
- Dynamo, The Selection of a—Poole, Amer Elec, July. W Aug 1.
- Dynamo, Theory of the Alternating Current—Goldborough, Phys Rev, May-June.
- Dynamos (III)—Boistel, L'Eclair Elec, Apr 25.
- Dynamos, Action of Iron in—Potier, L'Elec, June 6.
- Dynamos at Woolwich, Combined Alternating and Continuous Current—Moffett, Elec Lond, Aug 28. W September 19.
- Dynamos, Concentric Coil—Berthier, L'Eclair Elec, Apr 25.
- Dynamo Construction—J. B. Hall, Can Eng, May. 1300 w. M July.
- Dynamos, Design of—G. F. Sever, Elec Pow, Mch. P May. 2500 w. M May.
- Dynamo Electric Machinery, Notes on the Design and Manufacture of—C. H. Chalmers, Engineers Yr Book, Univ of Minn. 1200 w. M July.
- Dynamo—Electric Machines, Alternate Current—Hopkinson and Wilson, Elec Rev, Lond, May 29. W June 20.
- Dynamos, Energy Losses in—Corsepius, Elektrotechn Zeit, Aug 6.
- Dynamos, Faults in—Am Elect'n, May. 1700 w. M July. Am Electn, Aug.
- Dynamos for Telegraph Working—W. Slingo and A. Brooker, Elec Rev, Lond, May 1. W May 23. 2400 w. M July.
- Dynamos, Load Losses in—Mordry, Elec Lond, July 31. W Aug 22.
- Dynamos, Selection of Iron for—Wolcott, Amer Elec, July. W Aug 1.
- Dynamos, Steel for—Elektrotechn Zeit, Apr 30. W May 23.
- Dynamos, The Part Taken by Iron in—Potier, L'Ind Elec, June 10.
- Dynamos with Stationary Armatures, Alternating Current—Elek Anz, Apr 9.
- Dynamos with Concentric Helices—Berthier, L'Eclair Elec, May 9. W June 13.
- E**ARTH Currents at Vesuvius—Palmiere, L'Eclair Elec, June 6.
- Earthquake Countries, Construction in—Jno. Milne, Engng, July 3. Serial Part 1. 3400 w.
- Earthquake—See Vibrations and Engineering.
- ECCLESIOLOGICAL Notes from North Germany—T. F. Bumpus, Arch, Lond, July 3. Serial Part 1. 4500 w.
- ECONOMETER—Arndt System, L'Elec, July 11. W Aug 8.
- ECONOMIC Practice, Studies in—C. B. Fairchild, St Ry Jour, May. Serial Part 1. 3000 w.
- ECONOMICAL Heat, Light and Power Supply—Gerdtsen, Bul Univ Wis No 9, W July 18.
- EDINBURGH University, M'Ewen Hall of the—Arch, Mch 6. 2800 w. M May.
- EDISON Effect in Blow Lamps (III)—Fleming Phil Mag, July.
- Edison Laboratory, The (III)—Am Electn, June. 3000 w. M Aug.
- Edison Station at Brooklyn—Barstow, Cass Mag, Sept.
- EDISON'S New Light—Elec, June 3. W June 13.
- EDUCATION in Japan, Technical—Engng, July 17. 2200 w.
- Education, Natural Science in a Literary—Albert H. Tolman, Pop Sci M, May. 2300 w.
- Education, Quackery in Engineering—Eng Mag, June. 4200 w.
- EGYPT'S Coptic Antiquities—S. Clark, Build, July 18. 7000 w.
- EIDLITZ, Cyrus L. (III)—Montgomery Schuyler, Arch Rec, April-June. 7500 w. M June.
- ELASTICITY, The Variation of the Modulus of—A. M. Mayer, Stev Ind, Apr. 6000 w. M May.
- ELECTRIC and Magnetic Research at Low Temperatures—Fleming, Elec Eng Lond, June 19, 26. W July 11. W July 11. W July 18.
- Electric Arc, Luminous Efficiency of the—Blouel, L'Eclair Elec, July 4. W Aug 1.

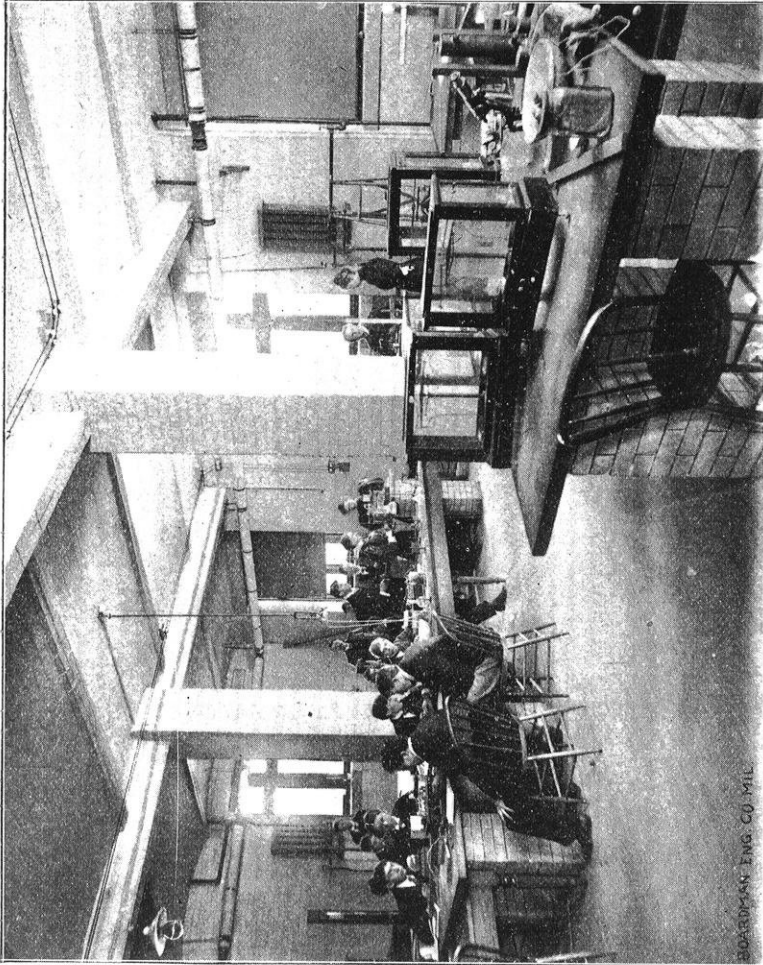


LIBRARY OF WASHBURN OBSERVATORY.

The Woodman Astronomical Library, established in connection with Washburn Observatory, and supported from the income of a fund given by the late Cyrus Woodman, Esq., possesses a large and valuable collection of works upon astronomy and kindred subjects.

By provision of law the results of important investigations conducted at the Observatory, and under this provision nine volumes, representing the more important work done here, have been issued.

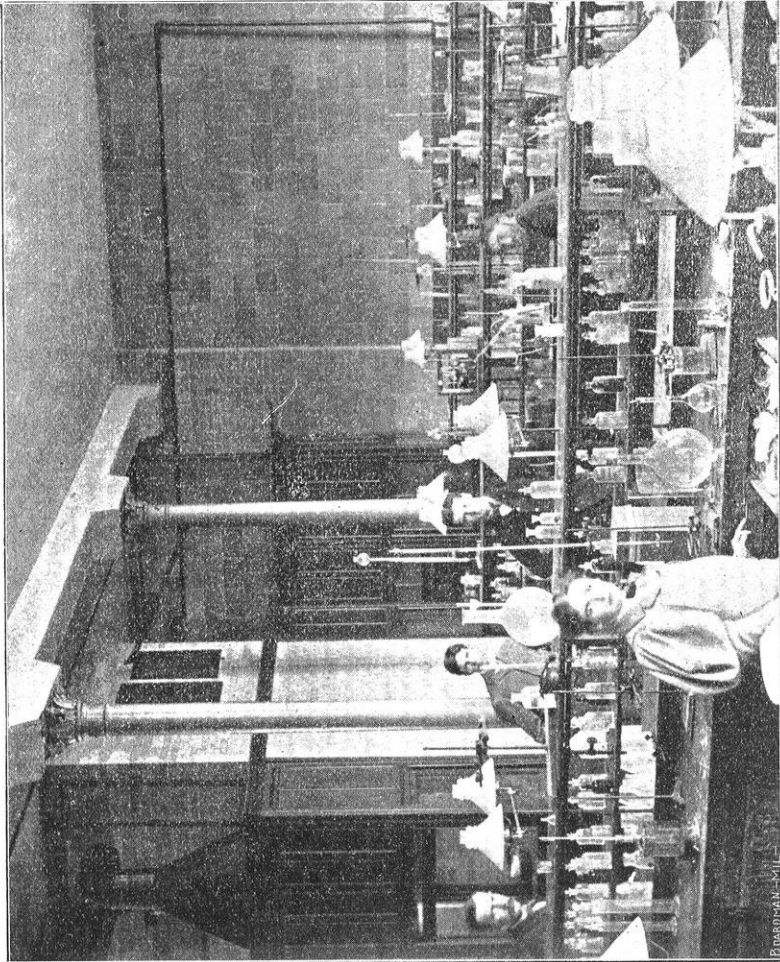
- Electric Arc, Practical Use in the Chemical Laboratory of the—M. S. Walker, *Am Gas Lgt J*, Apr 20.
- Electric Brake, A New—Frank M. Ashley, *Die Elek*, Apr 4.
- Electric Charges—See Electrons.
- Electric Company, Fourth Annual Report of the General—*Elec Wld*, May 2. 2800 w. M June.
- ELECTRIC Conductivity of Cement and Concrete, On the—Dr. St. Lindeck, *Elektrochem Zeit*, Mar 19. *Electn*, Apr 10. P June.
- ELECTRIC Current, Charging for—Lewis, *Elec Eng*, June 17. W June 2.
- Electric Current, Charging for—*Elec Rev*, Lond, July 10. W Aug 1.
- Electric Current, Chemical Effects on the—Gordon, *Elec Pow*, June.
- Electric Current in a Conductor—Silberstein, *Electro Chem Zeit*, June.
- Electric Currents in Mine Surveying Instruments, The Action of—W. Lenz, *Eng & Min J*, Apr 18. P June. W May 23.
- Electric Currents, Vertical Earth—Roucker, *Proc Lond Phys Soc*, Apr.
- ELECTRIC Discharges in Vacuo, Effects of a Strong Magnetic Field on—Swinton, *Electn*, July 10. W Aug 1.
- ELECTRIC Dredge—L'Eclair *Elec*, July 18.
- ELECTRIC Driving for Works—Daniel Adamson, *Col Guard*, *Mch* 20. 2300 w. M May.
- ELECTRIC Elevator, Test of an—MacGregor & Kingsford, *Elec Eng*, July 20. W Aug 8.
- ELECTRIC Endosmosis of Tannic Acid Through Hides—Roever, *Jour Inst Elec Eng*, May. W June.
- Electric Energy, Acetylene—L'Ind *Elec*, July 25. W Aug 29.
- Electric Heating—Puchta, *Elec Eng*, June 24.
- Electric Images, in the Field of a Hittorf Tube—Oumoff and Samoiloff, *L'Ind Elec*, June 10. W July 4.
- ELECTRIC Light and Power Co, The New 28th Street Station of the Unit. (III)—*Elec Eng*, May 6. 3400 w. M June.
- Electric Light and Power on a Railway Dock—H. C. Hope, *Paper Assn of Ry Tel Supts*, *Elec Rev*, June 24. 500 w. M Aug.
- Electric Light in Mining Operations, The—Wm. Baxter Jr, *Eng & Min J*, July 4. 1100 w. W *Elec*, Sept 12.
- Electric Light Mains—*Elec Eng*, Lond, July 3. W July 25.
- Electric Light Mains, Localization of Faults in—Raphael, *Electn*, May 1, 15, June 5, 12, July 24, Aug 7. W May 23, June 6, July 4, Aug 29.
- Electric Light on the Suez Canal—*Elektrotechn Zeit*, June 18.
- ELECTRIC Lighting and Traction Plants, Combined—J. Hesketh and J. H. Rider, *Ind & Ir*, June 26. 2500 w. M Aug. *Elec Rev*, July 29.
- Electric Lighting, A Practical Exposition of—Wm. A. Anthony, *Eng Mag*, July. 3800 w. M Aug.
- Electric Lighting Engines, Development of—H. Lindley, *Elec*, Mar 18. P May.
- Electric Lighting, Heating and Power Plant of the New Boston & Maine and Fitchburg Union Station, Boston (III)—*Safety V*—June. 3300 w. M Aug.
- ELECTRIC Lighting of the Hotel Cecil, The—*Elec Eng*, Lond, May 1. 2200 w. M July.
- Electric Lighting on the Steamer "Adirondack" (III)—*Elec Wld*, July 11. 800 w. M Aug.
- Electric Lighting, St. Pancras (III)—*Eng*, Lond, *Mch* 13. *Serial Part* 1. 1500 w. M May.
- Electric Lighting, The Industrial Development of—George R. Metcalf, *Elec*, May 20. 3000 w. M July.
- Electric Lighting, The Middle Age of—Ralph W. Pope, *Elec Pow*, May. 3400 w. M July.
- Electric Line at Lugano, Three-Phase—*Elec Ry Gaz*, Apr 25.
- Electric Line up the Gornergrat at Zermatt—*Elek Anz*, May 31.
- Electric Locomotive—*Eng News*, July 23. W Aug 1.
- Electric Locomotive in Baltimore, Experience with the—Lee H. Parker, *Elec Rev*, Mar 11. P May.
- Electric Metal Heating and Working (III)—Sachs, *Cas Mag*, Apr.
- Electric Mine Exploder—Itaps, *Elektrotechn Zeit*, July 9. W Aug 8.
- Electric Motor for Intermittent Work, The—Am Mach, May 14. 2200 w. M July.
- Electric Oscillations—Planck, *Proc Lond Phys Soc*, June.
- ELECTRIC Plants, Municipal Ownership of—Edit. *Elec Eng*, July 1. 1400 w. M Aug.
- Electric Plants, Storage and Reserve in—Mr. Massenbach, *Elektrotechn Zeit*, Apr 23.
- Electric Plows—*Electn*, June 26. W July 18.
- Electric Power and Light Plant, An Interesting—*Prac Eng*, June 12. 2800 w. M Aug.
- Electric Power for Mines and Iron Works—Carl Plankbueh, *Am Mfr & Ir Wld*, May 1. 1100 w. M June.
- Electric Power, Long Distance Transmission of—T. A. W. Shock, *St Ry Rev*, May 15. 1100 w. M July.
- Electric Power Transmission Plant, The Folsom Sacramento (III)—*Eng News*, May 7. 1100 w. M June.
- Electric Power—See Power.
- Electric Propulsion by Subterranean Conductors—*Sci Am Sup*, May 2. 1500 w. M June.
- ELECTRIC Railroad Experts, New York State Civil Service Examination for—*Elec Eng*, July 8. 500 w.
- Electric Railroads, Bridges for—Stowell, *R R Gaz*, *Elec Rev*, July 22. W Aug 1.
- Electric Railway and Urban Growth—Louis Bell, *Eng News*, June 11. 2700 w. M Aug.
- Electric Railway Apparatus, Repair of—Shepard, *Am Electn*, May.
- Electric Railway at Bridgeport (III)—*Elec Ry Gaz*, May 10.
- Electric Railway at Dublin (III)—*Elec Rev*, June 5. *Engng*, June 5. W June 27.
- Electric Railway at Lugano with Rotary Currents—*Elektrotechn Zeit*, Mar 26.
- Electric Railway at Rouen (III)—*L'Elec*, Apr 4.
- Electric Railway Construction in Germany—L. J. Magee, *St Ry J*, July. 5000 w.
- Electric Railway from New York to Philadelphia—*Elec Rev*, July 29. W Aug 8.
- Electric Railway, Nantasket Beach—*Eng News*, June 4.
- Electric Railway on the Isle of Man (III)—*Elec Rev*, Lond, July 17. W Aug 8.
- Electric Railway Power Plants, Steam Piping for—G. H. Davis, *St Ry J*, July. 4500 w. M Aug.
- Electric Railway System for Berlin—Kallmann, *Elektrotechn Zeit*, June 5. W June 27.
- Electric Railway, The Baltimore and Washington—*R R Gaz*, Apr 24. 1200 w. M June. *Elec Ry Gaz*, May 10.
- Electric Railway, The Dublin—Dalkey. *Elec Ry Gaz*, June 10.
- Electric Raek Railway, The Mont Saleve, Lighting, Apr 16. P June.
- Electric Railway, The Outlook for the—F. C. Armstrong, *Elec Rev*, July 1. 1800 w. M Aug.
- Electric Railways, Return Circuits of—Chas. Hewitt, *J Fr Inst*, July. 3000 w.
- Electric Railways, Rules and Regulations for—*Elektrotechn Zeit*, Apr 16.
- Electric Railways, Steep Grades on—S. L. Foster, *Eng News*, July 9. 2500 w. M Aug.
- Electric Resistance in Contact of Two Metals—Brauly, *Bul Soc Int des Elec*, April. W Aug 1.
- Electric Resonance—Domalip and Kolacek, *Proc Lond Phys Soc*, June. W July 18.
- Electric Road Carriage (III)—*Lond Engng*, June 12.
- Electric Road in Buda Pest, Underground—*R R Gaz*, July 31. 700 w.
- Electric Spark and the Fluorescent Screen, Relative Effects Upon Each Other of the—E. P. Thompson, *Elec Eng*, Mar 25. P May.



PHYSICAL LABORATORY.

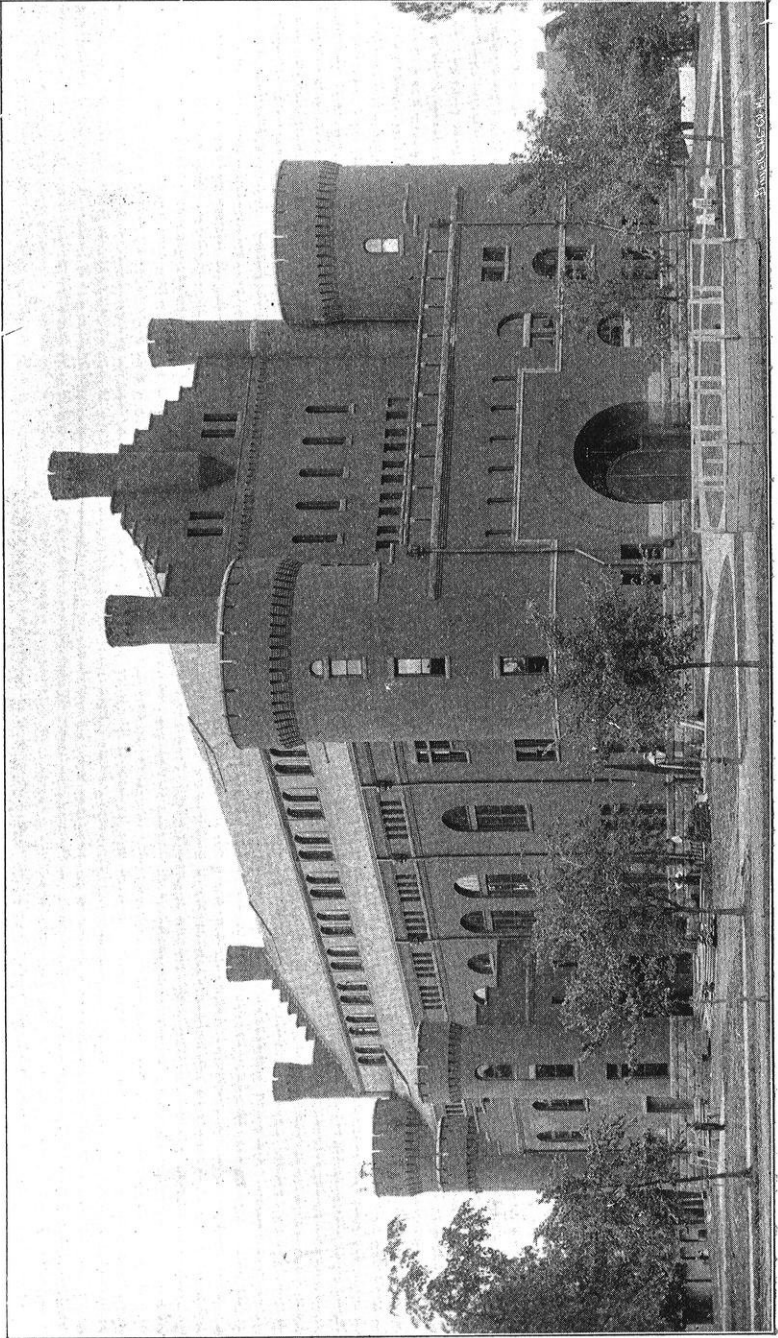
BOARDMAN ENG. CO. MIL.

- Electric Street Lighting—M. J. Francisco, Pro Age, July 1. 5000 w. M Aug.
- Electric Subway, Boston—Sci Amer, Sept 5.
- Electric Subways in Minneapolis—Eng July 23. W Aug 1.
- Electric Supply Station, Bristol Municipal (III)—Electn, Mch 6. 5800 w. M May.
- Electric Supply Data, Some—Elect'n, May 8. 800 w. M July.
- Electric Traction—Baker, Elec Eng., June 26. W July 18.
- Electric Traction in Berlin—Elec Eng, July 22.
- Electric Traction in Europe—Elec Eng, Lond, Apr 10.
- Electric Traction in the Paris Sewers—L'Ind Elec, June 25. W July 18.
- Electric Traction on Rack Railways—Frank B. Lea, Elec Eng, Lond, April 3. 2000 w. M June.
- Electric Tramways, Present and Prospective Development of—Field, Tr A S M E. 1895.
- Electric Tramway System, The Dublin—Engng, June 5. Serial Part 1. 2500 w.
- Electric Transmission in Mining—Elek Anz, Mar 22.
- Electric Treatment of the Minerals at Broken-Hall—Andreoli, L'Eclair Elec, June 13 and 27.
- Electric Waves—Cole, Phys Rev, July—Aug.
- Electric Works at Islington, New—Elec Plant, Apr. 5000 w. M June.
- ELECTRICAL and Thermo-Conductivity of Alloys, Comparison of—Van Abel and Paillet, J Inst Elec Eng, July, W Sept 8.
- Electrical Apparatus, Miscellaneous—L'Eclair Elec, Apr 18.
- Electrical Association, Municipal, Elec Eng, July 8.
- Electrical Cable Road on Monte San Salvatore, near Lugano, Switzerland—E. A. Zeller, Elek Anz, Apr 2. P May.
- Electrical Communication with Light Houses and Light Vessels—Elec Rev Lond, June 19.
- Electrical Companies, The Rights of—W. C. Jones, Elec, July 22. Serial Part 1. 1100 w.
- Electrical Conductors, Calculations of—Bochet, Bul Soc Int des Elec, June.
- Electrical Consonance, Notes on—A. W. Chapman, Elec Wld, June 15. 1200 w. M Aug.
- Electrical Current, Chemical Effects of the—Reginald Gordon, Paper Henry Elec Club, Elec Pow, July. 2400 w. M Aug.
- Electrical Discharges, Photographing—Woodbury, Pop Sci Mo, July. W Aug 1.
- Electrical Energy Generation, The Progress Made in (III)—Sci Am, July 25. 3600 w.
- Electrical Engineering in 1895, The Cost of—A. P. Haslam, Elec Lond, May 29. Serial Part 1. 1200 w. M Aug.
- Electrical Energy—See Distributing.
- Electrical Engineering Drawing, Notes on—Elec, Lond, May 22. Serial Part 1. 1000 w. M Aug.
- Electrical Engineering in Modern Central Stations—Louis A. Ferguson, Bul of Univ of Wis, Vol I No 8. 1300 w. M July. W May 23.
- Electrical Engineers, Union of German, Elec Eng Lond, July 10. W Aug 8. Elektrotechn Zeit, July 16. W Aug 8.
- Electrical Equipment for Mines—Ir & Coal Trs Rev, June 5. 2800 w. M Aug.
- Electrical Equipment, Mt Holly Branch Penn R R—C. Townley, Ry Rev, Apr 18. 1000 w. M June.
- Electrical Exhibition at New York, The National (III)—Eng, Lond, June 12. 4500 w.
- Electrical Exposition, Niagara Model for the (III)—O. E. Dunlap, W Elec, April 18. 1400 w. M June.
- Electrical Factories and Their Machinery (III)—Elec Rev, Lond, July 31.
- Electrical Heating of Wool Presses (III)—Muller, Elek Anz, June 14. W July 18.
- Electrical Industries in Germany (III)—Busset, L'Ind Elec, May 10.
- Electrical Influence Machine, New—Lebiez, J Inst Elec Eng, Apr. W May 9.
- Electrical Oscillations, Field Due to—Lecher, Proc Lond Phys Soc, July.
- Electrical Oscillations in Wires, Apparatus for Measuring the Heating Effect of—J. Klemensic, W Elec, Mar 21. P May.
- Electrical Phenomena, Mechanical Conceptions of—A. E. Dolbear, Jour Fr Inst, June. Serial Part 1. 4500 w. W July 4. M July.
- Electrical Plant in the Siegel-Cooper Co.'s "Big Store" New York, The (III)—Elec Eng May 6. 3800 w. M June.
- Electrical Resistance of Alloys—Lord Rayleigh, Lond Elec, June 26. W July 18.
- Electrical Rules, Meeting of the National Conference on Standard—Elec Eng, Mar 28. P May.
- Electrical Service, Practical Notes on Underground—E. J. Spencer, Jour of Assn of Engng Soc, June. 5000 w. M July.
- Electrical Stage Effects, See "Stage Effects, Electrical." M July.
- Electrical Station Economy—Dr. Rasch, W Elec, April 11. 1500 w. M June.
- Electrical Transmission in Spain (III)—Elec Rev, Lond, June 26. 900 w. M Aug.
- Electrical Trevelyan Record—Vaughton, Elec Eng, June 24.
- Electrical Units in France, Legal—L'Ind Elec, May 10. L'Eclair, May 6. W June 6.
- Electrical Works, The Westinghouse (III)—Engng, April 3, Serial Part 1. 1800 w. M June.
- ELECTRICALLY Driven Punches and Shears, Slipping Clutch for—Amer March, May 21.
- Electrically Operated Bicycle Works (III)—Ir Tr Rev, April 23. 800 w. M June.
- Electrically Operated Drawbridge—Elec Eng, July 22. W Aug 1.
- Electrically Operated, Model Factory (III)—W Elec, April 18. 700 w. M June.
- ELECTRICIANS at Geneva, International Congress of—L'Eclair Elec, July 4.
- Electricians, see Congress of.
- Electricity, A Biographical History of—Am Electn, May, Serial Part 1. 1700 w. M July.
- Electricity and the Horseless Carriage Problem—Wm. Baxter Jr, Eng Mag, May. 3300 w. M June. W May 23.
- Electricity and Water Power—Mark A. Replogle, Elec Rev, April 15. Serial Part 1. 1700 w. M June.
- Electricity Connected with Building—W. H. Preece, Arch, Lond, Mch 20. 3000 w. M May.
- Electricity, Contact—Christiansen, Electn, May 1.
- Electricity, Death by—Darin, L'Eclair Elec, p 398. Proc Lond Phys Soc, May. W June 6.
- Electricity Direct from Carbon—C. J. Reed, Elec Wld, Apr 25. 9000 w. M June.
- Electricity for Mine Pumping—Wm. Baxter, Eng & Min Jour, Apr 25. 1700 w. P June. M June.
- Electricity for Railway Work, Future of—Duncan, Jour Frank Inst, June. W July 11.
- Electricity, Experimental Researches to Determine the Origin of Frictional—L'Eclair Elec, Apr 18.
- Electricity from Coal, The Direct Production of (III)—G. H. Stockbridge, Eng Mag, July. 3200 w. M Aug.
- Electricity from the Wind—E. O. Baldwin, Can Eng, June. Serial Part 1. 3500 w. M Aug.
- Electricity in Algeria (III)—W Elec, Mch 28. P May. 900 w. M May.
- Electricity in Coal Mines—H. Ravenshaw, Col Guard, July 3. 3000 w. Electn, June 12. W July 4.
- Electricity in Connection with Building—W. H. Preece, Elec Eng, Lond, Mch 6. Serial Part 1. 900 w. M May.
- Electricity in Horticulture (III)—W Elec, April 25. 1800 w. M June. W May 2.
- Electricity in Mining—Eng & Min Jour, June 20. W July 4.
- Electricity in Private Houses—Theo. Waters, Elec Wld, Aug 8. 1800 w.
- Electricity in Paper Making (III)—O. E. Dunlap, W Elec, July 25. 900 w.

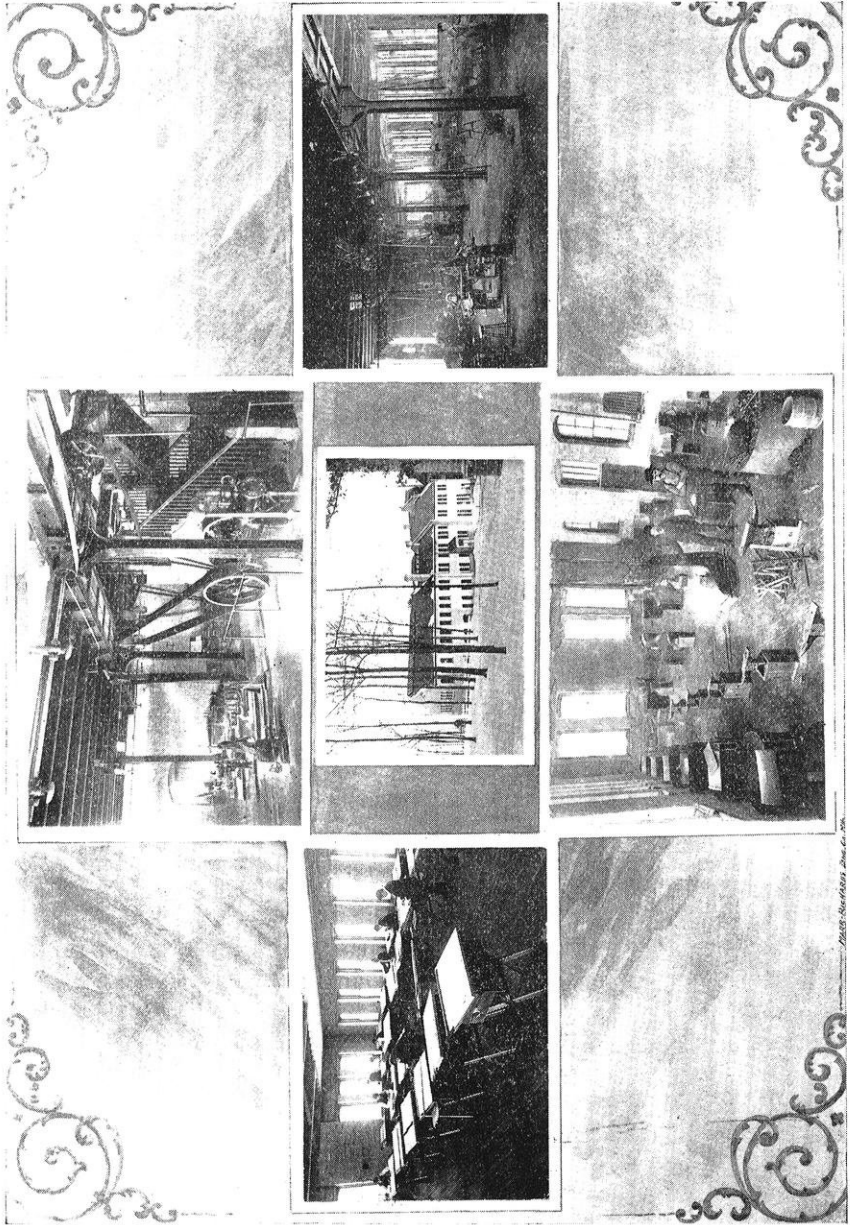


CHEMICAL LABORATORY.

- Electricity in the Italian Navy—Dary, L'Elec, Apr 18.
- Electricity on an Italian Cruiser (III)—L'Elec, May 16.
- Electricity on Elevated Roads—Ry Age, Apr 11, 800 w. M June.
- Electricity on Steam Railroads—Elek Anz, June 18, W July 18.
- Electricity on Steam Roads—Baxter, Elec Eng, May 20, W May 30.
- Electricity on Steam Railways—Baxter, Elec Eng, Apr 22, 29, May 6, 27. W May 2, 9, 16, June 13.
- Electricity on Steam Roads—Elec Rev, July 1.
- Electricity on Trunk Railways—Wm. Baxter, Sci Am, Apr 18. 1200 w. M June 9. M June.
- Electricity or Gas—Loss, Elektrotechn Zeit, July 16.
- Electricity, Seeing by—Probert, Elec Rev, Lond, Apr 10. W May 2.
- Electricity Station at the Earle's Court Exhibition, The—Eng, Lond, May 22. 4000 w. M July.
- Electricity Supply at 220 Volts—A. S. Bernard, Paper Ann Elec Assn, Engand, Elec Rev, July 8. Serial Part 1. 2500 w. M Aug. Eng, Lond, June 19. 1400 w.
- Electricity Supply, Cost of—Arthur Wright, Paper Ann Elec Assn, Ind & Ir, June 26. Serial Part 1. 3200 w. M Aug. Elec Eng, June 12. W July 4. Electn, Aug 21.
- Electricity Supply Works, Islington Vestry (II)—Elec Rev, Lond, Mch 6. 12000 w. M. May.
- Electricity, Theory of—Vaschy, L'Eclair Elec, Apr 4.
- Electricity, Total Capital Outlay, Receipts and Expenditure—Electn, Apr 17.
- Electricity, Velocity of—Le Clear, Pop Sc Mo, Mar. W May 23.
- Electricity Works, Hamburg—Max Meyer, Electrochem Zeit, Mar 12. P May.
- Electricity Works, The Walsall—Lighting, Mar 12. P June.
- Electricity, See Gas. Navy.
- ELECTRO-Aerostatics (III)—S. D. Mott, Elec Wld, June 20. 2260 w. M Aug.
- ELECTROCHEMICAL Actinometry—Marchal, Proc Lond Phys Soc, June. Electn, June 26. Electrochem Zeit, June 5.
- ELECTRO-Chemical Company's Works at St. Helena, The (III)—Eng, Lond, April 10. 2000 w. M June.
- Electro-Chemical Institute (III)—Neinst, Elektrochem Zeit, June 3.
- Electro-Chemical Instruction—Oettal, Zeit f Electrochem, June 20.
- Electrochemical Units of Measurements—Wilke, Zeit f Electrochem, July 20. W Aug 8.
- ELECTRO-CHEMISTRY and the Technic of Energy—Bucherer, Electrochem Zeit, May.
- Electro-Chemistry, Applied Swineburne, Elect Electn, May 15. W June 6.
- Electro-Chemistry in Organic Chemistry, The Importance of—Loeb, Electrochem Zeit, July 20. W Aug 8.
- Electro-Chemistry, The Outlook for—B. S. Summers, Elec Engng, Mar. P May.
- ELECTRODYNAMIC Force in Ironclad Armatures, On the Seat of the (III)—E. J. Houston and A. E. Kennedy, Elec Wld, July 4. 1600 w. M Aug.
- ELECTRODYNAMOMETERS, A New System of—Jacquiemier, L'Ind Elec, May 25. W June 20.
- ELECTROGRAPHS (III)—Walter H. Merrill, Elec Wld, Apr 4. 600 w. M May.
- ELECTROLYSERS, Ornamental (III)—Am Electn, May.
- ELECTROMAGNETIC Theory of the Inertia of Matter—Lond Elec, June 26.
- Electromagnetic Plant—Zeit f Elec, July 1.
- Electromagnetic—See Electrostatic.
- ELECTROMETER, Capillary (III)—Vigouroux, L'Elec, June 27.
- Electrometer in Theory and Practice, The Capillary—G. J. Burch, Electn, July 17. Serial Part 1. 2200 w.
- Electrometer, Modified Mascart Method for Using the Quadrant—Arno, L'Eclair Elec, May 9. W June 13.
- Electrometer, Quadrant (III)—Dolezalec and Senst, Elektrotechn Zeit, July 23.
- ELECTRO-MOTIVE Force, A Method of Increasing the Striking Distance of a Given—Elec Eng, June 10. 1900 w. M Aug.
- Electro-Motive Force, Counter Electro-Motive Force and Speed—Am Mach, May 14. 1800 w. M July.
- Electro-Motive Force Curves on Hysteresis Loss, Influence of the Form of—Alliamet, L'Elec, July 18. W Aug 8.
- Electro-Motive Force, Generation of—Am Elec, July. W Aug 1.
- Electro-Motive Forces Induced on Breaking a Circuit, An Experimental Study of—F. J. A. McKittrick, Elec Wld, June 27. Serial Part 1. 2400 w. M Aug.
- ELECTROPHOTOGRAPHY—Robinet and Perret, La Nature, May 9. W July 18.
- ELECTRO-PLATING of Aluminum with Copper—Margot, J Inst Elec Eng, July. W Sept 5.
- ELECTRO-PNEUMATIC Interlocking Plant at Grand Avenue, St. Louis, The—Ry Rev, April 18. 2000 w. M June.
- Electro-Pneumatic Plant—Elec Jour, May 15.
- ELECTROLYSIS—William Brophy, Elec Rev, May 27. 2500 w. M July.
- Electrolysis, Indirect—Andreoli, J Inst Elec Eng, Apr. W May 9.
- Electrolysis of Chloride of Sodium—Fourier, L'Elec, Apr 11 and 18.
- Electrolysis of Chlorides—Andreoli, L'Elec, Apr 25.
- Electrolysis of Chloride Solutions—Andreoli, J Inst Elec Eng, Apr. W May 9.
- Electrolysis of Hydrochloric Acid Without a Membrane—Ottel, J Inst Elec Eng, Apr.
- Electrolysis, On—R. Pauli, Elektrochem Zeit, Apr 1. P June.
- Electrolysis, Precaution Against—Potier, Bul Soc Int des Elec, May. W Aug 1.
- Electrolysis, The Production of Caustic Soda and Bleach by—Engng, April 24. 1800 w.
- Electrolysis—See Coloring Matters.
- ELECTROLYTIC Determination of Iron, Nickel and Zinc—H. H. Nicholson and S. Avery, J Am Chem Soc, July. 1700 w.
- Electrolytic Dissociation—Bredig, L. Blanc and Rohland, Elec Eng, Lond, July 10.
- Electrolytic Generator for Oxygen and Hydrogen—Franklin, Phys Rev, July—Aug. W July 25.
- Electrolytic Method of Making Welsbach Mantles—L'Elec, June 27. W July 18.
- Electrolytic Stand—Heath, Eng & Min Jour, July 25.
- Electrolytic Work, Measuring Volts and Amperes in—Pauli, Electrochem Zeit, Apr.
- Electrolytic Zinc Extraction—Eng & Min Jour, July 18. W Aug 1.
- ELECTROLYZER, New—Tommasi, L'Elec, June 6. W June 27.
- ELECTROTECHNICAL Institute at Hanover (III)—W. Kohlrausch, Elektrotechn Zeit, June 4.
- ELECTROSTATIC'S and the Electromagnetic Units, Ratio between the—Hurnmzesen, L'Elec, May 30.
- ELEVATOR at the Chesatee Mine, Georgia, The Hydraulic—W. R. Crandall, Abstract Paper A I Min Eng. Eng News, Mar 5. 600 w. M June.
- Elevator, Test on the Otis Electric—W. H. MacGregor, R. T. Kingsford, Elec Eng, July 29. 700 w.
- Elevator, The Hydraulic Gravel—Min & Sci Pr, Apr 4. 1000 w. M June.
- Elevator, Versus the Hydraulic Elevator, The Electric—Wm. Baxter, Jr., Eng Mag, June. 3800 w. W June 6. M July.
- Elevator Work, Some Problems in Electric (III)—H. Cochrane, W Elec, May 30. 5300 w. W June 13. M July.
- Elevator—See Air.
- ELEVATORS in an Elevated Railway Station, Electric (III)—W Elec, June 6. 600 w. W June 13. M July.

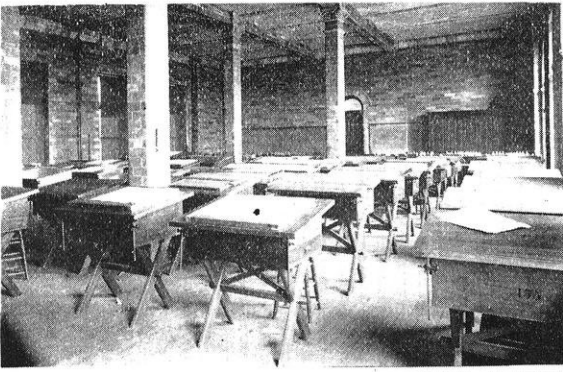
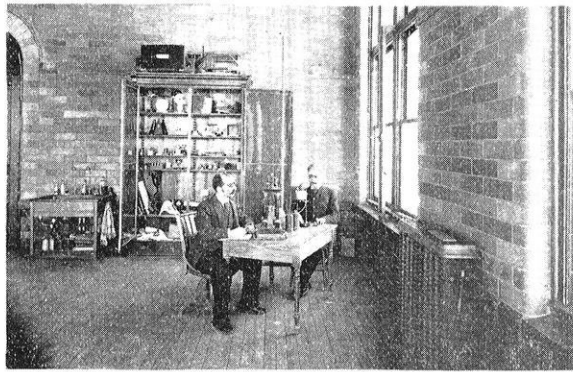
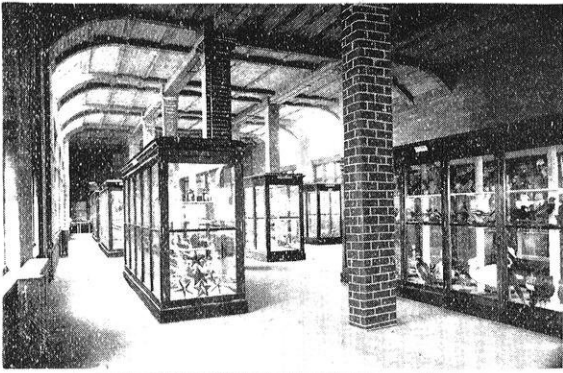


- Elevators, Electric (III)—Frank J. Sprague, Trans Am Inst of Elec Engrs, Jan. 23500 w. M July.
- ELEVATED Roads, The Future of—E. Klapp, Eng Mag, Apr.
- Elevated Motor Cars and Shops, Lake Street (II)—St Ry Rev, Apr 15. 250 w. M June.
- ELLIPTICALS—Grottrian, Electn, May 1. W May 23.
- ELLIPTICAL Current—See Magnetic Field.
- EMBREVILLE Estate, Tenn., The—G. R. Johnson, Tr Am Inst Min Eng, Apr. 2000 w. M June.
- EMPLOYEES of Government Railways—A. C. Fraser, Ry Age, Apr 11. 3300 w. M June.
- Employers, The Liability of—Ry Age, May 16. 2000 w. M Aug.
- ENGINEERING Among Professions—J. Kreepl, Arch & Bld, July 11. 1200 w.
- Engineering as Exhibited on the Great Lakes—John Birkinbine, Jour Fr Inst, June. Serial Part 1. 5300 w.
- Engineering at the University of Nebraska, Electrical (III)—T. C. Martin, Elec Eng, Mch 25. 3500 w. M May.
- Engineering Education, Quackery in—Edgar Kidwell, Eng Mag, May. 3700 w. W June.
- Engineering, Efficiency, Economy and Ethics in Municipal—C. C. Brown, Pav & Mun Eng, July. 1800 w. M Aug.
- Engineering Library, A Classification and Catalogue System for an—F. R. Hutton, Trans Am Inst Mech Engrs, Vol XVII. 3800 w.
- Engineering, Relations of Electrical and Mechanical—Elias E. Ries, Eng Mag, June. 4300 w. M July.
- Engineering, Railway Mechanical—H. Wade Hibbard, Eng's Yr Book, Univ of Minn. 4300 w.
- Engineering Schools, Admission Requirements to—Mark Talcott, Am Mach, June 4. 700 w.
- Engineering, Some Interesting Features of Electrical (III)—Elec Power, May. 800 w. M July.
- Engineering—See Architecture.
- ENGINE, A Compound Yacht (III)—Am Mach, July 23. 600 w.
- Engine and Boilers, Test for a Four-Cylinder Triple-Expansion—A. H. Eldredge, Trans Am Inst Mech Engrs, Vol XVII.
- Engines and Borax Mines, Gasoline—Min & Sci Pr, Mch 7. 800 w. M May.
- Engine and Its Electrical Applications, The Gas—Charles MacDonald, Elec, Apr 8. 4500 w. M May.
- Engine at the Atlantic Avenue Station of the Edison Illuminating Co. of Boston, Greene Wheelock Vertical Compound (III)—Power, June. 2000 w.
- Engine, Boston and Albany R. R., Express Passenger—Eng, Lond, June 19. 1000 w. M Aug.
- Engine, Compound Express—Eng, Lond, Apr 24. 500 w.
- Engine Design, Constants for—W. S. Goll and L. J. Gray, Sib J Engng, June. 1100 w. M Aug.
- Engine, Developing of Electric Lighting—H. Lindley, Eng Mag, May. 2800 w. M June.
- Engine, Erection of the Corliss—Paul Stapankey, Safety V, June. Serial Part 1. 900 w. M Aug.
- Engine for Boat Propulsion, Double Action Oil (II)—Engng, Apr 24. 500 w. M June.
- Engine for Direct Connected Electric Generator, Triple Expansion (III)—Am Mach, Apr 30. 2300 w. M June.
- Engine Foundations, Special Forms of (III)—E. A. Merrill, Am Electn, May. 600 w.
- Engine Foundations, The Vibration of—J. Whiteher, Elec Rev, Lond, July 17. Serial Part 1. 1400 w.
- Engine-House, Boston, Mass., The Ashmont (II)—Eng Rec, July 4. 1100 w. M Aug.
- Engine in E. S. Renwick's Yacht, Well's (III)—Shipbuilder, Mch 26. 300 w. M May.
- Engine, Influence of Back Pressure on the Economy of a Surface Condensing (III)—Stev In, Apr. 6000 w. M May.
- Engine, New Erie Passenger (II)—Loc Engng, June. 500 w.
- Engine of Yacht Josephine, Triple Expansion (II)—Am Mach, Mch 26. 300 w. M May.
- Engine Runner, The Passing of the—Power, July. 1200 w. M Aug.
- Engine, The Limits and Possibilities of the Gas—Sidney A. Reeve, Pro Age, Mch 16. 3700 w. M May.
- Engine, The Evolution of a Fast—Ry Age, May 16. 700 w.
- Engine, The Evolution of the "High Speed"—R. H. Thurston, Elec, May 6. 5400 w. M June.
- ENGINES, The Great Western Railway Company's Latest Express (III)—Ry Wld, June. 700 w. M Aug. Loc Engng, July. 600 w. M Aug.
- Engine, The Relative Importance of the Wastes in a Steam—Arthur L. Rice, Sib Jour of Engng, April. 2200 w. M June.
- Engine Valve Friction—Sib J Engng, June. 1000 w. M Aug.
- Engines and Boilers of the S. S. Aberdeen (II)—Eng, Lond, Mch 27. 700 w. M May.
- Engines, Compound Mill (II)—Engng, May 29. 1300 w.
- Engines, Development of Electric Lighting—H. Lindley, Elec, Mch 18. 3000 w. M May.
- Engines, Hydraulic Rotative—Arthur Rigg, Ind & Ir, May 8. Serial Part 1. 4500 w.
- Engines in Screw Steamers, Auxiliary—Eng, Lond, May 15. 3500 w. M July.
- Engines, Loop Losses in Compound—Charles M. Jones, Elec Engng, May. 1100 w. M July.
- Engines of the St. Paul and St. Louis, The—Sci Am, July 18. 1200 w.
- Engines of the White Star Liner "Germanic" (II)—Eng, Lond, July 17. 1200 w.
- Engines, Old B & O (III)—Loc Engng, Apr. 200 w. M May.
- Engines, Past and Present, Southeastern Railway—W. Paley, Ry Wld, July. 2200 w.
- Engines, Points in the Selection of Steam—W. H. Wakeman, Eng Mag, May. 3900 w. M June.
- Engines, The Duty of Pumping—D. Baird, Can Min Rev, June. 3500 w.
- Engines, The Pooling of—Ry Age, May 23. 3000 w.
- Engines without a Natural Supply of Condensing Water, Operating—E. J. Phillip, Can Elec News, July. 2000 w.
- ENGINEER in Naval Warfare, The—N Am Rev, May. 21700 w. M June.
- Engineer, The Relation of the Underwriter to the Electrical Engineer—William Brophy, Elec Power, May. 3500 w. W May 23. M July.
- Engineer, The Store and Office-Building—W. L. Patterson, Safety V, June. 1000 w. M Aug.
- ENGINEER'S Estimating, Mechanical—Eng, Lond, Mch 13. 1800 w. M May.
- Engineer's Department of an Extensive Railway, The Organization of the Chief—Ry Rev, June 6. 1900 w.
- Engineer's Practice, Experience in an—Walter Rice, Jour Assn of Eng Soc, March. 2000 w. M June.
- Engineers and Architects, The Legal Duties of—J. C. Bradford, Eng News, July 30. 2500 w.
- Engineers, Consulting, Inspecting, Contracting—George W. Dickie, J Assn Eng Soc, Feb. 7000 w. M May.
- Engineers in the Royal Navy, Assistant—Eng, Lond, April 10. 8000 w. M June.
- Engineers, Licensing—W. H. Wakeman, Safety V, Apr. 3000 w. M June.
- Engineers or Road Foremen? Traveling—Ry Age, July 17. 800 w.
- Engineers, Qualifications for Municipal—Pav & Mun Engng, June. 2300 w.
- Engineers, Rules Governing Railroad—Ry Age, May 30. 1800 w.
- Engineers, The Duties of Traveling—C. E. Slayton, Ry Rev, July 25. 2500 w.
- Engineers, The Remuneration of—Eng Rec, Mch 14. 600 w. M May.
- ENGLISH House, The—III Car & Build, July 17. 3200 w.



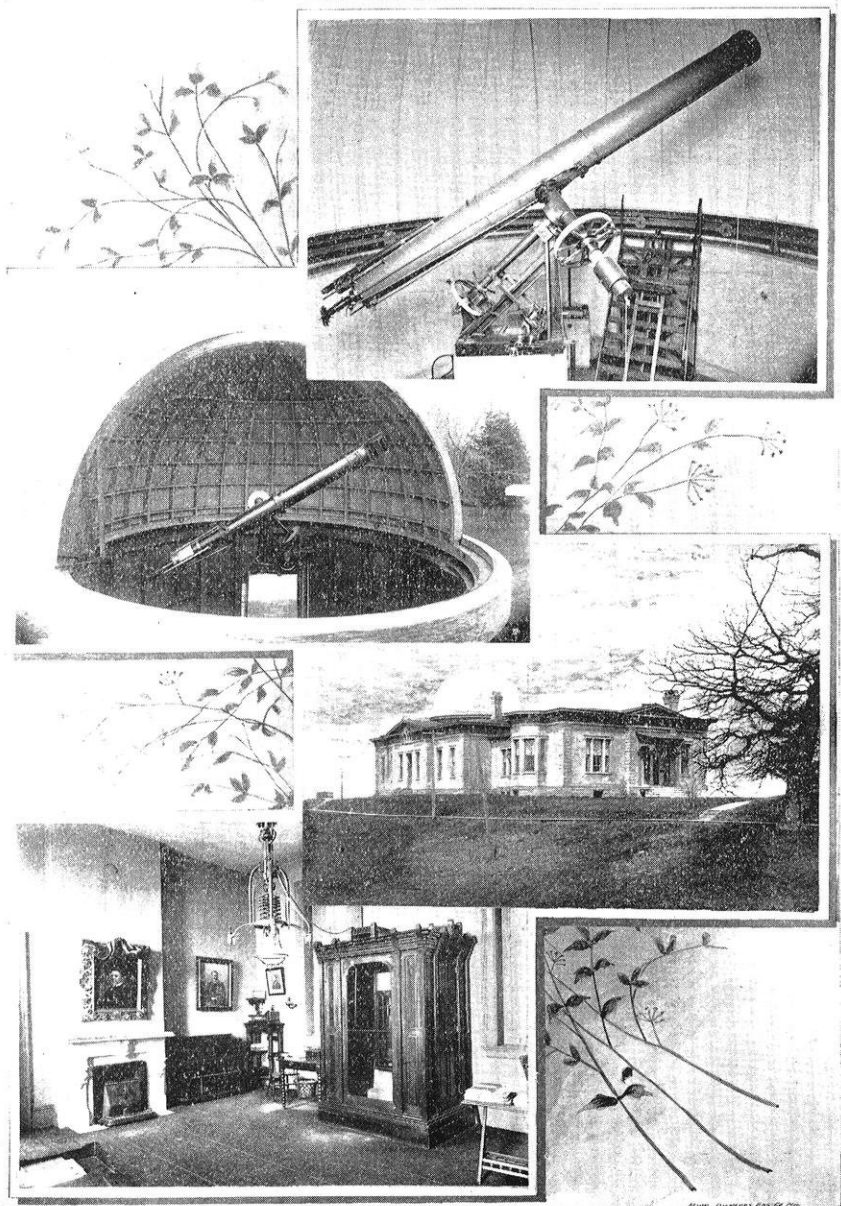
THE WISCONSIN ENGINEER

- ENTROPY Diagram, The Temperature—G. A. Goodenough, *Tech*, May, 2200 w. M Aug.
 Entropy—See Temperature.
- EQUALIZER System of Distribution—A. Churchward, *Elec Wld*, May 23. 800 w. M July.
- ERIE Canal, Description of a Break on the (III)—*Tr Assn Civ Eng*s of Cornell Univ, June, 3000 w. M Aug.
- ETHER, On the Generation of Longitudinal Waves in—Lord Kelvin, *Elec*, Mch 25. 1200 w. M May.
- EXHIBITION—*L'Ind Elec*, June 10.
- EXPERIMENT Station of Sibley College, The Engineering—R. H. Thurston, *Sib Jour Eng*, Apr. 7500 w. M June.
- Experiment Stations, State Engineering—J. P. Jackson, *Elec Wld*, Mch 28. 1100 w. M May.
- EXPERIMENTAL Error—Engng, May 15. 1600 w.
- EXPLOSION in the Oil Engine, The—Samuel Rodman, Jr., *Am Mach*, Mch 19. 900 w. M May.
- Explosion, The Dayton Mine—F. P. Clute, *Eng Assn of the South*, April. 4500 w.
- Explosion, The Vulcan—David Griffiths, *Col Eng*, June, 6000 w.
- EXPLOSIONS for 1895, Report of Her Majesty's Inspectors of—*Col Guard*, May 29. 1800 w.
- Explosions, The Causes of Death in Colliery—*Col Guard*, June 19. Serial Part 1. 8000 w. M Aug.
- EXPLOSIVE Mixture for Combustible Gases—Frank Clowes, *Gas Wld*, June 13. 4000 w. M Aug.
- Explosive—See "Cordite."
- EXPLOSIVES, High—H. F. Metcalf, *Yale Sci M*, June, 1700 w. M Aug.
- EXPOSITION of 1881-82, The Crystal Palace. Electrical—*Elec Wld*, May 30. 500 w. M July.
- EXPRESS Engines, Caledonian Express—*Ry Wld*, May, 450 w.
- Express, The Albany Troy Electric (III)—*St Ry Rev*, May 15. 1300 w.
- Express, The Black Diamond (III)—*Ry Age*, May 16. 700 w.
- Express Trains, Lightning (III)—*Elec Eng*, July 24. W Aug 15.
- FABRICS—Aldam Heaton, *Arch*, Lond, May 15. 7200 w.
- FACTORY, Electrical—Martin, *Elec Eng*, June 17.
- FACING, Plumbago—John A. Walker, *Foundry*, April. 600 w. M June.
- FANS, Electric (III)—S. D. Mott, *Elec Wld*, Apr 11. 600 w. M May.
- FARE Fallacy Exposed, Three Cent—*St Ry Rev*, Apr 15. 1100 w. M June.
- Fare, Power to Change Rates of—*Ry Age*, May 9. 600 w.
- FEED and Circulating Water, etc., by Chemical Means, Measurement of—C. E. Stromeyer, *Eng*, Lond, April 10. 3500 w. M June.
- FENDERS, Are They Practicable?—M. D. Stein, *St Ry Rev*, June 15. 2800 w. M Aug.
- FENESTRATION—*Arch*, Lond, May 29. 2000 w. M July.
- FIELD, The—F. M. Pederson, *Elec Pow*, Mar. P May.
- FILAMENTS, Transparency of—Allingham, *Electn*, May 15.
- Filaments, Transparency of—Cassels, *Electn*, June 5. W June 27.
- FILTRATION Experiments, The Providence—*Eng Rec*, Apr 11. 2800 w. M June.
- Filtration, Mechanical—*Fire & Water*, Apr 25. 2000 w. M June.
- Filtration of City Water Supplies, The—*J Fr Inst*, May, 6000 w. M June.
- Filtration of Water, Some Facts about Slow Sand—P. Frankland, *Eng News*, July 30. 2000 w.
- Filtration—See Water.
- FILTER Plant at Wilkesbarre, Pa., The Jewell Mechanical Water (III)—*Eng News*, May 21. 4400 w.
- FILTERS for Water Purification, Factors Which Determine the Efficiency of—*Eng Rec*, July 25. Serial Part 1. 2800 w.
- Filters, The Ottumwa, Iowa—*Eng Rec*, May 9. 600 w. M June.
- FIRE Apparatus Station, N. Y., An Extensive (III)—*Eng Rec*, April 11. 1800 w. M June.
- Fire Service, Pipe Distribution and Water Supply for—William Perry, *Can Eng*, Mch. 1400 w. M May.
- Fire Damp—F. C. Keighley, *Col Eng*, July, 4200 w. M Aug.
- Fire Damp and Coal Dust, Experiments on the Action of Flameless Explosives upon (III)—*Sci Am Sup*, Apr 4. 1000 w. M Aug.
- Fire Damp, Periodicity of—A. Dobeux, *Col Guard*, April 10. 550 w. M June.
- Fire Damp, The Formenophone and the Indicating Safety Lamp—Ernest Hardy, *Col Guard*, April 17. 2000 w. M June.
- FIRE-HOSE Requirements in New York City—*Ind Rub Wld*, June 10. 1300 w.
- FIREPROOF Building Construction, The Efficiency of Modern—*Eng News*, Apr 16. 3000 w. M June.
- Fireproof Floors in Modern Buildings, F. L. Douglas, *Engineers' Year Book*, Univ of Minn. 4300 w. M July.
- FIREPROOFING, The Art of (III)—H. B. Seely, *Eng News*, April 9. Serial Part 1. 3600 w. M June.
- Fireproofing Materials, The Effect of Fire on—J. C. Rossi, *Eng News*, May 14. 800 w. M July.
- FIRES and the Tillinghast Patents, Single-Tube—*Ind Rub Wld*, Apr 10. 2200 w. M May.
- FLAMES, The Temperature of Certain—W. Hartley, *Am Gas Lgt Jour*, July 27. 1600 w.
- FLAN Scutching and Hackling Machinery—J. Horner, *Eng*, Lond, July 31. 2500 w.
- FLIGHT Successfully Achieved by Prof. Langley's Aerodrome, Artificial—*Sci Am*, May 23. 800 w.
- FLOODS, Flow of River—*Ind Engng*, July 4. 600 w.
- FLOORS, American—F. Maire, *Ill Car & Builder*, Apr 24. 1200 w. M June.
- FLOUR, Relation of Color to Value in—Am Miller, May 1. 1700 w.
- Flour Testing Laboratory, In a—*Milling*, Feb. 1700 w. M May.
- FLOW of Water in Branching Pipes, On the—A. L. Colsten and R. H. Keays, *Tr Assn Civ Eng*s of Cornell Univ, June.
- Flow of Water Through Siphons (III)—M. S. Ketchum, *Tech*, May, 1700 w. M Aug.
- FLOWAGE Test at New Westminster, B. C.—A. Hawks, *Eng News*, July 30. 2000 w.
- FLUE Sheets, Distortion of—*Loc Engng*, May, 300 w.
- FLUES, The Strength of Boiler—*R R Gaz*, Apr 3. 2000 w. M May.
- FLUORESCENCE of Solids and Solid Solutions—Wiedmann and Schmidt, *Proc Lond Phys Soc*, June.
- Fluorescence Under the Cathode Ray, Further Experiments in—Thos. A. Edison, *Elec Eng*, Apr 18. P May.
- FLUORESCENT Screen—See Electric Spark.
- FLUORIDES on Feed Water and Corrosion in Steam Boilers, The Action of—A. Wangermann, *Stat Eng*, May, 4000 w. W June.
- FLUORSCOPE, Edison's (III)—*Elec Rev*, Apr 1. 600 w. M May.
- Fluoroscope Exhibit, The Edison—*Elec Eng*, June 3. 1300 w. M July.
- Fluoroscope, On the Bleyer Photo—J. M. Bleyer, *Elec Eng*, July 1. 1600 w. M Aug. W July 11.
- FLY-WHEEL Built of Steel Plates, A (III)—*Eng News*, Apr 23. 400 w. M June.
- FLY-WHEELS, Structural Steel—T. E. Murray, *Paper A S M E*, *Tr A I M E*, Vol XVII. 1000 w. M June.
- FOCUS Tube, An Improved (III)—J. Smith, *W Elec*, July 25. 500 w.
- FOCUSING Tube—See Alternating Currents.
- FORMULAS for Long Columns—*Eng News*, April 30. 3800 w. M June.
- FOREST Resources Briefly Stated, Facts and Figures Regarding Our—B. E. Fernow, *U S Dept of Agriculture Circ No 11*. 3500 w. M May.

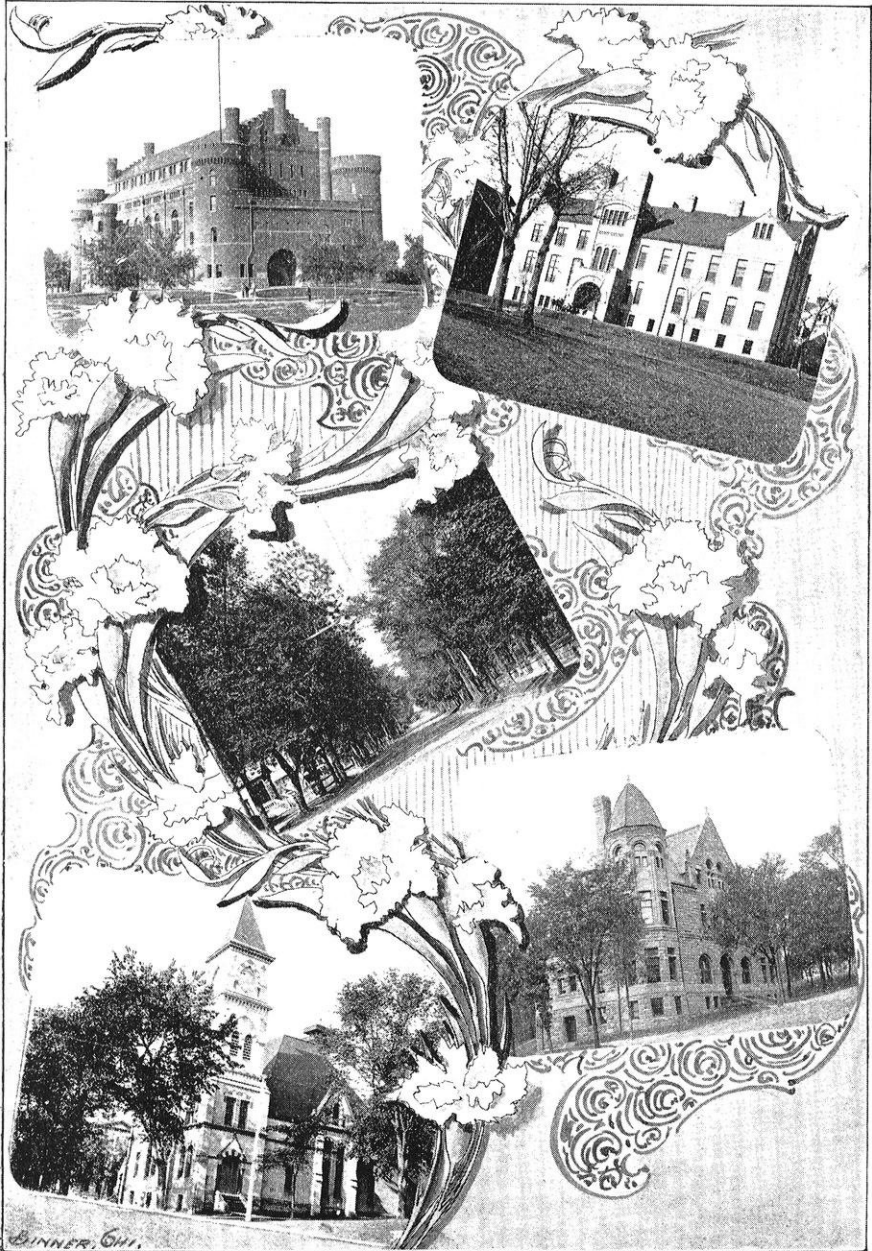


W. H. KENNEDY
1900

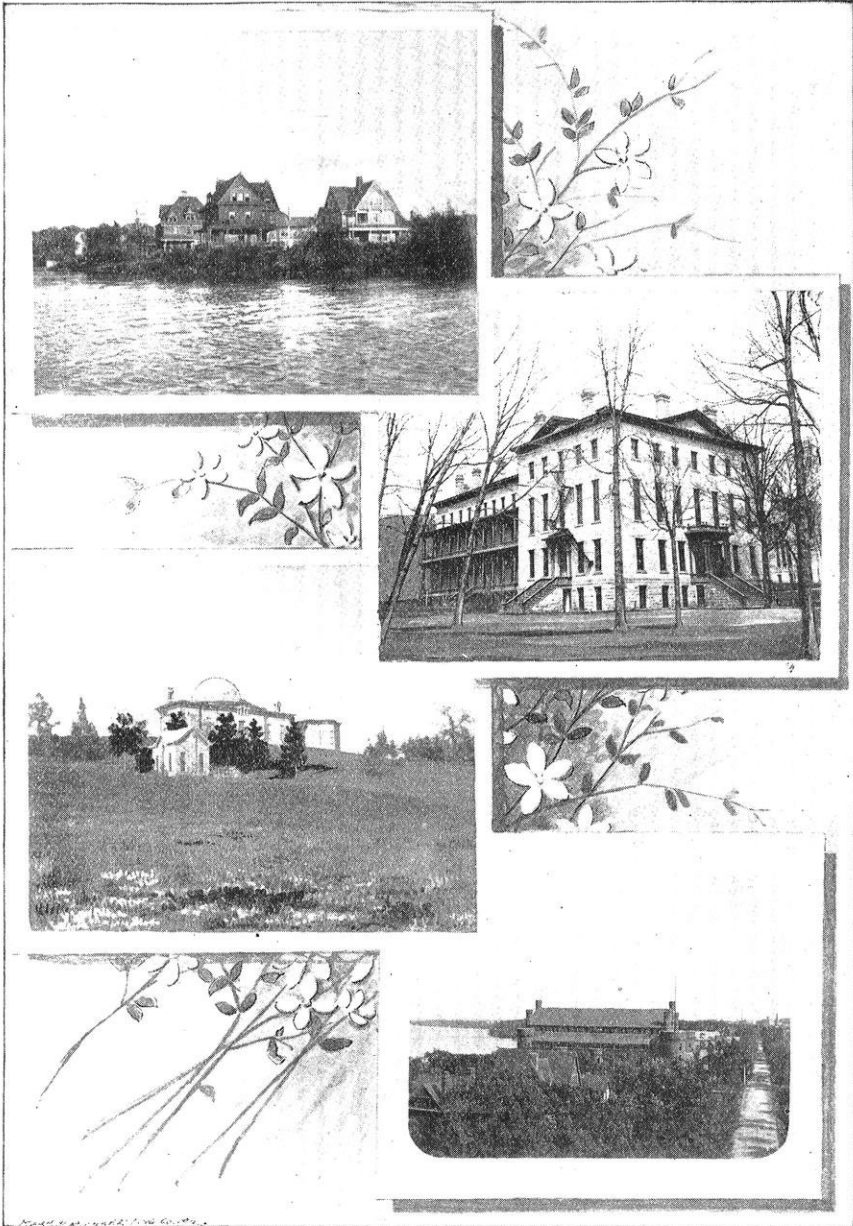
- FORESTRY** at Biltmore—Arch & Build, July 18. 1000 w.
- FORGINGS**, Hollow Steel—H. F. J. Porter, Paper A S M E. Tr A I M E, Vol XVII. 2800 w. M June.
- Forgings, The Manufacture of Naval—Ir & Coal Trs Rev, Mch 27. 1800 w. M May.
- FOUCAULT** and Hysteresis Losses—Klemenec, Weid Ann, No 6. Elec Lond, July 10. W Aug 1.
- FOUNDATIONS** of Heavy Buildings in New York City, Concerning—Charles Svoysmith, Tr Am Soc of Civ Eng, Mch. 4400 w. M May.
- Foundations of the Meyer-Jonasson Building (Ill)—Eng Rec, Apr 4. 2500 w. M May.
- Foundation Tests for the St. Paul Building, Preliminary—Eng Rec, May 2. 700 w. M June.
- FOUNDER** Determine the Value of New Devices and Fluxes Which Are Recommended to Him, How Can a—Foundry, Mch. 900 w. M May.
- FOUNDRY** Building, Iron—O. Benson, Foundry, Apr. 1200 w. M June.
- Foundry, Compressed Air in the—Cutis W. Shields, Ir Age, May 14. 2400 w.
- Foundry Foreman, The—H. R. Ramp, Foundry, Mch. 800 w. M May.
- Foundry Literature, The Growth of—T. D. West, Foundry, Apr. 2000 w. M June.
- Foundry, Money Saving Devices in the (Ill)—E. H. Putna, Foundry, Apr. 650 w. M June.
- Foundry Practice in Connection with Manufacture, Modern—John Morris, Eng's Yr Foundry—See Niles Tool Works.
- FOUNTAIN**, Simple but Effective Electric (Ill)—W Elec, Apr 4. 600 w. M May.
- FREIGHT** Cars in England and America, Demurrage of—R R Gaz, July 10. 900 w.
- Freight Cars, Steel Underframes for—D. L. Barnes, R Rev, April 25. 800 w.
- Freight, Mail, Express & Baggage Service—St Ry Jour, May. 3900 w.
- Freight Yard at Dresden—R R Gaz, July 31. 800 w.
- FREQUENCY**, Instruments for Measuring—Campbell, Electn, May 29. Elec Rev, Lond, May 29. Elec Eng, Lond, May 29. W June 20.
- Frequency, Method of Measuring the—Meyer, Elec Tech, Mar 14. W May 16.
- FRICTION** in Electric Motor and Transmission Shafting, Experiments Upon—Mech Wld, Apr 17. 800 w; W June.
- "FRIEDRICHSHOF"**, near Hamburg (Ill)—Builder, July 25. 2000 w.
- FRONT**, The Original Extension—Loc Engng, May. 850 w.
- FUEL** Problems, Some—J. D. Weeks, Trans Am Inst of Min Eng, April. 4500 w. M June.
- FURNACE** and Apparatus, Wegener's Powdered Fuel Boiler—Eng, Lond, May 15. 1000 w.
- Furnace Construction and Fine Ores—Guy R. Johnson, Ir Tr Rev, May 7. 500 w. M July.
- Furnace Practice and the Pig Iron Manufacture of Different Countries, Modern Blast—Ir & Coal Trs Rev, May 1. Serial Part I. 6500 w. M July.
- Furnace, Products of the Electric—Moissan, L'Eclair Elec, July 11.
- Furnace Work—Dom Engng, May. 800 w. M July.
- FUSE** in Fiery Mines, Dangers from the Use of—Col Guard, June 12. 2600 w. M Aug.
- FUSES** for Telegraph Circuits—Strecker, Elektrotech Zeit, July 2. W July 25.
- Fuses, Non-Interchangeable—Ritterschauen System, Elektrotech Zeit, July 16. W Aug 8.
- Fuses, Safety—See Circuit-Breakers.
- GALVANIC** CELLS, Polarization of—Streintz, Elektrotech Zeit, June 25.
- GALVANOMETER**, Increasing the Sensitiveness of a—Abraham, L'Eclair Elec, May 9. L'Ind Elec, May 10. L'Elec, May 9. W June 6.
- Galvanometer of Great Sensitiveness, An Absolute Astatic—Broca, L'Ind Elec, July 25. L'Eclair Elec, Aug 1. W Aug 29.
- Galvanometer, Sullivan University—Elec Rev, Lond, May 22. W June 13.
- Galvanometer When Current Is Not of Short Duration, Use of the Ballistic—Weiss, Jour Inst Elec Eng, May. W June 13.
- Galvanometers—Pettinelli, Proc Lond Phys Soc, July. W Aug 29.
- GARBAGE** Cremation in Europe—J. Fuertes, Eng Rec, July 11. 2300 w.
- Garbage Cremation Experiments in Germany—Eng Rec, June 20. 4500 w. M Aug.
- Garbage Disposal at Tacoma and Seattle (Ill)—A. Mel. Hawks, Eng News, July 9. 1400 w.
- Garbage Disposal in England—J. H. Fuertes, Eng News, July 2. 2200 w. M Aug.
- Garbage, The Disposal of—C. S. Hill, Ill Soc of Eng & Surv, 11 An Rept. 1300 w.
- GARDEN**, Delights of a Rough—Gar & For, July 29. 1000 w.
- GARDENS**, English, Unsited for America—R. Clepson, Gar & For, July 15. 2000 w.
- Gardens, Old Time Flower (Ill)—A. M. Earle, Scrib Mag, Aug.
- GAS** and Coke for Boston and Suburbs, Cheap—Sci Am Sup, April 18. 2500 w. M June.
- Gas and Its Use as a Fuel, Natural—Bert M. Seymour, Sta Eng, June. 1000 w.
- Gas Apparatus on Hire, Letting—N. H. Humphrys, Gas Wld, June 13. 3000 w. M Aug.
- Gas Association, Wrinkle Department at the Meeting of the Western—Am Gas Lgt Jour, June 1. 6500 w.
- Gas Business of America, The Future of the—M. S. Greenough, Am Gas Lgt Jour, June 1. 8200 w.
- Gas, Carbide of Calcium-Acetylene—Pro Age, April 15. 12000 w. M June.
- Gas Coals, Laboratory Apparatus for Testing—G. Jouanne, Am Gas Lgt J, Mch 16. 900 w. M May.
- Gas, Comparative Efficiency of Pintsch and City—P. H. Brangs, R R Gaz, June 13. 1200 w. M Aug.
- Gas Engine Plant, Test of—Charles E. Barry, Sib Jour of Engng, May. 3000 w.
- Gas Engine Sub-stations—Electn, May 22. W June 13.
- Gas Engine—See Power Plant.
- Gas Engines as Economical Motors—J. Holliday, Prac Eng, July 17. Serial Part 1. 2000 w. Gas Wld, June 13. 6800 w.
- Gas Engines, Electrical Igniter for (Ill)—Elec Eng, July 8. W July 18.
- Gas Engineering, Self-Education in—A. C. Humphreys, Am Gas Lgt Jour, June 1. 12000 w.
- Gaseous Mixtures, The Storage and Explosion of Compressed—J Gas Lgt, Mch 10. 2200 w. M May.
- Gasholder Construction, New Details in (Ill)—E. L. Pease, Gas Wld, June 13. 1100 w. M Aug.
- Gasholders in New England Be Housed or Not, Should—Fred H. Shelton, Am Gas Lgt J, Mch 23.
- Gas in Birmingham, Water—Arch, Lond, Apr 3. 2200 w. M June.
- Gas in Cooled Flames and Gas Motors, Researches on the Combustion of Illuminating—Dr F. Haber and A. Weber, J Gas Lgt, Mch 10. Serial Part 1. 2800 w. M May.
- Gas in Relation to Temperature, The Measurement of—George Livesay, Gas Wld, May 23. 1600 w. M July.
- Gas in the Metropolis of Texas, One Year's Experience with—W. A. McGoldrich, Am Gas Lgt Jour, June 1.
- Gas Light Trials, The Judgment in the Incandescent—Gas Wld, April 25. 1600 w. M June.
- Gas Lighting, Incandescent—V. B. Lewes, Gas Wld, May 23. 12500 w.
- Gas Liquor in Small Plants, Utilizing—B. P. Holmes, Am Gas Lgt J, Mch 30. 6500 w. M May.
- Gas Manufacture, Nine Years Ago and Now—William Foulis, Gas Wld, May 16. 5500 w.
- Gas Motor Tram Cars (Ill)—Eng, Lond, July 17. 1900 w.



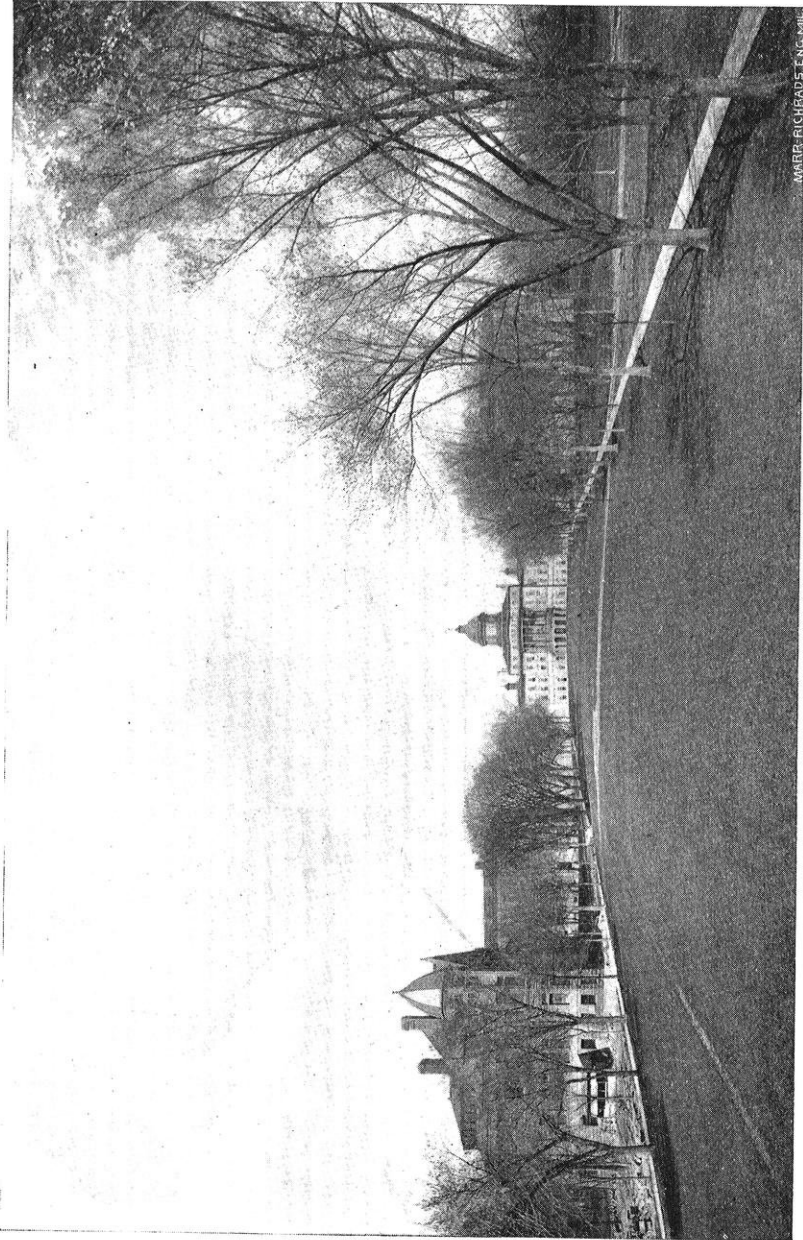
- Gas Meter Tramway Cars, The Lührig System of—G. Grosch, *Ind & East Eng*, July 11, 500 w.
- Gas or Electricity—Ross, *Elektrotechn Zeit*, July 16.
- Gas Passing Through Meters, The Application of the Expansion of Fluids to the Correct Measurement of—W. W. Fidaes, *Gas Wld*, May 23, 640 w.
- Gas Pipes and Steam Rollers—Norton H. Humphrys, *J Gas Lgt, Men & M*, May 5.
- Gas Producer, Automatic feed Device for (III)—C. W. Baldt, *Ir Age*, Apr 30, 1869 w. M June.
- Gas Producer, The Kitson (III)—*Ir Age*, Apr 30, 2400 w. M June.
- Gas Producers, The Efficiencies of—Charles F. Jenkin, *Col Guard*, Mch 27, Serial Part 1, 2800 w. M May.
- Gas Sales on Fuel and Illuminating Account, Diagrammatic Outlining of—*Am Gas Lgt Jour*.
- Gas, Sealing—Henry L. Doherty, *Am Gas Lgt J*, Apr 6, Serial Part 1, 5600 w. M May.
- Gas Testing Burner, On the Efficiency of the London Argand—*Gas Wld*, May 16, 7800 w. M July.
- Gas, The Popularization of—A. Dongall, *Gas Wld*, June 13, 8400 w. M Aug.
- Gas Well, Notes on a Breathing (III)—H. W. Fairbanks, *Science*, May 8, 900 w.
- Gas vs. Electricity as an Investment for Towns—Troughton, *Elec Eng, Lond*, Apr 24, *Elec Rev, Lond*, Apr 24.
- GASES—See Explosive mixtures.
- GATE in Davis Island, Bear Trap—Wm. Martin, *Jour Assn of Engng Soc*—June, 1000 w.
- GATES in Navigable Pass, Minn., Bear Trap (III)—*Jour Assn of Engng Soc*, June 7, 7000 w.
- GEARS and PINIONS, A Study of the Causes Which Lead to Breakage of—St Ry J, *Apr*, Serial Part 1, 1800 w. M May.
- GEAR for Japanese Submarine Cable Steamer (III)—*Elec Rev, Lond*, Apr 17, 400 w. M June.
- Gear Question, The Draft—*Ry Mas Mech*, May, 1700 w.
- GEISSLER and CROOKES Tubes, Phosphorescence and X-Rays in—Campanile and Stromeli, *Elec Eng*, June 24.
- GENERAL ELECTRIC—WESTINGHOUSE Combination—*Elec Rev*, Mar 18, P May.
- GENERATION and DISTRIBUTION of Current by an Edison Station, The—J. W. Lieb, Jr., *Elec Plant*, April, P May, M May.
- GENERATOR, Dr. W. W. Jacques' Carbon Electrical—*Elec*, June 3, 900 w. M July.
- GENERATORS Run as Motors—William Baxter, Jr., *Power*, May, 3400 w. M June.
- Generators in Parallel, The Operation of Compound Wound—J. E. Woodbridge, *Elec Ry Gaz*, April 25, 2600 w. M June, W May 9.
- Generators, Steam Engines for Direct Connected Electric (III)—E. A. Sperry, *J Assn Engng Soc*, May, 2200 w. M Aug.
- Generators, The Sibley College Multi-Phase—Sib J of Eng, June, 900 w. M Aug.
- Generators, Winding for Motor—F. M. Heldt, *Elec Wld*, July 18, 800 w.
- GENEVA—See Electrical, International.
- GEOMETRY in Connection with the Stability of Ships, Some—J. Bruhn, *Engng*, April 10, 4300 w. M June.
- GEOLOGICAL Formations of the United Kingdom, On the Industrial Products of the—*Col Guard*, June 12, Serial Part 1, 8000 w.
- Geological Formations Traversed by the Principal Rivers of England—J. Dickinson, *Col Guard*, July 24, 2000 w.
- GERMAN Society of Electrical Engineers—*Elec Rev*, July 15.
- German Union of Electrical Engineers—*Elektrotechn Zeit*, July 23, *Elec Eng*, July 3.
- GLACIAL Gravel and Sand in Southern Michigan—C. Hunnicut, *Trans Am Inst of Min Eng*, July.
- GLASS, The Manufacture of Cut (III)—Charles H. Garlic, *Safety V*, Mch, 3000 w. M May.
- GLOBULAR Discharge, Recent Experiments with the—*Elec Rev, Lond*, Apr 3, Serial Part 1, 3000 w. M June.
- Globular Spark Experiments on—Righi, *J Inst Elec Eng*, July.
- GLOBES, Preparation of Lamb and Kid Skins for (III)—*Sci Am*, Mch 21, 300 w. M May.
- GLOBULAR M—*Mag of Phys Tests*, July.
- Glucinum for Leading-in Wires—*Elec Eng, Lond*, May 1, W May 23.
- GOB-Lowering Balance with Water Brake (III)—*Col Guard*, Apr 24, 1200 w. M June.
- GOB-Rig—See Shaft Sinking.
- GOLD, An Age of—*Aust Min Stand*, Feb 6, 1300 w. M May.
- Gold and Bromine Process, The Cassel-Hinman—P. C. McIlhenny, *Jour Am Chem Soc*, May, 2200 w. M June.
- Gold and Silver, Notes on the Hydro-metalurgy—W. G. Waring, *Eng & Min Jour*, May 9, 2400 w. M June.
- Gold Belt of Gunnison County, Colorado—T. Jonge, *Min & Sci Pr*, July 25, 1500 W.
- Gold, Cyanide Process for the Extraction of—*Elec Rev, Lond*, May 8, W May 30.
- Gold Extraction, Complete and Cheap—C. Grollet, *Min Jour*, Apr 18, 2500 w. M June.
- Gold Extraction, Improvements in—H. L. Sulman, *Inst Min & Met Lond*, Vol III Pt II, 22500 w. M Aug.
- Gold, in Course of Preparing Jewelry in Bengal, The Waste of—L. S. Chakrabarti, *Ind Eng*, Mar 14, Serial Part 1, 2000 w. M June.
- Gold in Granite, An Occurrence of Free—George P. Merrill, *Am J of Sci*, Apr, 800 w. M May.
- Gold in Granite and Plutonic Rocks—Wm. Blake, *Trans Am Inst of Min Eng*, July, 2800.
- Gold in New Zealand—*Min Jour*, Apr 4, Serial Part 1, 3700 w. M June.
- Gold in South Africa, The Deposition of—*Am Geol*, May, 7000 w. M June.
- Gold in Western Australia—C. Alford, *Min Jour*, July 18, 2500 w.
- Gold Field, The Ballarat—*Aust Min Stand*, Mch 19, Serial Part 1, 1200 w.
- Gold Field, The Opening up of Our Big—Dan De Quille, *Eng & Min Jour*, June 6, 2400 w.
- Gold Field, The Victorian Alluvial—*Aust Min Stand*, Feb 6, 2400 w. M May.
- Gold Fields, Coramba Creek—*Aust Min Stand*, Mar 26, Serial Part 1, 3000 w. M June.
- Gold Fields of Alaska, The—Robert Stein, *Rev of Rev*, June, 3000 w.
- Gold Fields of Ecuador, The Placer—*Min Jour*, May 16, 1200 w.
- Gold Fields, The Yalgoo—*Aust Min Stand*, Mar 5, 1100 w. M June.
- Gold Lode, The World's Greatest—Dan De Quille, *Min & Sci Pr*, Mch 7, 3500 w. M May.
- Gold Milling, Notes on—E. B. Preston, *Can Min Rev*, April, Serial Part 1, 12000 w. M June.
- Gold Milling, Recent Improvements in—H. M. Chance, *Eng Mag*, June, 3900 w.
- Gold Mines, Russian—Mach, *Lond*, Mch 15, 3000 w. M May.
- Gold Mining Activity in Colorado—T. A. Rickard, *N Amer Rev*, Apr, 3000 w. M May.
- Gold Mining and Milling in the Black Hills—C. G. W. Lock, *Inst Min & Met, Lond*, Vol III Pt II, 2800 w. M Aug.
- Gold Mining in Colorado as an Investment—T. Tonge, *Min Jour*, July 25, 1800 w.
- Gold Mining in Georgia—B. M. Hall, *Eng Assn of the South*, April, 1600 w.
- Gold Mining in Rhodesia—W. T. St Auburn, *Min & Sci Pr*, Mch 28, 2700 w. M May.
- Gold Mining in Rhodesia—W. Fisher, *Jour Soc of Arts*, July 3, 4000 w.
- Gold Mining in the Appalachian Belt—W. H. Adams, *Eng & Min J*, July 4, 2000 w. M Aug.
- Gold Mining in West Australia, The Present Position of—C. Schmeisser, *Min Jour*, June 20, Serial Part 1, 4500 w. M Aug.
- Gold Mining Industry in Georgia and Ala-



- bama—W. M. Brewer, Eng & Min J, June 27. 1600 w. M Aug.
- Gold, On the Liquefaction of Certain Alloys of—E. Matthey, Nature, July 16. 1000 w.
- Gold Ore, The Cyanide Process as Applied to the Concentrator from a Nova Scotia—Richard W. Lodge, Tech Quar, Dec. 800 w. M June.
- Gold Ores, An Improved Method of Extracting—Aust Min Stand, July 2. 1500 w. M. Sept.
- Gold Ores, An Improved Process of Extracting—W. M. Grosvenor, Eng & Min J, May 2. 1500 w. M June. W May 16.
- Gold Ores by Means of Bromine, Treatment of Roasted—R. W. Lodge, Tech Quar, Dec. 800 w. M June.
- Gold Ores, Improvements in the Dressing of—F. Hille, Can Min Rev, Mch. 6000 w. M May.
- Gold Production, Cost of—Eng & Min J, Apr 25. 1800 w. M June.
- Gold, The Geological Age of—D. De Quille, Eng & Min Jour, July 18. 1600 w.
- Gold, The Land of—Trans, June 12. 2500 w.
- GOVERNOR, A Cheap and Reliable Exhaustive (III)—F. Egner, Am Gas Lgt J, Mch 23. 800 w. M May.
- GOVERNORS, Fly-Wheel—George T. Hauchett, Elec Wld, Apr 11. 1600 w. M May.
- GRADE Crossings in Newark, N. J., Plan for Removing (III)—R R Gaz, May 29. 900 w.
- GRADES, Ascending—Foster, St Ry Jour, June. W June 27.
- Grades, the Uses of Momentum—W. G. Raymond, R R Gaz, April 17. 1100 w. M June.
- GRAFTING, Cast Iron—W. Hayden, Foundry, July 30. 400 w. M Sept.
- GRASS Killer, Electric—Wallace, Elec Rev, June 24.
- GREENHOUSE, Building a—Ill Car & Build, July 25. 2000 w.
- GROUND—See Alternating Current.
- GUARANTEES, Impossible—Eng Rec, Mch 14. 1000 w. M May.
- GUARD WIRES, A German Substitute for (III)—St Ry Rev, Apr 15. 600 w. M June.
- GUN—See Pneumatic.
- Guns, Automatic Firing—Hiram S. Maxim, Quick Firing (III)—Engng, May 1. 1400 w.
- Guns, Automatic Firing—Hiram S. Maxim, Ind & Ir, Mch 20. Serial Part 1.
- GUN BARRELS—See Damascus.
- GYPSPUM, Nova Scotia—Can Min Rev, Mch. 800 w. M May.
- H**AEMOSTAT—Elec Eng, Lond, May 22. W June 13.
- HALL Phenomenon in Bismuth. Experiments on the—Dr A. Lebert, Electn, Apr 19. P. June. W May 2.
- HAMBURG—Electn, June 10.
- Hamburg, Free Port of—Consular Rep, Feb. 2700 w. M June.
- Hamburg, The Maritime Position and the Principal Features of the Port of—F. A. Meyer, Paper Inst Nav Arch. Eng, Lond, June 12.
- HARBOR Development in New Zealand—Trans, Apr 10. 3000 w. M June.
- Harbor, Mallaig Railway and—Eng, Lond, May 15. 1500 w.
- Harbor Works at Tampico, The—Trans, Apr 3. 1000 w. M June.
- HAULAGE at a German Colliery. Electrical—Herr Koepe, Col Guard, July 17. 1200 w.
- HAUSMAN for London, A.—Ill Car & Build, July 10. 2000 w.
- HEAT Conductivity, Laboratory Note in—J. Pennock, Trans Am Inst of Min Engs, July. 700 w.
- HEATING, Air Pump and Ejector in Steam—G. W. Scott, Ir Tr Rev, Mch 12. 1300 w. M May.
- Heating and Ventilating a Brooklyn Church and Chapel—Eng Rec, May 9. 1100 w. M June.
- Heating and Ventilating of a U. S. Custom House (III)—Eng Rec, Apr 4. 1000 w. M May.
- Heating and Ventilation by the Hot Blast System—F. H. Green and J. Weinschenk, Tech, May. 1400 w. M Aug.
- Heating and Ventilation, Fan-Furnace System of—George W. Kramer, Heat & Ven, Mch 15. 2000 w. M May.
- Heating and Ventilation of the Fitchburg High School (III)—Heat & Vent, June 15. 1800 w. M Aug.
- Heating and Ventilating Plants in the Suffolk County Court House and the Massachusetts State House, Study of the—P. N. Renway, Heat & Ven, Apr 15. 2700 w. M June.
- Heating by Means of Electricity—Elec Tech, July 31. W Sept 5.
- Heating Carriages on the Eastern Railway of France—Engng, June 5. Serial Part 1. 3000 w. M Aug.
- Heating, Electric—E. Puchta, Elec Eng, June 24. 1800 w.
- Heating, German (III)—Dom Engng, June. Serial Part 1. 1500 w. M Aug.
- Heating in a Rochester Residence, Indirect Hot Water (III)—Eng Rec, Mch 28. 500 w. M May.
- Heating, Mill (III)—Heat & Ven, May 15. 2000 w. M July.
- Heating of Medical Baths at Bellevue Hospital (III)—Eng Rec, June 20. 700 w. M Aug.
- Heating of the Armour Buildings at Chicago (II)—Eng Rec, Mch 21. 1200 w. M May.
- Heating, Or Church (III)—H. B. Prather, Dom Engng, April. 2500 w. M June.
- Heating of the Lord's Court Building (III)—Eng Rec, June 6. 1200 w. M July.
- Heating Plant, Novel Residence Hot Water (II)—Heat & Ven, Mch 15. 1400 w. M May.
- Heating Plants, Steam—Sta Eng, May. 2500 w. M June.
- Heating Surface, Increase of, in Locomotives—C. W. Whitney, Ry Rev, April 25. 2500 w.
- Heating, The Drop Systems of Steam—Thomas Barwick, Heat & Ven, Mch 15. 2000 w. M May.
- Heating the Law Court's Branch of Lloyds Bank, Limited, London, England (III)—Heat & Ven, May 15. 1700 w. M July.
- Heating with Exhaust Steam, Economy of—Heat & Ven, May 15. 900 w. M July.
- Heating—See Ventilation, Vacuum, Electric.
- HEAT, Light and Power Supply for Buildings, Economical—G. A. Gerdtsen, Wis Eng, June. 800 w.
- HEINRICHBURG Canal Lift, The (III)—Eng, Lond, April 17. 1300 w. M June.
- HELLIUM—See Argon.
- HERBERTON, N. Q., Mining in—J. Munday, Min Jour, Aug 1. 2800 w.
- HIGHWAYS of Massachusetts, Specifications for the State—Eng News, April 9. 2200 w. M June.
- HITTORF Tube—See Electric Images.
- HOLLAND'S War with the Sea—Tr Assn Civ Engs of Cornell Univ, June. 8000 w. M Aug.
- HOLLOPHANE Globes—See Lighting.
- HOISTING Machinery (III)—W. M. Morris, Col Eng, July. 1700 w.
- HOME-MAKING, The Architecture of (III)—C. E. Benton, Eng Mag, July. 3500 w. M Aug.
- HOMES, Our; As They Are and as They Ought to Be—John Balbinnie, Ill Car & Build, May 15. 2000 w. M July.
- HONOLULU, Four-Masted Steel Schooner (III)—Am Ship, June 25. 800 w. M Aug.
- HORSELESS Carriage, Evolution of the—Spalding, Cas Mag, Apr.
- Horseless Carriage—See "Carriage," "Motorcycles," and "Vehicles."
- Horseless Vehicles—L'Ind Elec, July 25.
- HORSE-power and Floor Space—Cas Mag, June. W June 27.
- Horse, The Pull of a—Elec Rev, July 17. W Aug 8.
- HOSPITALS in Europe, Modern (III)—A. de Calorne, Arch Rec, July—Sept. 8000 w.
- Hospital, South Calcutta, Bhowanipore (III)—Ind Engng, May 2. 2000 w. M July.
- LIOT Blast Stove, The Ford and Moncur—



- Benjamin James Hall, Col Guard, May 8. 1800 w.
- Hot Boxes and Their Causes—Pro Cent Ry Club, March. 5000 w. M June.
- Hot Boxes, About—Loc Engng, July. 600 w.
- HOTEL Cecil, London, England (III)—Arthur Lee, Stone, Mich. 400 w. M May.
- Hotel Cecil—Plumb & Dec, Apr 1. 1700 w. M June.
- Hot Pressures with Electrically Heated Glass Boards—Elec Lond, July 17.
- Hot-Water Heating and Ventilating of the U. S. Post Office Building at Lowell, Mass. (III)—Eng Rec, May 16. 1400 w. M July.
- Hot-water Heating in a Baltimore Building (III)—Eng Rec, July 4. 700 w. M Aug.
- HOUSES in Paris, City Apartment (III)—Arch Rec, April—June. 6000 w. M June.
- Houses of the English Suburbs and Provinces. The Smaller—Banister Fletcher, Arch Rec, April—June. 6400 w. M June.
- HOUSTON, Kennelly and Kinnicutt, The Reply—Pro Age, July 15. 3000 w.
- HUMIDITY of Southern England, The Relative—Bos Jour of Com, July 25. 5500 w.
- HUNGARIAN National Exhibition—Col Guard, July 3. 2500 w.
- HYDRAULIC Engines—See "Engines."
- Hydraulic Formulae as Determined by Flow Measurements in the Diversion Channel of the Desplaines River for the Sanitary District of Chicago, Coefficients in—W. T. Keating, Jour of W. Soc of Engg, April. 38 w. M July.
- Hydraulic Ram for Use in Public Water Works—D. Mead, III Soc of Engg & Surv, 11 An Report. 2800 w. M Sept.
- Hydraulic Rams—(III) Carl Pixis, Eng & Min J, June 20. 1000 w. M Aug.
- Hydraulic Shield for Shallow Tunnels (III)—Eng News, July 9. 1100 w. M Aug.
- Hydraulics, The Theory of Energy in—L. M. Hoskins, Wis Eng, June. 1500 w.
- Hydro-Electric Installation, The Rhone (III) Engng., April 17. 3500 w. M June.
- HYDROGEN—See Electrolytic.
- HYGROMETER, The Use of the Hair—C. Trowbridge, Science, July 17. 1100 w.
- HYPERPHOSPHORESCENCE—S. P. Thompson, Phil Mag, July. W July 25. Elec. July 15. 600 w.
- HYSTERESIS and Foucault Currents on Polar Diagrams, Effects of—F. Beddell and J. Boyd, Elec Wld, July 18. Serial Part 1.
- Hysteresis, A Method of Measuring the Loss of Energy in—G. F. Searle, Elec'n, April 10. 1200 w. M June. P. June, W May 2.
- Hysteresis Curves, An Apparatus for Determining Induction and (III)—Frank Holden, Elec Wld, June 27. 1000 w. M Aug.
- Hysteresis—Ewing, Elec Eng, Lond. May 29.
- Hysteresis of Iron in a Revolving Field—Fleming, Electn, June 5. W June 27.
- Hysteresis, Viscous Dielectric—Arno, Electn, May 15. W June 6.
- Hysteresis—See Foucault.
- ICE Boat, The Dauzenbaker (III)—Shipbuilder, Mich 26. 900 w. M May.
- Ice Breaking Boat—See "Ice Boat."
- Ice Crystals, Plasticity of—Science, May 8. 300 w.
- Ice, Strength of—Digest Phys Tests, April. 2000 w. M June.
- ILLINOIS, A Topographical Survey of—J. W. Alvord, III Soc of Engg & Surv. 11 An Rept. 4000 w.
- Illinois Central Lake Front Improvements—Ry Rev, June 27. 1100 w.
- Illinois Central Railroad—Mfrs Rec, July 17. 5500 w.
- Illinois Central Railroad Improvements at Chicago—R R Gaz, July 10. 1500 w.
- ILLUMINATING Gas, The Permanency of—W. Young, Gas Wld, July 25. 6800 w.
- IMPORT Rate Case, Justice Harlan's Dissenting Opinion in the—Ry Rev, May 3. 800 w.
- IMPRESSIONS Upon Cast Iron Surfaces from Lacc. Ferns, Etc (III)—W. J. Keep, Foundry, April. 1600 w. M June.
- INCANDESCENT Lamp Filament, Photograph of an—Cassels, Electn, Apr 24. W May 16.
- Incandescent Lamp Filaments—Delahaye, L'Eclair Elec, No 6. Jour Inst Elec Eng, May. W June 6.
- Incandescent Lamp Filaments, Photographs of—Elec Eng, June 3.
- Incandescent Lamps, Exhausting—Zeit f Beleucht, Apr 20. W May 23.
- Incandescent Lamps, Life of—Smith, Elec Rev, Lond, Apr 10. W May 2.
- Incandescent Lamps, Non-Blackening—Elec Rev, July 24. W Aug 15.
- Incandescent Lamps, The Welsbach and Other—G. Barrows, Pro Engg Club of Phila, July. 3000 w.
- Incandescent Lamps with Alternating Currents, Series—L'Ind Elec, July 25.
- Incandescent Lighting, High-Voltage—Am Elec, Aug. W Aug 29.
- INCREASING the Striking Distance of a Given E M F—E. Thomson, Elec Eng, June 24. W July 4.
- INDIA Rubber Supply, The State of the—Elec Eng, July 15. 1800 w.
- INDUCTANCE as a Negative Capacity in Submarine Cables—A. Davidson, Elec Eng, July 8. 350 w. W July 18. M Aug.
- INDUCTION Coefficients, A New Method of Increasing—Andreissen, Elec Zeit, July 9.
- Induction Coils, Self—Wien, Electn, July 24.
- Induction Curves—See Hysteresis.
- Induction, Fundamental Laws of—L'Ind Elec, May 25.
- Induction, Series of Magnetic—Potier, L'Ind Elec, June 25. L'Eclair Elec, June 6. L'Eclair, June 20.
- INDUS and the Best Way of embanking it, The River—Indian Forester, April. 10800 w. M Aug.
- INDUSTRIAL Interests in Electricity—Stockbridge, Eng Mag, September.
- INERTIA of Matter, An Electromagnetic Theory of the—Edwin J. Houston and A. E. Kennelly, Elec Wld, June 6. 2000 w. M July.
- INFIRMARY, The Halifax New (III)—Arch, Lond, July 17. 2500 w.
- INFLUENCE Machine Discharges, Influence of Light on the Character of—Elster and Geitel, Electn, May 22.
- INJECTOR, A Theory of the—Myron G. Stolp—Mas St. Fitter, May. 2000 w.
- Injector, Tests of Efficiency of—Karl Andria, Eng News, July 16. 700 w.
- INJUNCTION Suit, Joint Traffic Association Injunction Suit, The Gov. Argument in the—R R Gaz, May 15. 2800 w.
- INSPECTORS, Civil Service Examination for Building—Arch and Build, Apr 4. 1800 w. M May.
- INSTALLATIONS in Damp and Swampy Districts—Pflaumer, Elektrotechn Zeit, June 11. W July 11.
- INSTRUMENTS against Vibration, Protecting (III)—La Nature, July 11.
- Instruments from Electric Railroad Currents, Protecting—Corsepius, Elektrotechn Zeit, May 14.
- INSULATING Materials, Effect of Temperature on—G. F. Sever, A. Monell and C. L. Perry, Elec Wld, May 30. 3800 w. M July.
- Insulating Materials, The Effect of Temperature on—Chas. F. Scott, Elec Wld, July 11. 1200 w. M Aug.
- INSULATION Resistance of Continuous Current, Three Wire Systems, The Measurement of—E. Houston, Elec Wld, July 25. 1400 w.
- INSULATORS, Organic Membranes as—Richardson, Elec Rev, July 29.
- INFLUENCE of Electrical Plants—R. H. Pierce, W Elec, July 25. 1600 w. M Sept.
- INTENSITY, Direct Measurement of Mean Spherical—Blondel, L'Eclair Elec, July 11. W Aug 8.
- INTERLOCKING at Toronto (III)—R R Gaz, Apr 3. 800 w. M May.
- Interlocking Machine of the National, New (III)—R R Gaz, Apr 10. 700 w. M May.



MARR, RICHARDS, ENG. BUIL.

- INTERNATIONAL Congress at Geneva—S. P. Thompson, *Electn*, July 24. *Elec Rev*, Lond, July 24. *Elec Eng*, Lond, July 24.
- INTERPOLATION—Formulæ, Thermo-Electric—Silas W. Holman, *Tech Quar*, Dec. 5500 w.
- INTERURBAN Express at Binghamton, N Y—*St Ry Rev*, Apr 15. 1200 w. M June.
- INVENTION During the Past Fifty Years, The Progress of—*Sci Am*, July 25. 2200 w.
- Invention, What is an—*Eng*, Lond, May 29 1500 w.
- Inventions on the People's Life, The Effect of—*Sci Am*, July 25. 3500 w.
- INVENTORS, Distinguished—*Sci Am*, July 25. 2800 w.
- IRON and Steel Industries of South Russia (III)—*Ir & St Trs Jour*, April 4. 900 w. M June.
- Iron Analyses, Review of the Present Status of—Gus C. Henning, *Stevens In*, Apr. 3800 w. M May.
- Iron and Steel Industries, Statistics of the—*Eng News*, June 11. 1600 w. M Aug.
- Iron and Steel, Investigation on the Influence of Low Temperatures on—M. Rudeloff, *Mech Wld*, Lond, Mch 20. 1500 w. M May.
- Iron and Steel, Uniform Testing of—*Eng News*, July 16. 1800 w. M Sept.
- Iron and Steel Works at Han-Yang, China, The Government—G. Toppe, *Am Mfr & Ir Wld*, Apr 10. 1200 w. M June.
- Iron and Steel Works of the United States—*Eng*, Lond, July 13. 1600 w. M May.
- Iron and Steel Works, The Bowling—*Ir & St Trs J*, Mch 14. 700 w. M May.
- Iron and Steel, The Direct Productions of—Carl Otto, *Am Mfr & Ir Wld*, Mch 20. 2500 w. M May.
- Iron Casting, The Effect of Expansion and Contraction in Iron Casting—T. D. West, *Tr A I Min Eng*, Apr. 3800 w. M June.
- Iron, Comparative Costs of Producing Pig—*Ir Age*, Mch 19. 700 w. M May.
- Iron Deposit, A Newfoundland—R. E. Chambers, *Ir Age*, Apr 2. 1200 w. M May.
- Iron from the Eyes, Magnetic Extraction of—Zeit f *Elek*, June 15. W July 25.
- Iron, How to Make—R. W. Raymond, *Eng & Min J*, Mch 14. 1200 w. M May.
- Iron in Japan, The Demand and Supply of—*Ir & Coal Trs Rev*, Mch 27. 1000 w. M May.
- Iron Industry of Birmingham and Bessemer, C. S. A., The—Jeremiah Head, *Ir & Coal Trs Rev*, May 15. 1500 w.
- Iron Industry of Southern Russia—*Ir Age*, July 16. 3800 w.
- Iron Lands, On the Treatment of New Zealand Magnetic—E. Metcalf Smith, *Col Guard*, May 8. 800 w.
- Iron, Manipulation and Deterioration of Cast—H. J. Grof, *Foundry*, Arch. 1200 w. M May. May 16. 2000 w. M July.
- Iron Mine, Determining the Value of an—Nelson P. Hulst, *Eng Mag*, Apr. 3800 w. M May.
- Iron Mining in Michigan, Early—W. P. Kibber, *Ir Age*, June 25. 2900 w.
- Iron, On the Rate of Diffusion of Carbon in—Prof. Roberts Austen, *Ir & St Trs Jour*, May 16. 2900 w. M May.
- Iron Ores, Concentration of Low Grade—W. Phillips, *Eng & Min Jour*, July 25. Serial Part I. 1500 w.
- Iron Ores in the Blast Furnaces, The Effects of Additions of Titaniferous to Phosphoric—A. J. Rossi, *Tr Am Inst Min Eng*, Apr. 1500 w. M June.
- Iron Ores, The Action of Blast Furnace Gases on—O. Sandig, *Trans Am Inst of Min Eng*, July. 1700 w.
- Iron, Physical Tests and Chemistry of Cast—W. J. Keep, *Ir Tr Rev*, May 14. 4800 w. M July.
- Iron Products of Texas, The—J. F. Fuller, *Tradesman*, July 1. 1800 w. M Aug.
- Iron, The Chemical Composition and the Strength of Malleable—A. Ledebur, *Ir & Coal Trs Rev*, May 15. 1500 w.
- Iron, The Manufacture of Wrought—*Ir & Coal Trs Rev*, May 1. 3500 w.
- Iron, The Mobility of Molecules of Cast—A. E. Outerbridge Jr, *Foundry*, Mch. 2800 w. M May.
- Iron, The Preparation of Chemically Pure—W. McGilivray, *Ind & Ir Eng*, July 24. 3000 w. M Sept.
- Iron Trade of Great Britain Half-a-Century Ago, The—*Ir & Coal Trs Rev*, May 1. 2500 w.
- Iron Trade, The Canadian—*Ir Age*, Apr 3. 1600 w. M June.
- Irons Used for Different Purposes, Analysis of Pig—*Eng News*, Mch 26. 700 w. M May.
- Iron see Atmospheric Temperature. Synagogue.
- IRRIGATION Engineering in the United States—C. H. Kendall, *Engineers' Year Book*, Univ of Minn. 2500 w. M July.
- Irrigation for Profit, Sewage—W. C. Parmley, *Ill Soc of Eng & Surv*, II An Rept. 4000 w. 1000 w. M June.
- Irrigation in Siam—*Consular Reports*, May 1000 w. M June.
- Irrigation in the Northwest—*Ind & East Mag*, Mar 28. 1600 w. M June.
- Irrigation in Utah—*Eng & Min Jour*, July 11. 700 w.
- Irrigation, Methods of—F. P. Hallahan, *Am Soc of Ir Eng*, April 1895. 700 w.
- Irrigation on the Great Plains, Pump—*Eng Mag*, Apr. 3400 w. M May.
- Irrigation, Some Late Features of the Hydraulics of—*Eng Rec*, Apr 4. 900 w. M May.
- ISLINGTON, London, The Electric Lighting of—*Elec Eng*, Apr 15. P May.
- ITALIAN Cities, The Modernizing of—*Am Arch*, June 6. 1300 w. M July.
- ITHA'CA Street Railway—*Elec Wld*, July 18. 1700 w.
- JACQUES Carbon Battery, The—*Elec Eng*, July 22. 1800 w.
- JETTIES at Galveston Harbor, The (III)—Walfred Wilson, *Sci Am*, May 23. 1000 w. M July.
- JETTY, Improving the Entrance to a Bar Harbor by a Single—T. W. Simons, *Am Soc of Civ Eng*, May. 4800 w. M July.
- JIG, Middle Product—E. Tuttle, *Tr Am Inst Min Eng*, July. 1700 w. M Sept.
- Jig, The Cycle of a Plunger—R. Richards, *Tr Am Inst of Min Eng*, July. 1800 w.
- JUNCTION Boxes and Feeder Switching System, Controllable (II)—*Elec Eng*, June 10.
- JOULE Effect, The—C. E. Basevi, *Eng*, Lond, May 29. 3200 w.
- JOURNALS, Roller for Car Axle—*Loc Engng*, May. 250 w.
- KOLIN Mine, A Florida—*Clay Rec*, Mch 28. 1800 w. M May.
- KOLIN Mine, A Florida—*Clay Rec*, Mch 28. 1800 w. M May.
- KEARSARGE, The New Double-Deck-Turret Battle Ship (III)—*Sci Am*, June 27. 1300 w. M Aug.
- KELVIN, Lord—*Elec Wld*, June 20. 1600 w.
- KELVIN, The Electrical Measuring Instruments of Lord—J. Rennie, *Electn*, June 19. 3800 w. M Aug.
- KELVIN'S Jubilee, Lord—A. Gray, *Nature*, June 25. 13500 w. M Aug.
- Kelvin's Researches, Lord—*Electn*, June 19. 5000 w.
- KENT Coalfield, The—F. Brady, *Col Guard*, July 17. 1100 w.
- KEROSENE Shale in New South Wales—*Aust Min Stand*, Mar 12. 1700 w. M June.
- KEY-Seating on the Planer (III)—J. F. McNutt, *Am Mach*, July 2. 400 w. M Aug.
- KINKS, Some Fitchburg—*Loc Engng*, May. 400 w.
- KITE, A Weather Bureau (III)—C. F. Marvin, *Sci Am Sup*, July 4. 2400 w.
- KITE, Flying, Recent Experiments in Scientific (III)—*Sci Am*, Mch 14. 1800 w. M May.
- L A BRILLADORA Mine, Jalisco, Mexico—J. Bushett, *Eng & Min Jour*, July 25. 600 w.
- LABORATORY, Davy Faraday Research—*Electn*, July 24.
- LAD and Lead—Harrison, *Lightning*, Apr 23. W May 16. *Lightning*, May 28. W June 20.
- Lag and Lead—Mordey, *Lightning*, May 21.

Index of Advertisers.

	<i>Page.</i>		<i>Page</i>
Addyston Co.....	308	Keuffel & Esser Co.....	282
American Photo-Engraving Co.....	302	King & Walker Co.....	278
Atlas Portland Cement Co.....	136	Kuhlo & Ellerbe.....	298
Battle Creek Steam Pump Co.....	iv	Lawrence Cement Co.....	300
Besley, C. H.....	iv	Link Belt Machinery Co.....	280
Boardman Engraving Co.....	290	Lord, Geo. W.....	294
Brown, Geo. J.....	318	Madison Gas & Electric Co.....	318
Canton Steel Roofing Co.....	288	Mahn & Co.....	288
Champion Bridge Co.....	302	Menges, A. F.....	318
Chicago & Milwaukee & St. Paul Ry..	314	Monarch Cycle Co.....	292
Chicago & Northwestern Ry.....	310	Mueller & Co., William.....	280
Chicago Photo Engraving Co.....	282	Natural Premium Life Ins. Co.....	316
Cleveland Ship Building Co.....	302	Nielson, A. U.....	320
Cutler Manufacturing Co.....	302	Northern Electric Co.....	ii
Davy.....	320	Passaic Rolling Mill Co.....	280
Dietzgen Co., The E. C.....	ii	People's Electric Co.....	280
Eastman Kodak Co.....	284	Richardson & Ross.....	144
Flanner, Jos.....	286	Rochester Optical Co.....	286
Galena Oil Co.....	278	Rundell, S. P.....	320
Gallagher, John.....	320	Sicilian Asphalt Paving Co.....	304
Grafton Quarry Co.....	308	Snow Steam Pump Works.....	288
Graves Elevator Co.....	302	Star Accident Ins. Co.....	300
Grinde, Schmedeman & Quammen....	320	Tracy, Gibbs & Co.....	298
Harloff, P. F.....	318	Wedderburn Co., Jno.....	302
Hunt & Co., Robt. W.....	278	Western Filter Co.....	300
Indiana Bermudez Asphalt Co.....	306	Westinghouse Electric & Manfg. Co..	276
Iowa Life Insurance Co.....	284	University Co-Operative Association..	312
Jones, N. P.....	308	University of Wisconsin.....	iii

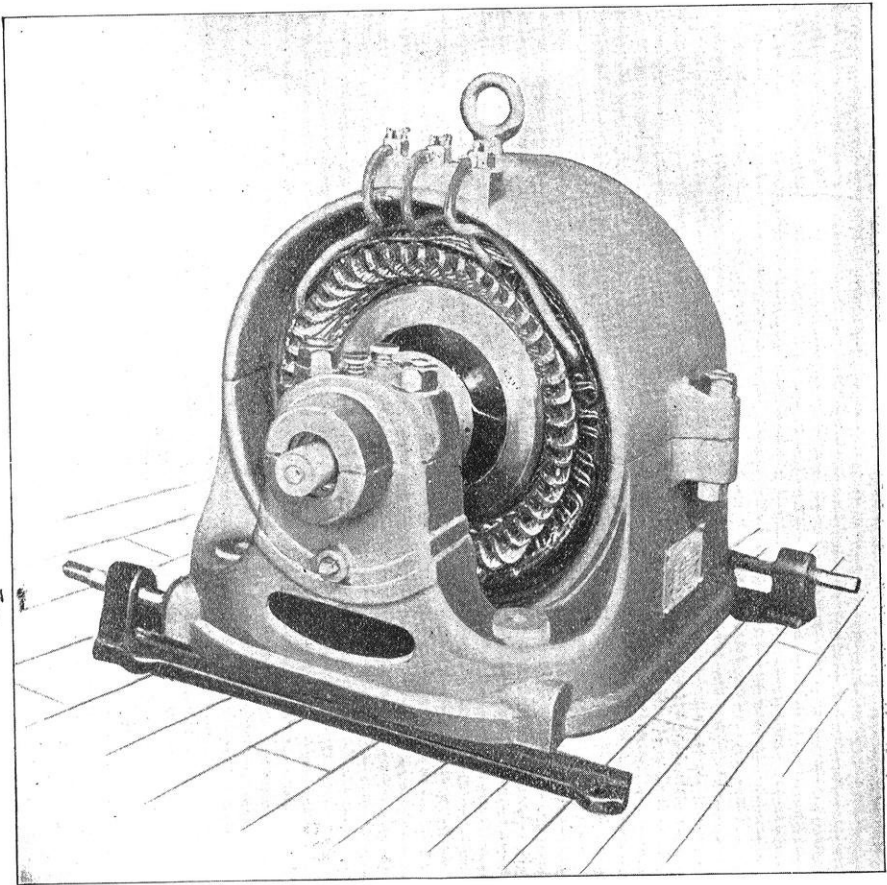
- Lag, Determining the Angle of—Clarke, Phil Mag, Apr. W May 16.
- LAKE FLEET of Today, The—Sea, July 30. 900 w.
- LAKE Street Elevated Road, Electrical Operation of the—W Elec, June 27. 1200 w. M Aug.
- LAKE STREET Elevated Road, Electrical Operation of the—W Elec, June 27. 1200 w. M Equipment of the (III)—St Ry Rev, Mar 15. 600 w. M May.
- LAKES were Built, How the Great—J. W. Spencer, Pop Sci M, June. 4800 w.
- LAMP, A New—Schnabel, Elek Anz, May 3. W May 30.
- Lamp Efficiency, Incandescent—W. Stuart-Smith, J of Elec, Feb. 1800 w. M May.
- Lamp, Jandus—Toerring, Elektrotechn Zeit, July 20. W Aug 22.
- Lamp, Sussmann Miner's—Eng & Min J, June 13. W June 27.
- Lamp, Tesla's Vacuum (III)—Elec Eng, May 27. W June 13.
- Lamp, The Incandescent—Can Elec News, Apr. Serial Part 1. 2400 w. M June.
- Lamp, See Arc.
- Lamps, A Simple Method of Testing Railroad Signal—T. A. Lawes, Loc Engng, July. 1200 w. M Aug.
- Lamps and Their Influence on Central Station Practice, High Voltage—G. L. Addenbrooke, Ind & Ir, May 8. Serial Part 1. 4000 w. M July.
- Lamps, Electric and Other Safety (III)—Ir & Coal Trds Rev, June 5. 1200 w.
- Lamps, High-Voltage and their Influence on Central Station Practice—G. L. Addenbrooke, Elec Eng, Lond, Mch 6. Serial Part 1. 2700 w. M May.
- Lamps, High-Voltage or High Efficiency—Gruenwald, Elek Anz, May 21. W June 29.
- LANES, and Flood, The Gohna—Eng, Lond, Apr 24. M June.
- LANTERN Heat—Am Mach, Apr 2. 1600 w. M May.
- LATERALS, Which Should Have the Steeper Grade, Main Drains or—Ill Soc of Eng & Surv, 11 An Rept. 1800 w.
- LATHE for Boring and Turning Sixteen Inch Gun at Watervliet Arsenal (III)—Am Mach, Apr 9. 5400 w. M May.
- Lathe Work on Heavy Guns (III)—Am Mach, Apr 9. 5200 w. M May.
- LATITUDE—William K. Hoag, Eng's Year Book, Univ of Minn., 2000 w. M July.
- Latitude—See Azimuth.
- LEAD Accumulators, Chemical Theory of—D. G. Fitzgerald, Elec Rev, Lond, July 31. W Aug 22.
- Lead and Zinc Deposits in Iowa—A. G. Leonard, Eng & Min J, June 27. 1900 w.
- Lead, Separating Silver from—Tonasi, L'Ind Elec, July 20. W Aug 8.
- LEAKAGES from Main and Service Pipes, Elusive—H. Tobey, Gas Wld, May 9. 5400 w.
- LEATHER Refuse, The Value of—J. B. Lindsey, J Am Chem Soc, July. 2000 w.
- Leather, Some Experiments on the Strength of—W. G. McMillan, Leather Mfr, July. 2800 w. M Aug.
- LETTER, An Open—Sea, April 30. 1500 w. M June.
- LIBRARY at Washington, D. C., Electrical Features of the New National—George H. Draper, Elec Rev, June 10. 1600 w. M July.
- LIGHT, Cold—W. M. Stine, Elec Wld, Mch 14. 2500 w. M May.
- Light, Dark—Le Bon, Sci Am, July 18.
- Light, Determination of the Unit of—Murphy, Jour of Elec, Apr. W June 27.
- Light Houses and Light Ships—Elec Eng, July.
- Light Houses and Light Vessels, Electrical Communication with—Elec Rev, Lond, June 19. 3800 w. M Aug. Electn, June 5. W June 27.
- LIGHTHOUSE Illumination in France, Coast and—C. S. Du Riche Preller, Engng, May 1. Serial Part 1. 2800 w. M July.
- LIGHT of the Future, The—Hospitalier, L'Ind Elec, July 10, W Aug 8. Pro Age, Sept 1.
- Light Railways—Ind Eng, June 6. 1100 w.
- Light, Some Advantages of Electric—G. D. Shepardson, Imp Bul, April 17. 1600 w. M June. W May 23.
- Light, Standards of—E. Nichols, C. Sharpe and C. Matthews, Pro Age, July 15. 4500 w. Elec Wld, May 30. 1000 w.
- Light Station, Islington Electric (III)—Eng, Lond, May 29. 5000 w. M July.
- Light Unit, The Determination of a—D. W. Murphy, Am Gas Lgt Jour, May 11. 2500 w. M July.
- LIGHTING, A Season's Experience with Incandescent Public—F. G. Dexter, Gas Wld, June 13. 6200 w. M Aug.
- Lighting by Arc Lamps, Public—Blondel, Electn, May 1, Apr 3. Serial Part 1. W May 2. 9, 16, 23, 30. P June.
- Lighting by Holophane Globes—Guilbert, Pro Age, Apr 1.
- Lighting Convention, Street—Pro Age, July 1.
- Lighting Country Residences and Institutions—Henry Stooke, Ill Car & Build, June 26. 1000 w. M Aug.
- Lighting for Workshops, Sheds and Open Spaces, Some Experiences in Incandescent—E. C. Riley, Gas Wld, May 2. 2800 w.
- Lighting, General Street—Walton Clark, Pro Age, July 1. 3000 w. M Aug.
- Lighting in a Pioneer Town, Electric—J. W. Dickerson, Elec Wld, Apr 11. 1600 w. M May.
- Lighting in Belfast, Electric—V. A. McCowen, Ind & Ir, July 31. Serial Part 1. 5000 w.
- Lighting in China—Elec Eng, Lond, Apr 10. P June.
- Lighting, Industrial Development of Electric—Metcalf, Elec, May 20.
- Lighting of Collieries by Electricity—Ir & Coal Trds Rev, June 5. 2800 w. M Aug.
- Lighting of the Metropolitan Life Insurance Company's Building, New York (III)—Elec Eng, July 15. 1600 w.
- Lighting of Norwich, Eng., The Electric (III)—Engng, May 29. 4000 w. W June 20. M July.
- Lighting on Railway Trains in Australia, Electric—D. Maratta, Elec Rev, July 15. 800 w. W July 25.
- Lighting Plant at Syracuse, N. Y., Railway Station (III)—W Elec, April 11. 500 w. M June.
- Lighting Plant, Combined Railway and—Engng, Lond, July 10. W Aug 1.
- Lighting Plant for Utica, N. Y., Report on Municipal Ownership of Electric—Eng News, May 7. 900 w. M June.
- Lighting Plant in the American Surety Building, The Electric (III)—Elec Wld, Apr 4. 1200 w. P May. M May.
- Lighting Plant, South Norwalk Municipal—Elec Eng, Mar 18. P May.
- Lighting Plants, Comparison of Economy of Various Central Stations—Eng News, May 14. 800 w. M July.
- Lighting, Recent Developments in—D. McFarlane Moore, Paper A I E E, Elec Rev, Apr 29. Elec, Apr 29. Elec Eng, Apr 29.
- Lighting Service, Charging for Electric—Arthur J. Farnsworth, Elec Eng, June 3. 2700 w. W June 13. M July.
- Lighting Staircases (III)—Zeit f Beleucht, July 20.
- Lighting System of Salt Lake City, The New 22. 1800 w. P June. M June.
- Three Phase Electric (III)—Elec Eng, Apr Lighting, The History of Electric—F. B. Crocker, Elec Wld, May 9. 3700 w. M June.
- Lighting, Vacuum Tube—Elec Eng, May 6.
- LIGHTNING and Trees—Elec Rev, Lond, May 1. W May 23.
- Lightning and Trees—Jonescu, Elek Zeit, May 7. W June 6.
- Lightning Arresters—Elektrotechn Zeit, June 18. W July 11.
- Lightning Arrester—Baxter, Elec Eng, Sept

WESTINGHOUSE ELECTRIC AND MFG. CO., PITTSBURG, PA.

WE ARE THE MANUFACTURERS OF

“Tesla Polyphase Alternating Current Apparatus,”

which embodies the HIGHEST DEVELOPMENT OF COMMERCIALY
SUCCESSFUL POWER TRANSMISSION.



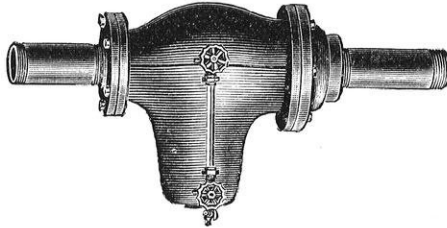
New York, 120 Broadway; Pittsburg, Westinghouse Bldg.; Charlotte, N. C., 36-38 College St.; Boston, Exchange Bldg.; Buffalo, Erie County Building; Syracuse, N. Y., Rastable Bldg.; Chicago, New York Life Bldg.; Philadelphia, Girard Building; San Francisco Mills Bldg.; Tacoma, Wash., 102 S. 10th St.; St. Louis, American Central Bldg.; Washington, D. C., 1533 F. St. N. W.
For Canada, address AHEAME & SOPER, Ottawa, Canada.

Please mention Wisconsin Engineer when you write.

9. W Sept 19. Elec Eng, Lond, April 17. P June.
- Lightning Arresters—W. R. Gaston, Elec Eng, July 29. 1100 w. M Sept. W Elec, Aug 1.
- Lightning Collected During the Summer of 1895, Notes on Protection Against—A. J. Wurts, Elec Pow, Mch. P May. 1000 w. M May.
- Lightning Protecting Devices for Heavy Current Installations—Elec Rev, Lond, Aug 28.
- Lightning Rods, Apparatus for Testing—Elek Anz, May 31 and June 4.
- LIGHTS, A Spectroscopic Examination of Moore's and Edison's—Nelson W. Perry, Elec, June 3. 900 w. M July.
- Lights, Inaccessible Maritime (III)—E. L. Corthell, Sci Am, Mch 14. 1500 w. P June. M May.
- Lights, Vacuum Tube—Wessels, W Elec, June 6. El Age, May 30. W June 13.
- LINE, A New North and South—Ry Age, May 16. 800 w.
- LIQUIDS, On the Heat Effect of Mixing—C. w.
- LIXIVIATION of Silver Ores. The—John H. Clewes, Ind & Ir, Mch 20. 1500 w. M May.
- Lixivation Sulphides, Sulphuric Acid Process of Treating—F. Dewey, Trans Am Inst of Min Eng, July. 2700 w.
- LOADING Long Structural Material on Railway Cars, Eng News, July 23. 3500 w.
- LOCK-NUTS—See "NUTS."
- LOCOMOTIVE, A Combination Steam and Electric—Eng News, Mch 12. 500 w. M May.
- Locomotive, A New Type of Mining (III)—T. W. Sprague, Eng & Min J, July 4. 800 w.
- Locomotives, Advantages of Raising the Center of Gravity of—Ry Rev, Mch 28. 1200 w. M May.
- Locomotive and Other Matters, A Ride on a Compound—R R Gaz, April 24. 600 w. M June.
- Locomotive, A Twelve Wheel—Eng News, June 18. 500 w.
- Locomotive Boiler Construction, Safety in—Edit, Eng News, July 9. 1200 w. M Aug.
- Locomotive Boiler with Mason Work Fire-box—Am Eng & R R Jour, May. 1800 w.
- Locomotive Building in Japan—Eng, Lond, July 17. 1400 w.
- Locomotive, Compound Switching (III)—R R Gaz, Apr 24. 1000 w. M June.
- Locomotive, C. R I & P Ry, New Fast Passenger—Ry Mas Mech, June. 300 w.
- Locomotive's Counter-Balancing—Eng News, July 2. 1000 w.
- Locomotive Details, Boston & Maine R R O H R—Loc Engng, May. 450 w.
- Locomotive Driving Wheels, The Destructive Action of—Sci Am, May 2.
- Locomotive Electric Mine—Elec Eng, Sept 2.
- Locomotive Engines, The Fire-boxes of—Eng, Lond, May 8. 1700 w.
- Locomotive Exhaust Pipes and Smokestacks, Experiments with—R R Gaz, Mch 20. 4000 w. M May.
- Locomotive, Extended Front Ends of—Loc Engng, June. 2200 w.
- Locomotive for Contractor's Use, A Geared (III)—Eng News, May 21. 800 w.
- Locomotive for the Elevated Railways of New York—Eng News, June 18.
- Locomotive Grates—Am Eng & R R Jour, May. 2500 w.
- Locomotive, Hellmann—Dronin, L'Elec, July 4. W July 25, Elec Rev, Lond, July 10. W Aug. 1.
- Locomotive in France, The Present Status of the Compound (III)—R R Gaz, May 22. Serial Part 1. 2200 w.
- Locomotive in Suburban Service, A Compound—R R Gaz May 22. 500 w.
- Locomotive in Ten Days, Painting a—A. Ashmun Kelly, Ry Mas Mech, May. 1600 w. M July.
- Locomotive Jacket Pattern for Gusset Sheet for—Met Work, May 2. 1000 w. M June.
- Locomotive, Mining (III)—Eng & Min J, May 23. Elec Rev, July 1. W July 11.
- Locomotive, New Eight-Wheel Passenger—Ry Rev, May 30. 1000 w.
- Locomotive of Boston and Maine, New Eight-Wheel—R R Gaz, June 19. 2800 w.
- Locomotives, Old Philadelphia and Reading (III)—Loc Engng, May. 400 w.
- Locomotive Painting, Ornamentation in—A. A. Kelly, Ry Mas Mech, Apr. 900 w. M May.
- Locomotive Rating and Fuel—Tracy Lyon, Ry Rev, May 30. 2700 w.
- Locomotive Records of the Illinois Central Railroad—R R Gaz, July 10. 300 w.
- Locomotive "Schenectady," Performance of the Purdue—W. F. M. Goss, R R Gaz, June 5. 2700 w.
- Locomotive, Ten-Wheeled (III)—Am Eng & R R Jour, May. 1600 w.
- Locomotive Testing Plant, Chicago & Northwestern (III)—R R Gaz, Apr 10. 1300 w. M May.
- Locomotive, Testing Slide Valves on the Purdue University—Loc Engng, May. 900 w.
- Locomotive, The American—Sci Am, July 25. 2000 w.
- Locomotive, The Dunlaster (III)—Loc Engng, May. 500 w.
- Locomotives, The Hauling Capacity of—H. H. Vaughan, R R Gaz, Mch 27. 2500 w. M May.
- Locomotives, Tonnage Rating of—R R Gaz, Mch 20. 1900 w. M May.
- Locomotive, Trials of an Express—W. Adams and F. Pettigrew, Ind & Ir, July 17. 1700 w.
- Locomotives, Triple Cylinder—Eng, Lond, Mch 13. 2000 w. M May.
- Locomotive, Underground Haulage by Electric—Leon Sindle, Col Guard, Apr 2. 2200 w. M June.
- Locomotives, A Substantial Indicator Rigging For (III)—Am Eng & R R Jour, June. 800 w.
- Locomotives, Baltimore Tunnel—Duncan, Elec Rev, Apr 29. W May 9.
- Locomotives, Comparative Test of Compound and Simple—W. S. Hanson, F. I. Hartwell and E. W. Meyer, Wis Eng, June. 250 w.
- Locomotives, Compressed Air—Ry Age, April 25. 400 w.
- Locomotives, Economical High-Power—James Dunlap, Eng, Lond, May 15. 1400 w.
- Locomotives, Electric—Elec Rev, Lond, July 10. 700 w.
- Locomotives, Is It Good Practice to Use Blank Drivers on—L. E. Molineux, N Y R R Club, May 21. 9400 w. M Aug.
- Locomotives, Relations Between Boilers, Cylinders and Weight on Driving Wheels of—M. Demoulin, Ry Rev, June 13. Serial Part 1. 2200 w. M Aug.
- Locomotives, Ribbed Tubes for—Ry Rev, April 25. 1600 w.
- Locomotives, The Form of the Exhaust Jet in Locomotives—J. F. Deems, Eng News, June 4. 2100 w.
- Locomotives, Types of High-Speed (III)—Ry Mas Mech, May. 900 w.
- LOGARITHMS, The Use of—C. K. Jackson, Am Mach, Mch 19. Serial Part 1. 1500 w. M May.
- LONDON and Northwestern Railway, Jubilee of—W. Paley, R R Gaz, July 17. 1100 w.
- London Churches, Old (III)—Geo. H. Birch, Builder, June 6. 3700 w. M Aug.
- LOOKOUT Mountain, New Incline up—St Ry Rev, June 15. 2200 w.
- LORENZ, Apparatus (III)—Elec Rev, Lond, July 10. Electr, June 26.
- LOSSES in Continuous-Current Machines, Experimental Determination of the—seidner, Elektrochem Zeit, Apr 1. W May 9.
- LUBRICANTS, A New Method for Testing—aul MacGahan, Elec Wid, May 30. 900 w. M July.
- Lubricant for Railway Axles, A New—Eng, Lond, June 19. 800 w. M Aug.
- LUGANO, Three-Phase Traction at—Elektrotechn Zeit, Apr 30. W May 23.
- LUMINESCENCE—See Roentgen Rays.
- LUMINOUS Fountain, The Adamoff—Elec Eng, Apr 15. P May.
- MACHINE Designing, Notes on—John H. Barr, Eng's Yr Book, Univ of Minn. 1400 w. M July.

KING'S Exhaust and Water Separator.

REMOVES ALL
OIL
FROM
EXHAUST.



REMOVES ALL
WATER
FROM
LIVE STEAM.

Six of these separators are in use in the University of Wisconsin Buildings.

Three Separations. No Back Pressure. Satisfaction Guaranteed.

Send for circulars and prices to

KING & WALKER CO., Mfrs.,
623 E. Main Street,
Madison, Wis.

GALENA OIL WORKS

(LIMITED)

FRANKLIN, PA.

GALENA OILS ARE THE
STANDARD LUBRICATING
OILS OF AMERICA.

New York to Chicago in 20 hours without a hot box. Cold test 10 to 20 degrees below zero. Galena Oils run all the lightning trains of this country.

We also supply our patrons with Galena Air Brake O.I. perfectly pure and free from gum.

CHICAGO BRANCH OFFICE:
Western Union Bldg.

CINCINNATI BRANCH OFFICE:
Neave Building.

The Robert W. Hunt & Co.,

o o o o

Bureau of Inspection, Tests and Consultation.

NO. 80 BROADWAY, NEW YORK.
1137 THE ROOKERY, CHICAGO.
PARK BUILDING, PITTSBURGH.

INSPECTION OF..

Steel Rails, Splice Bars,
Railroad Cars, Wheels,
Axles, Etc. ❁ ❁ ❁ ❁

CHEMICAL LABORATORY.
Analysis of Ores, Iron, Steel, Oils, Water, Etc.

PHYSICAL LABORATORY.
Test of Metals, Drop and Pulling Test of Couplers, Draw Bars, etc.

❁ Efficiency Tests of Boilers, Engines and Locomotives. ❁

- Machine-Shop Economics, Modern—Eng Mag, Apr. 3700 w. M May.
- Machines, Improvements in Standard—P. Burleigh, Age of St, July 4. 2400 w. M Aug.
- MADISON Square Again—H. A. Caparn, Gar & For, Apr 29. 350 w. M June.
- Madison Square, The Plans of—Gar & For, Apr 15. 600 w. M June.
- MAGNET, Do Magnet Poles Emit Light Rays?—Magnes, Ind & Ir, June 5. Serial Part 1. 2400 w. M Aug.
- Magnet Windings, Testing for Faulty—Szapiro, Elektrotechn Zeit, May 28. W June 20.
- MAGNETIC Chucks (III)—Amer Mach, July 16, 30 and Aug 13.
- Magnetic Concentration—Eng & Min Jour, June 13. W June 27.
- Magnetic Field Due to an Elliptical Current—Jones, Electn, May 29. Phil Mag, July.
- Magnetic Field, Principles of the—Frederick Bedell, Elec Pow, Mch. Serial Part 1. 2800 w.
- Magnetic Homogeneity of Iron and Steel and the Effect of Annealing—Dr. A. Ebeling and Dr. E. Schmidt, Electn, Apr 17. P June. W May 9. Elektrotechn Zeit, Aug 20. W Sept 12.
- Magnetic Influence of the Planets—A. Schuster, Sci Am Sup, Mar 14.
- Magnetic Phenomenon, New—Duane, Electn, July 24. W Aug 15.
- Magnetic Properties of Iron and Steel—Elec Rev, Lond, May 29. W June 20. Engug, May 29. 1000 w. M July.
- Magnetic Qualities of Iron and Steel—See Testing.
- Magnetic Testing of Iron, Apparatus for—Ayerton and Mather, Electn, June 12. W July 4.
- Magnetic Theories, The Graphical Representation of—Harold N. Allen, Phys Rev, May-June. 2000 w. M July. W May 30.
- Magnetic Units, Fundamental—Allen, Electn, Apr 24. W May 16.
- MAGNETISM, Method of Determining Units of—Ossian Chystræus, Elec Wld, Apr 18. P May.
- Magnetism, Terrestrial—Bigelow, Sci, July 17.
- MAGNETIZATION of Alloys of Iron and Antimony—Weiss, L'Ind Elec, June 10. L'Eclair Elec, Aug 8. W Sept 8.
- Magnetization of Crystallized Magnetite—Weiss, L'Eclair Elec., June 13.
- Magnetization of Iron, The Time Rate of Growth of—Ernest Wilson, Elec. Mar 18.
- MAGNETOGRAPHS Made by Radiations from the Poles of a Magnet—John S. McKay, Sci Am, April 18. 800 w. M June. W May 9.
- MAGNETOSTRICTION—Nagaoka and Jones, Phil Mag, May.
- MAGNESIUM as a Constructive Material—R. H. Thurston, Mach, May. 2700 w. M June.
- MANGANESE, and Mananiferous Ore in Spain—R. W. Barrington, Am Mfr & Ir Wld, June 19. M Aug. 400 w.
- Manganese Deposits of Huéla, The—Frank Johnson, Inst Min & Met, Lond, Vol III Pt II. 8200 w.
- Manganese District and Its Mines, The Covadonga—J. A. Jones, Inst Min & Met, Lond, Vol III Pt II. 2800 w. M Aug.
- Manganese in Iron Ores, Lärnström's Method of Determining—C. T. Mixer and H. W. Du Bois, J Am Chem Soc, April. 1400 w. M May.
- MANHATTAN Elevated Railway—Eng News, Apr 30. W May 9.
- MANHOLE Explosions and Their Remedy—Dobbs, Elec Eng, June 10. W June 20.
- MANTELS—A. Mason, Brickbuilder, May. 1700 w. M July.
- MANTES, The Port of—Consular Reports, March. 2500 w. M June.
- MAINS and Service: Their Extension and New Territory—George Light, Am Gas Lgt J, Apr. 6. 3600 w. M May.
- MAP of Butte, Montana, A Topographic—R. H. Chapman, Eng & Min Jour, May 9. 650 w. M June.
- MARBLES, Georgia (III)—William M. Brewer, Tradesman, Mch 15. 600 w. M May.
- MARINE OF JAPAN, Merchant—Consular Reports, May. 400 w. M June.
- MARINE Propulsion, Calculation of Horse-Power for (III)—Thos. English, Jour Am Soc of Nav Engrs, May. 2000 w. M July.
- Marine, The Condition of the French Mercantile—Board of Tr Jour, April. 1500 w. M June.
- MASONIC Temple, Montgomery, Ala. (III)—So Arch, May. 800 w. M July.
- MASONRY—Harvey Flint, Abs Paper Arch Assn, England. Arch, Lond, Mch 13. 5800 w. M May.
- MASSACHUSETTS, The Speed Trial of the U. S. Battleship (III)—Sci Am, May 9. 900 w. M June.
- MASTER Mechanics' Association, The Reports of—Ry Rev, June 27. 10000 w. M Aug.
- MASTICATOR, The Invention and the Development of the—Ind Rub Wld, July 10. 2000 w. M Aug.
- MATERIAL, Systematic Inspection of—L. S. Randolph, Digest Phys Tests, Apr. 1300 w. M June.
- MEASUREMENT of Surface Conductivity of Glass—Kremmenacker, J Inst Elec Eng, July. W Sept 5.
- Measurements in Engineering—Kennedy, Electn, May 1.
- Measuring Instruments—Arinagnat, L'Eclair Elec, July 25.
- Measuring the Insulation Resistance—Picon, L'Ind Elec, June 10. W July 4.
- MEDIAEVAL Architectural Refinements—W. H. Goodyear, Arch Rec, July-Sept. Serial Part 1. 5000 w.
- MELDOMETEER, Determination of High Temperatures with the—Ramsay and Eumorfopoulos, Phil Mag, Apr. Proc Lond Phys Soc, May.
- MEMBRANES as Insulators, Organic—B. W. Richardson, Elec Rev, July 29. 1800 w. M Sept.
- MEN-OF-WAR, Development in Design and Construction of—A. Deitrich, Paper Inst Nav Arch, Lond, June 12. 4000 w. M Aug.
- MERCURY, Arc Between—Arons, Wied Ann Vol 58, p 73.
- MERIDIAN by an Observation of the Sun, Obtaining the True—C. C. Hommann, Eng News, July 9.
- MERIDA'S Engines, Breakdown of the (III)—Eng, June 20. 1000 w. M Aug.
- MERRIMAC Bridge—See Rock River.
- MESABI Ores and Top Explosions—F. E. Bachman, Ir Tr Rev, Apr 23. 600 w. M June.
- METALLOIDS in Cast Iron, Practical Value—M McDowell, Ir Age, July 23. 4500 w.
- METALLURGIC Revolution, A—Theo. B. Comstock, Eng & Min Jour, May 30. 1200 w.
- METALLURGY, The History of Electric Heating Applied to—F. P. Dewey, Elec Rev, Mch 25. Serial Part 1. 2200 w. M May.
- Metallurgy, Uses of Electricity in—Borchers, Elec Rev, Lond, Aug 21.
- METAL, A Rare—T. L. Phipson, Knowledge, June. 1500 w.
- Metals Experimentally Considered, Inherent Defects in Fuse—Walter E. Harrington, Jour Fr Inst, June. 3000 w. M July. W July 4.
- Metals, The Diffusion of—W. C. Roberts Austen, Nature, May 21. 2500 w.
- METEOROLOGY, Pseudo-Science in—B. E. Fernow, Science, May 8. 1600 w.
- METER, Aron (III)—L'Eclair Elec, May 23.
- Meter, Electricity Supply—Ricks, J Inst Elec Eng, March. W May 9.
- Meter for Accumulators (III)—Aliament, L'Eclair, Apr 18.
- Meter Records Are Kept at Battle Creek, Mich., How—Eng News, May 21. 400 w.
- Meters Prepayment—H Van der Horst, Pro Age, July 15. 1800 w.
- Meters, The Best Method of Setting—Fire & Water, July 25. 900 w.
- Meters, Vibration—Engng, May 22. 1600 w.
- METRIC System of Measurements Demanded—Loc Engng, Apr. 1800 w. M May.



ELECTRICAL SUPPLIES

We Test Them, We Buy Them==Then we Sell Them.



We know they are good before we offer them to you.
You take no risk in sending your order to us.



Everything Electrical for the

Central Lighting Station.	Central Telephone Station.	Railway Power House and Line.	Isolated Plants and Private Lines.	Laboratory, School, Fire and Police Alarm.
---------------------------------	----------------------------------	-------------------------------------	--	--



PEOPLE'S ELECTRIC COMPANY,
THE SUPPLY HOUSE OF THE NORTHWEST,
MADISON. - - - - WIS.

LINK-BELT MACHINERY CO.,



ENGINEERS, FOUNDERS, MACHINISTS,
CHICAGO, U. S. A.

Link Belting, Sprocket Wheels, Malleable Iron Buckets,
Saw Mill Machinery, Elevators,
Conveyors, Etc.

NOTE.—The Coal and Ashes Handling Machinery in Power House
of University of Wisconsin was designed and installed by us.

PASSAIC ROLLING MILL CO.

Bridge Builders and Steel and Iron Manufacturers.

Rolled Beams, Channels, Angles and Tees, Roofs, Turntables, Eye-Balls, etc.
Works: Paterson, N. J. New York Office: 45 Broadway

Please mention Wisconsin Engineer when you write.

- Metric System, The—Engng, April 17. 2500 w. M June.
- Metric System, The—Herbert Spencer, Pop Sci M, June. 7800 w.
- METROLOGICAL Standards and Gauging Implements—J. Richards, J Assn Engng Soc, May. 5800 w. M Aug.
- MEXICO: Tehantepec Railway—Ind & East Eng, June 20. 2500 w.
- MICA, The Mining of—Min & Sci Pr, Mch 14. 500 w. M May.
- MICROPHONE (III)—Elektrotechn Zeit, May 7.
- Microphone Patent Suit, The Berliner (III)—Elec, Mch 11. 2200 w. M May.
- MICROSCOPE as Used in Mining, The—J. A. Edman, Min & Sci Pr, April 25. 2500 w. M June.
- MILEAGE, Empty Car—R R Car Jour, April. 500 w. M June.
- MILLING Machine for Heavy Engineering Work, On the Development of the—Samuel Dixon, Ind & Ir, April 17. 5800 w. M June.
- Milling Machine, The Development of the—S. Dixon, Col Guard, Apr 2. 3000 w. M June.
- MILK, Modified (III)—Sci Am, May 23. 1600 w.
- MILWAUKEE City Hall, Electrical Equipment of the (II)—W Elec, May 2. 2000 w. M June.
- MINERAL and Metal Production of the United States in 1895, The—Eng & Min J, Apr 11. 5400 w. M June.
- Mineral Kingdom, The Individuality of the—H. Miers, Nature, July 2. 6000 w.
- Mineral Production of California in 1895, The—Eng & Min Jour, May 16. 1000 w.
- Mineral Resources of the Judith Mountains, Montana—Walter Harvey Weed, Eng & Min Jour, May 23. 1700 w. M July.
- Minerals of the United States, Minor—D. T. Day, Eng Mag, May. 3900 w. M June.
- MINE May Be Dry but not Dusty, How a—George Gowler, Col Guard, April 19. 5400 w. M June.
- Mine Shafts, New Arrangement for Putting Down (III)—Col Guard, May 15. 1700 w. M July.
- Mine-Surveying—See Electric.
- Mine Ventilation, A Theory in—Col Guard, May 1. 2400 w. M July.
- Mines in the Loire Coalfield, Regulations as to Fiery—Col Guard, May 8. 2800 w. M July.
- Mines of Southeastern Siam, The Sapphire and Ruby—Min Jour, May 30. 3000 w.
- Mines, Safety Cables for (II)—L'Elec, July 11. W Aug 1.
- Mines, Separate Ventilation in Fiery—Bergrath J. J. Meyer, Col Guard, Mch 20. 1500 w. M May.
- Mines, The Treatment of Timber for Use in—Robert Martin, Can Min Jour, May. 2500 w.
- Mines, The Use of Safety Explosives in German—Col Guard, Mch 13. 3500 w. M May.
- Mines, Transmission of Power in—Kennedy, Elec Rec Lond, Aug 28. W Sept 19.
- MIXING and Earthwork in Asia Minor, Cost of—T. Wynne, Min Jour, July 10. 1800 w.
- Mining and Metallurgy of France, State of—Col Guard, Apr 17. 2200 w. M June.
- Mining by the Use of Mechanical Appliances, Economies in—C. Robinson, Col Eng, July. 2900 w. M Aug.
- Mining Based Upon Lake Superior Practice, Elements of Methods of Metal (III)—F. W. Denton, Eng's Yr Book, Univ of Minn. 6200 w. M July.
- Mining Company, Grass Valley, Cal., A Water Power and Compressed Air Transmission Plant for the North Star (III)—Am Soc of Civ Eng, May. 6500 w. M July.
- Mining Country, Ontario as a—Dr. A. P. Coleman, Can Min Rev, Mch. 3500 w. M May.
- Mining District, Utah, The Oquirrh Mountains or the Mercur—Col Eng, June. 5400 w.
- Mining, Electric Light in Operations—See Electric.
- Mining in the Brown Coal District of North-west Bohemia and the Pilsen (Hard) Coal Field—Remy, Col Guard, May 22. 3000 w.
- Mining in the State of Chiapa, Mexico—Min Jour, April 4. 3800 w. M June.
- Mining Machines, Some Early—Mach, Apr. 1500 w. M May.
- Mining, Placer (III)—Arthur Lake, Col Eng, May. 5800 w. M June.
- Mining Plant, A California—Min & Sci Pr, Apr 18. 800 w. M June.
- Mining Reports and Mine Salting—W. McDermott, Inst Min & Met, Lond, Vol III Pt II. 15800 w. M Aug.
- Mining Safeguards—Col Eng, July. 3500 w. M Aug.
- Mining Tenure in Western Australia—R. Radclyffe, Min Jour, June 20. 1200 w. M Aug.
- Mining, The Financial Aspect of—J. H. Chewitt, Can Min Rev, Mch. 1500 w. M May.
- Mining: With Especial Reference to That Carried on in Gt. Britain, Ancient—A. Cooper Key, Min Jour, May 16. 1200 w. M July.
- MISSISSIPPI River, Bank Revetment on the (II)—H. St. L. Coppée, Eng Mag, June. 4000 w. M May.
- Mississippi, The Hydrology of the—Jas. L. Greenleaf, Am Jour Sci, July. 5500 w. M Aug.
- MODEL of the Earth, Proposed Gigantic—Alfred R. Wallace, Contemporary Rev, May. 4500 w.
- MODIFIED Apparatus for Demonstration—Larousse System, L'Elec, July 25.
- MOISTURE in Steam, Determination of the—R. C. Carpenter, Sib J of Engng, Mch 4. 4000 w. M May.
- MOLDING Bronze Tuyeres (III)—G. O. Vair, Am Mach, June 18. 700 w.
- Molding Machines and Air Hoists (III)—John Randol, Am Mach, June 11.
- Molding Machines and Their Field—Harris Tabor, Ir Tr Rev, May 21. 2500 w.
- Molding, The Utility of Green, Dry Land, and Loam—Thomas D. West, Ir Tr Rev, May 14. 1700 w. M July.
- MOLYBDENITE—Guichard, L'Eclair Elec, June 20.
- MORTARS, Notes on Cement—Edward Mead, Eng Assn of the South, Apr. 4800 w. M July.
- MOTOCYCLES at Chicago, The Tests of—Am Mach, Mch 26. 550 w. M May.
- Motocycles, Power for—L. L. Summers, Elec Engng, July. 3400 w. M Aug.
- MOTOR, A Study of a Three-Phase—Sib J of Engng, June. 2000 w. W July 18. M Aug.
- Motor, Alternate Current (III)—Elec, Lond, June 19. W July 11.
- Motor and Generator, The Action of the Series—Am Mach, June 4. 2200 w. M July.
- Motor Armatures, Torque of—Wolcott, Amer Elec, July. W Aug 1.
- Motor Cars on the Buffalo & Niagara Falls Electric Railway, Tests of Heavy—St Ry Rev, July 15. 900 w.
- Motor Control—Burke, Elec Eng, June 10. W June 20.
- Motor, Electric—Baxter, Amer Mach, June 4. 18 and July 2.
- Motor for Street Cars, The Hardie Compressed Air—R R Gaz, May 29. 1200 w.
- Motor for Street Cars, The Hoskins Gasoline—Eng News, Mch 12. 700 w. M May.
- Motor, How Is Motion Given to the Armature in a Direct Current—T. Wolcott, Am Electn, July. 1800 w.
- Motor in Rolling Mills and Steel Works, The Electric—Am Mach, May 28. 1800 w. M July.
- Motor Maintenance, Cost of—St Ry Rev, May 15. Serial Part I. 2500 w. W May 30.
- Motor Regulation by Field Variation—Anthony, Elec Eng, May 6. W May 16.
- Motor, Small—L'Elec, Apr 25.
- Motor, The Action of the Differentially-Wound—Wm Baxter, Jr., Am Mach, July 2. 1200 w.
- Motor, The Action of the Shunt—Wm. Baxter, Jr., Am Mach, June 18. 1300 w. M Aug.
- Motor, The Langdon-Davies Alternate Current (III)—Engng, June 19. 2800 w. M Aug.
- Motor, The Langdon-Davies Self-Starting Mono-Phase Induction (II)—Elec Rev, Lond, June 26. 1800 w.
- Motor, The Panhard Levassor Road (III)—Engng, May 1. 2600 w.

PARAGON DRAWING INSTRUMENTS.

Superior to all others in CONSTRUCTION, FINISH, MATERIAL, DURABILITY, and everything else which goes to make up QUALITY.

Each Instrument Stamped "PARAGON."

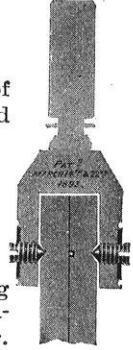
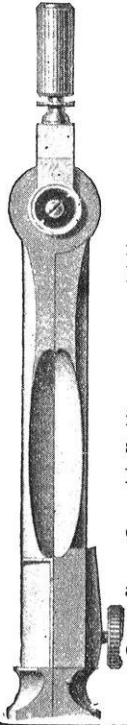
They are the **American Pattern** of instruments, made of rolled German Silver (no hardened castings) and hand-forged English steel.

Esser's Patent Pivot Joint

is far superior to the old-style pivot joint. No projecting screws to break off, no exposed threads to collect dirt, no impinging of the end of one screw against the thread of another.

We warrant our Paragon Instruments to last a life-time under proper care and to permanently retain their perfect action.

We make and carry the most complete assortment of **Drawing Materials and Surveying Instruments** in America.



Chicago Branch: **KEUFFEL & ESSER CO.,**
 111 Madison Street. **NEW YORK.**

ESTABLISHED 1885

COLLEGE WORK
 A SPECIALTY.

❁ **CHICAGO**
 ❁ **PHOTO-**
 ❁ **GRAVURE**
 ❁ **COMPANY,**

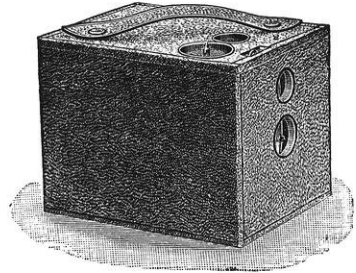
Sole Manufacturers of Photo-Gravure Album, "Of-
 ficial Views," published by the World's Columbian
 Exposition. Our World's Fair Exhibit received the
 Highest Award.

358 Dearborn St., CHICAGO, ILL.

Please mention Wisconsin Engineer when you write.

- MOTORS and Small Gas Engines—Soubeyran, L'Eclair Elec, June 6. W July 18.
- Motors at a Distance, Operating—Reynal, L'Eclair Elec, Apr 11. W May 9.
- Motors at Schenectady, Testing (III)—St Ry Rev, May 15. 150 w.
- Motors, Alternate Current—B. V. Swenson, Tech, May. 4200 w. W June 20. M Aug.
- Motors, Alternating Current—D. C. Jackson, Elec Wld, Aug 8. 1600 w. Electn, July 17. W Aug 8.
- Motors for Intermittent Work, Electric—Amer Mach, May 14.
- Motors for Street Railways, Compressed Air—Amer Elec, July.
- Motors, Methods of Starting Induction—P. M. Heldt, Am Electn, June. 1200 w. M Aug.
- Motors, Polyphase—Von Dobrowsky, Elec Eng, Lond, July 31. W Aug 22. W Elec, Aug 22.
- Motors, Regulation of Rotary Current—H. Behn-Escherburg, Elec Wld, June 6. 1200 w. M July.
- Motors, Single Phase (III)—Elec Eng, June 24. W July 4.
- Motors, Synchronous—Ossana, Elek Zeit, May 14 and 21. W June 13.
- Motors, Synchronous—Dubsky, Elec Eng, July 29. W Aug 8.
- Motors, Synchronous and Non-Synchronous—Bouchert, L'Eclair Elec, Vol 5 No 44. W May 9.
- Motors with Machines of Various Types, The Direct Connection of Electric—William Baxter, Jr., Elec Wld, Mch 21. Serial Part 1. 1600 w. M May.
- Motors—See Gas Engines.
- MOUNT Lyell Mine, Tasmania, Some Notes on—Sidney Fawns, Paper Inst Min & Met. Min J. June 27. 2200 w. M Aug.
- MULTIPHASE Motors, Graphical Theory of—Blondel, Electrotechn Zeit, June 11.
- MULTIPOLAR Type of Elec Machinery, The Advantages of—Wm. Baxter, Am Mach, July 30. Serial Part 1. 900 w.
- MUNICIPAL Control, Mistakes of—Beau, Elec Eng, July 29. W Aug 8.
- Municipal Electrical Association—Elec Eng, Lond, June 19. W July 11. Lighting, June 18. Eng, Lond, June 12. 4000 w.
- Municipal Ownership—Prog Age, July 15. Elec Eng, Aug 12.
- Municipal Ownership of Street Railways—R R Gaz, July 24. 2300 w.
- MUSHROOM Industry in France, The—Consular Reports, March. 7800 w. M June.
- NANTASKET Beach Road—Elec Eng, July 1. W July 11.
- NAPHTHALINE—Am Gas Lgt J, Mch 23. 2800 w. M May.
- Naphtaline, A Few Words on—John Gimper, Am Gas Lgt Jour, June 1. 2000 w.
- NASHUA AQUEDUCT, The (III)—Eng Rec, June 20. 700 w.
- NAVAL Machinery, Auxiliary (III)—H. S. Pickands, Yale Sci M, June. 1800 w. M Aug.
- NAVIGATION, The Present Status of Aerial (III)—Octave Chanute, Eng Mag, Apr. 3200 w. M May.
- NEGATIVE Resistance—Heaviside, Electn, July 31. W Aug 22.
- NEGLECTANCE with Some Statistics, The Law of—St Ry Jour, May. 3000 w.
- NEUCHÂTEL (III)—L'Energie Elec, July 1 & 16. W Sept 5.
- NEW EAST Coast Corridor Trains, The—Trans, July 3. 2400 w.
- NEWFOUNDLAND—See Iron.
- NEW ORLEANS, The Era of Better Buildings in (III)—Mfrs' Rec, July 17. 1000 w.
- New Orleans Street Railway—St Ry J, Apr.
- NEW SOUTH WALES Coast. The—J. Carne, Aust Min Stand, July 9. 2000 w.
- NEW ZEALAND, The Mineral Wealth of—Mach, Lond, Apr 15. 5000 w. M June.
- NIAGARA FALLS Electric Railway, Car and Line Tests on the Buffalo and—H. O. Pond and H. P. Curtiss, Sib Jour of Engng, May. 1000 w. M July.
- Niagara Falls Hydraulic Power Plant (III)—Sci Am, Apr 4. 1600 w. M May.
- Niagara Falls, The Gorge Road at (III)—Sci Am, Mch 28. 1200 w. M May.
- Niagara Falls, The New Water Power Development Below (III)—Eng News, Mch 26. 800 w. M May.
- NIAGARA, Telephoning the Roar of—Treat, Elec Rev, July 22. W Aug 1.
- Niagara, The Roar of—Elec Rev, July 22. 1000 w.
- NICARAGUA CANAL Board, Report of the—Eng News, Mch 26. 36000 w. M May.
- Nicaragua Canal Commissioners' Report, Mr. Menocal's Reply to—Eng News, April 30. 10500 w. M June.
- Nicaragua Canal Estimates, The—Engng, May 1. 3000 w. M July.
- Nicaragua Canal, The Absence of Facts About the—Charles B. Going, Eng Mag, June. 4300 w. M July.
- Nicaraguan Canal, The Medical Aspect of the—E. R. Stitt, San, Mch. 6000 w. M May.
- NICKEL Iron Alloys—See "Alloys."
- Nickel Plating of Wood—Eng & Min J, Apr 18. W May 16. Elec Rev, Lond, July 24.
- NILES Tool Works, New Foundry at (III)—Eng News, July 16. 600 w.
- NITRATES by Bacteria, Reduction of—E. O. Richards, G. Rolfe, Tech Quar, March. 3600 w.
- NITROGEN and Nitrogenous Products of Coal, On the—Dr. Knublauch, Pro Age, May 1. 1000 w. M June.
- NORTH River Bridge, The (III)—G. Lindenthal, Tr Assn Civ Engrs Cornell Univ, June. 4900 w. M Aug.
- North River Water Front, New York City, The Improvement of the (II)—Sci Am, June 6. 1300 w.
- NUMERATION in the United States, Decimal—E. Slosson, Science, July 17. 1800 w.
- NUTS and Nut Locking Devices, Lock—E. G. H. Brewster, Engng, May 1. Serial Part 1. 3000 w. M July.
- OBSERVATORY and How They Tell the Time at Greenwich, The Royal (III)—Sci Am, May 2. 1800 w. M June.
- Observatory, Edinburgh, The New Royal (III)—Engng, Apr 10. Serial Part 1. 3800 w. M June.
- Observatory, The Edinburgh Royal—Brit Arch, Apr 3. 1300 w. M June.
- OCEAN WAVES and Wave Force, Some General Notes on—Theo. Cooper, Tr Am Soc Civ Eng, Apr. 6000 w. M June.
- Ocean Wave, The Life History of An—W. F. Durand, Sib J Engng, Apr. 2200 w. M June.
- OCTAVES, Sixty Eight—T. H. Mavas, Elec Rev, Lond, April 24. 250 w.
- OHMMETER, Portable—Chauvin and Arnoux System, L'Ind Elec, July 10. W Aug 8.
- OIL Corn—Harry W. Allen, Eng's Yr Book, Univ of Mich, 1200 w.
- Oil Engine Signal Plant on U. S. Lightship No. 42 (III)—Sci Am, July 4. 1600 w.
- Oil in Bulk Steamers—Eng's Gaz, Apr. 1000 w. M May.
- Oils, Testing Lubricating (III)—W. E. Crane, Am Mach, May 21. 500 w.
- Oil Wells, Starting Dry—Young's Method, Eng & Min Jour, July 25. W Aug 8.
- OMNIBUSES, Horseless—Elec Rev, Lond, May 22. W June 13.
- ONTARIO as a Mining Country—A. P. Coleman, Can Eng, May.
- Ontario—See "Mining."
- OPEN-Conduit Systems (III)—Dawson, Engng, Lond, July 31.
- OPERA HOUSES and Theaters, Modern—Edit, Builder, June 27. 3000 w. M Aug.
- "ORACLE" Cottage Contest (III)—Arch & Build, July 18. 400 w.
- ORDINANCE, The New York Building—Eng Rec, July 11. Serial aPt 1. 3500 w.
- ORE CAR, Combination: Duluth, South Shore & Atlantic Ry—R R Car Jour, April. 900 w. M June.
- Ore Deposits in Minnesota—Arthur H. Eftman, Eng's Yr Book, Univ of Minn. 900 w.
- Ore Deposits of the Little Rocky Mountains, Montana—W. H. Reed, Eng & Min Jour, May 2. 1900 w. M June.

PHOTOGRAPHIC SIMPLICITY...



It's a simple thing to take pictures with our Cartridge system cameras—that's why the Pocket Kodak is known as the photographic success of the decade. In the hands of the absolute novice, it produces a larger percentage of perfect pictures than any camera, big or little, has ever produced before.

THE 1896 BULLET reproduces the Pocket Kodak features in a camera of large size and greater capabilities, yet retains the Pocket Kodak simplicity. It uses either Film cartridges or glass plates, has a fixed focus achromatic lens of great depth, is carefully made in every detail, is covered with fine grain leather and beautifully finished. In short, is up to our high standard of excellence—the standard that made the Kodak famous.

**IMPROVED ROTARY SHUTTER,
SET OF THREE STOPS,**

**SQUARE FINDER,
SOCKET FOR TRIPOD SCREW.**

When used with film has a capacity of 18 exposures $3\frac{1}{2} \times 3\frac{1}{2}$ inches and can be **RELOADED IN DAYLIGHT.**

Price, Improved No. 2 Bullet, for pictures $3\frac{1}{2} \times 3\frac{1}{2}$ inches	\$10.00
Improved No. 4 Bullet, for pictures 4×5 inches	15.00

BOOKLET FREE.

EASTMAN KODAK CO., Rochester, N. Y.

Iowa Life Insurance Co.

Principal Offices; SIOUX CITY, IOWA; CHICAGO, ILL.

C. E. MABIE, President.	O. D. WETHERELL, Treasurer.
S. H. SWEET, Vice-President.	J. H. STOWELL, Medical Director.
GEO. B. SWIFT, Second Vice-President.	E. L. BARBER, General Counsel.
R. E. SACKETT, Secretary.	CRAIG L. WRIGHT, Attorney for Iowa.
A. T. PARISH, Superintendent of Agencies.	

Premium receipts, 1895.....	\$205,084 59
Interest and other receipts, 1895.....	34,976 26
Total amount paid policy holders since organization.....	841,550 75
New insurance written during 1895.....	5,432,408 37
Insurance in force December 31, 1895.....	8,121,892 20

All Policies are Absolutely Secured by a Deposit with the State of Iowa, of the Full Reserve or Cash Value.

Agents desiring First-Class Contract, Salary or Commission, address,

W. F. Gorrell & Son,
315 Manhattan Bldg., Chicago.

Please mention Wisconsin Engineer when you write.

- Ore Requirements of German Blast-Furnaces, Present and Prospective—E. Schrodtter, *Ir & Coal Trs Rev*, Mch 27, 2200 w. M May.
- Ores of the Slovan, B. C., Gold and Silver—J. C. Gwilliam, *Can Min Jour*, May, 1000 w.
- ORGANIZATION of an Electricity Works Staff—Ruthven-Murray, *Electn*, July 31.
- OSCILLATING Current, On the Theory of—C. P. Steinmetz, *Elektrotechn Zeit*, Apr 6.
- Oscillating Instruments, Elementary Principles of—Armagnat, *L'Eclair Elec*, May 30.
- OTAY DAM, The Construction of the Lower (III)—*Eng Rec*, June 27, 3500 w.
- OUTLYING Districts, Extension to—Gibbins, *Elec Eng*, Lond, June 19, W July 11.
- OWEN Jones, Student—J. Joaso, Notes on Italy, *Jour Roy Inst of Brit Arch*, June 25, 5000 w.
- OXYGEN—See Electrolytic.
- OZONE, Commercial—Andreoli, *L'Elec*, July 25, W Sept 5.
- Ozone Generator—*Elec Rec*, June 19, W July 11, *Elec Eng*, Apr 29.
- Ozone Generator—Andreoli, *Electn*, Aug 7, W Aug 29.
- Ozone-Producing Apparatus (III)—Andreoli System, *Elec Eng*, Aug 26, W Sept 5.
- Ozone, Production and Utilization of—*Electn*, July 24, W Aug 15.
- PACKING for Piston Rods and Valve Stems—*Ry Rev*, May 16, 1200 w.
- Packing, Metallic Stuffing-Box—E. N. Wiest, *Am Mach*, July 2, 456 w. M Aug.
- Packing, Something About—W. H. Wake-man, *Safety V*, June, 2800 w.
- PAINTING Plant, Portable Electric (III)—*Electn*, May 29, W June 20, *Elec Eng*, June 24.
- Painting, Talks on House—*Can Arch & Build*, July, 1800 w.
- PAPER, The Manufacture of—*Sci Am*, Apr 4, 1500 w. M May.
- PARIS Street Railway Notes—Chas. King, *St Ry Rev*, July 15, 1500 w.
- PARKS County—*Gar & For*, June 3, 1200 w. M July.
- PAIKK, The Palisades National—Waldo G. Morse, *So Arch*, May, 2700 w. M July.
- Park, The Revised Plan for Jackson, Chicago—*Gar & For*, May 20, 1500 w. M July.
- PASSENGER Man, The Successful—George H. Daniels, *Ry Age*, May 9, 2000 w.
- PASSENGERS to Obey Company's Rules, Duties of—*St Ry Rev*, June 15, 1200 w. M Aug.
- PATENT Legislation, Proposed—*Sci Am*, Apr 18, 1800 w. M June.
- PATHS—The Old Paths, Where Is the Good Way?—*Arch*, June 5, *Serial Part 1*, 2200 w. M Aug.
- PATTERN Making, A Few of the Snares of—John M. Richardson, *Mach*, Apr, 1800 w. M May.
- Pattern Shop Costs—A. Sorge, Jr., *Ir Age*, June 18, 6000 w. M Aug.
- PAVEMENT in American Cities, Kinds of—*Pav & Mun Engng*, June, 200 w.
- PAVEMENTS, Current Street—*Ill Car & Bld*, July, 1700 w.
- Pavements of an Australian City, The (III)—F. A. Campbell, *Pav & Mun Engng*, May, 1000 w. M June.
- PAVING BRICK—F. P. Anderson, *Dig Phys Tests*, Apr, 3000 w. M June.
- Paving Brick at Williamsport, Tests of—*Eng News*, Apr 9, M June.
- Paving Bricks, Impact and Abrasion Tests of—H. J. Burt, *Tech*, May, 2300 w.
- PAVING in Jackson, Mich., Brick Street (III)—*Eng News*, April 30, 1300 w. M June.
- Paving Is Essential to the Success of a City, Why Good—J. W. Howard, *Pav & Mun Engng*, Apr, 1800 w. M May.
- Paving Statistics, Brick—George W. Kumaner, *Brick*, June, 1500 w.
- PECKSPORT Connecting Line of the N. Y., O. & W., The—*R R Gaz*, May 22, 400 w.
- PENNSYLVANIA Railroad Voluntary Relief Department—*R R Gaz*, June 12, 1400 w.
- PENYVERN House Technical College (III)—*Engng*, June 5, 1700 w. M Aug.
- PERIODIC Curves, A Simple Method of Analyzing—E. B. Wedmore, *Paper Inst Elec Engs*, *Elec Eng*, Lond, June 5, 4000 w. M Aug.
- PERMANENT Way—W. Lawford, *Eng*, Lond, July 24, 2000 w.
- Permanent Way—Some Recent Features of—*Ir & Coal Trs Rev*, April 10, 3200 w. M June.
- PERMEABILITY Bridge, Prof. Ewing's—*Electn*, May 8, 1100 w. M July.
- PEROXIDE Electrodes—Tower, *Elec Rev*, Lond, July 17, W Aug 8.
- PERIGNEUX, Saint, Front of; and the Domed Churches of Périgord and La Charente—R. Phené Spiers, *J of Roy Inst of Brit Arch*, Feb 20, 13000 w. M May.
- PERIODIC Phenomena, Variation Rates of—Muras, *Elec Rev*, Lond, Apr 24, W May 16.
- PETROLEUM (III)—Mach, Lond, July 15, 1800 w.
- Petroleum, Chemistry of the Berea Grit—Charles F. Mabery and Orton C. Dunn, *Am Chem J*, Mch, 4800 w. M May.
- Petroleum Industry in Japan—*Ind Engng*, June 13, 600 w.
- Petroleum in Peru—Dr. H. Polakowsky, *Am Mfr & Ir Wld*, June 26, 1800 w.
- Petroleum Oil Fields, The Wyoming—Wilbur C. Knight, *Am Mfr & Ir Wld*, May 29, 1600 w.
- PHASE-Shifting in Single and Tri-Phase Systems—Rodet, *L'Ind Elec*, May 25.
- PHASING Transformers, Experiments with the—Ferraris and Arno, *L'Eclair Elec*, July 18, W Aug 22.
- PHONOGRAPH, The (III)—*Sci Am*, July 25, 1400 w.
- PHOTO-CHRONOGRAPH, Experiments with the Polarizing—A. C. Crehore and G. O. Squier, *Elec Wld*, June 27, *Serial Part 1*, 200 w. M Aug.
- PHOTO-GALVANOGRAPHY — Pilitschikou, *Elektrotechn Zeit*, June 18.
- PHOTOGRAPH and See Through Opaque Bodies, How to (III)—E. Andreoli, *Elec Rev*, Lond, Mch 27, 1100 w. M May.
- PHOTOGRAPHING Electrical Discharges (III)—W. E. Woodbury, *Pop Sci M*, July, 1200 w.
- PHOTOGRAPHY, Color—Prof. Lippman, *Nature*, April 30, 2800 w.
- Photography in Vacuo—Joseph Cottier, *Elec Wld*, May 23, 600 w.
- Photography, The New—Charles Barnard, *Chau*, Apr, 3000 w. M May.
- Photography, The New—Richard C. Shettle, *Elec Rev*, Lond, Mch 6, 900 w. M May.
- PHOTOGRAPHS—See Crookes Tubes.
- PHOTOMETER, An Inexpensive (III)—*Pro Age*, Mch 16, 900 w. M May.
- Photometer, A Standard—W. J. Dibbin, *Gas Wld*, June 13, 10000 w. M Aug.
- Photometer Bar, Graduation of a 100-Inch—Smith, *Tech Quart*, Mar, W July 18.
- Photometer Bar, The Graduation of a 100-Inch—W. Smith, *Tech Quar*, March, 350 w.
- PHOTOMETRICAL Testing, Labor Saving Methods in—H. O'Conner, *Gas Wld*, July 15, 3000 w.
- PHOTOMETRY—*L'Eclair*, July 4, W Aug 1, *L'Eclair Elec*, July 11, W Aug 15.
- Photometry, A Method for the Use of Standard Candles in—Clayton H. Sharp, *Phys Rev*, May—June, 2500 w. M July.
- Photometry, A Suggested Remedy for a Source of Error in Official—L. T. Wright, *J Gas Lgt*, June 2, 2000 w. M Aug.
- Photometry of Phosphorescent Sulphide of Zinc Under Action of Cathode Rays—Henry and Legury, *L'Ind Elec*, June 10, W July 4.
- Photometry, Practical (III)—Alton S. Miller, *Stev In*, Apr, 2800 w. M May.
- PHYSICAL Experiment in Relation to Engineering—A. B. W. Kennedy, *Elec Eng*, Lond, May 8, *Engng*, May 15, 1500 w.
- PHYSICS—*Sci Am*, July 25, 1500 w.
- Physics, Fundamental Ideas in—Osterberg, *Elec Pow*, June.
- PHYSIOLOGICAL Phenomena—Weiss, *L'Eclair Elec*, July 11, W Aug 22.

Important to Piano Players.

Flanner's own Collection of Piano Music No. 3 contains 31 complete pieces of music, among which are the "American Cavalry Grand March," "Country Club March," "Lion du Ball," "Love's Dream After the Ball," "Mill in the Forest," "La Czarina," "Silver Stars," "Toreador Waltz," "Waves of the Danube," "España Waltzes," etc. For sale at

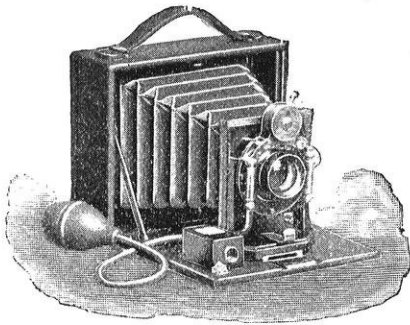
Flanner's Music House,

MILWAUKEE, WIS. Price, 50c. by Mail.

The Latest in Music is the "Calve Waltz,"

And a beautiful ballad called "I CAN FORGIVE BUT NOT FORGET"
Both sent by mail upon receipt of 50 CENTS—Stamps accepted.

TO ENGINEERS



SIZE OF 4 x 5
5 x 7 x 1 1/2.

THE PONY PREMO

Furnished with Our

**NEW VICTOR LENS
AND SHUTTER.**

PRICE, \$24.00.

Will be found valuable in making reports of the progress of work on a contract. A photograph conveys a more definite idea than the longest written report.

Send Your Address for Illustrated Catalogues.

ROCHESTER OPTICAL CO., Rochester, N. Y.

Please mention Wisconsin Engineer when you write.

- PIECE WORK SYSTEM, The—Ry Mas Mech, Apr. 600 w. M May.
- PIER and Pavillion, Clacton-on-Sea (---)—Engng, Mch 20. 2000 w. M May.
- PILES, New Method for Determining the Supporting Power of Piles—Franz Kreuter, Ry Rev, May 9. 1000 w. M July.
- PINE, Mechanical and Physical Properties of Southern—U. S. Dept Agri, Cir 12. 5800 w. M June.
- Pine, Notes on Overloaded White—Ry Rev, Mch 28. 500 w. M May.
- PIPE Laying, Costs of—Eng Rec, April 11. 900 w. M June.
- PIPES, Areas and Discharging Powers of—J. L. Bixby, Jr., Met Work, Apr 18. 700 w. M June.
- Pipes from 28 to 42 Inches in Diameter, Flow of Water in Wrought and Cast-Iron—Isaac W. Smith, Am Soc of Civ Eng, May. 4600 w. M July.
- Piping, Fittings and Joints for High Pressure (II)—John Platt, Eng News, Mch 19. 1100 w. M May.
- PISTON Rings, Snap—F. Halsey, Am Mach, July 30. 1200 w.
- Piston Rods, Some Interesting—H. K. Landis, Jr Age, June 11. 1000 w. M Aug.
- PLACER Machine, A Dry (II)—Min & Sci Pr, Mch 14. 400 w. M May.
- PLANK, A Stone (II)—Am Mach, Apr 2. 1000 w. M May.
- PLANING, Peculiar (III)—John Randol, Am Mach, June 25. 1400 w. M Aug.
- PLANT, A Cotton Mill Electrical Transmission (II)—A. F. McKissick, Elec Wld, Mch 14. 1500 w. M May.
- Plant, An Interesting (II)—S. D. Benoliel, Elec Pow, Mch. 3000 w. P May, M May.
- Plant at Scranton—Elec Ry Gaz, Apr 10.
- Plant at the New York Custom House, Electric Lighting and Power (II)—Elec Wld, July 18. 1500 w.
- Plant, Bergen County (II)—Elec Eng, June 3.
- PLANTS, Combined Light and Power (II)—Engng, July 10. Serial Part 1. 1700 w.
- Plants, Combined Lighting and Traction—J. Hesketh & J. H. Rider, Elec Rev, July 29. 2000 w.
- Plant, Private (II)—Elec Eng, July 15.
- Plant, Rome (II)—Engng, Lond, July 24. W Aug 22.
- Plant, Rules and Regulations in Japan—Engng, Lond, July 31.
- PLANTWORKS, Advantage of Station, Loc Engng, May. 450 w.
- Platform for Railway Work, Traveling—Elec Eng, Lond, July 3.
- PLOW, Electric—West Elec, July 4.
- PLUMBING Details in Three Large Apartment Buildings (III)—Dom Engng, May. 2800 w. M July.
- Plumbing in a New England Residence (II)—Eng Rec, June 27. 1200 w.
- Plumbing in Hotel Jefferson (III)—Eng Rec, July 25. Serial Part 1. 1600 w.
- Plumbing in the American Surety Building (III)—Eng Rec, Mch 14. Serial Part 1. 1400 w. M May.
- Plumbing in the Metropolis of the Mississippi, Early—T. D. Turner, Dom Engng, May. 1800 w. M July.
- Plumbing, Kitchen (III)—Dom Engng, Mch. 500 w. M May.
- Plumbing, Samples of Work (III)—Dom Eng. June. 350 w. M Aug.
- Plumbing System, A Stand-Pipe (II)—Eng Rec, June 13. 900 w. M Aug.
- Plumbing, The "Sanctet" Commission on—Arch, Lond, July 10. 2500 w.
- PLUMB Our Houses, How to—H. C. Patterson, Dom Engng, Apr. 2200 w. M June.
- PNEUMATIC Appliances, Some Convenient (II)—Ry Rev, May 2. 800 w.
- Pneumatic Gun, The Dudley Power—Sci Am, April 25. 1400 w. M June.
- Pneumatic Power in Workshops—F. Barnett, Can Eng, July. 6000 w. M Sept.
- Pneumatic Process, William Kelly's Own Account of His Invention of the—Bul of the Am Ir & St Assn, June 1. 1500 w.
- POLARITY Tester—Keim, Amer Elec, July. W. Aug 8.
- POLARIZATION and Resistance of Galvanic Cells—Streintz, Elektrotechn Zeit, June 25.
- Polarization of Thin Metallic Membranes—Lugin, Proc Lond Phys Soc, June.
- Polarization Phenomena in Electrostatic Fields—Lombardi, Elektrotechn Zeit, July 30. W Aug 22.
- Polarization, Rotary Magnetic—Cotton, L'Eclair Elec, July 25.
- Polarization—Streinitz, Electn, May 1. W May 23.
- POLE DECISION, An Important—St Ry Rev, July 15. 900 w.
- POLYPHASE Circuits, Measuring Power in—Guilbert, L'Eclair Elec, Aug 1.
- Polyphase Currents, Notes on—Gerard and Hanrad, Jour Inst Elec Eng, July. L'Eclair Elec, May 2.
- Polphase Mountain Railway up the Gornegrat at Zermatt—Electn, June 5. W June 27.
- Polyphase System of Ferraris and Arno—L'Eclair Elec, June 13.
- POOLING of Freight Equipment—R. Cavanaugh, Ry Age, July 31. 1900 w.
- PORCELAIN: How Beleck Ware is Made—Clay Rec, May 14. 1000 w.
- Porcelain Works at Meissen, The (III)—Sci Am Sup, Apr 4. 2200 w. M May.
- PORTSMOUTH, The New Docks at—Trans, June 19. 4200 w. M Aug.
- POTASSIUM, Platino-Cyanide—Sci Am, May 23. W May 30.
- POTENTIAL and Dielectric Constants, Measuring—Lombardi, Electn, June 26.
- Potential Arrester, Automatic (II)—Elec Eng, Lond, July 10. Elec Rev, Lond, July 10. W Aug 1.
- Potential Differences, Measurement of Very High—Abraham and Lemoine, Jour Inst Elec Eng, May. W June 13.
- PO, The Embankments of the River—Frank D. Adams, Science, May 22. 1500 w.
- POWDER, High Explosives and Smokeless—Hudson Maxim, Jour Soc of Arts, May 8. 5700 w.
- POTENTIOMETER (II)—Kollert, Elektrotechn Zeit, Apr 16.
- Potentiometer—Fisher, Electn, May 1. W May 23.
- Potentiometer, The Crompton—Fischer, Electn, June 26. W July 18.
- POWER at Rheinfelden, Transmission of—Rathenau, Elec Eng, Lond, July 17.
- Power by Wire Rope, The Transmission of—Wm. Hewitt, Eng News, May 7. 1200 w. M June.
- Power Development, Future of—Strong, West Elec, Sept 12.
- Power Factor, Practical Significance of the—Elec Rev, Lond, July 3.
- Power House, Economical Equipment Operating of—H. S. Newton, Lords Mag, April. 1800 w. M June.
- Power House, Foundations for a—George J. Loy, Eng's Yr Book, Univ of Minn. 1000 w. M July.
- Power House Performance—St Ry Rev, Apr 15. 800 w. M June.
- Power in Brick Yard and Foundry, Electric (II)—F. M. Tait, Elec Eng, Apr 22. 800 w. P June. M June.
- Power in Central Stations, The Economical Generation of—C. J. Field, Sib Jour of Engng, May. 2700 w. W June 27. M July.
- Power in Factories, Transmission of—J. J. Flather, W Elec, Apr 18. 1300 w. M June.
- Power in New England, Water—James Francis, Eng Rec, May 16. 2200 w. M July.
- Power of the Future, The—T. Frood, Can Eng, July. 1500 w. M Sept.
- Power Plant, An Interesting—Eng Rec, July 4. 800 w. M Aug.
- Power Plant at La Goule (II)—Brunswick, L'Eclair, Apr 11.
- Power Plant at North Tonawanda, Test of—Sib Jour, May.
- Power Plant at Pelzer, S. C., The (II)—Eng Rec, May 2. 2200 w. M June.

Mahn & Co..

MANUFACTURERS OF



Engineering,
Surveying and
Scientific Instruments.

No. 212, Locust Street,
ST. LOUIS, MO.

ILLUSTRATED CATALOGUE ON APPLICATION.

ESTABLISHED 1862.

WM. MUELLER & CO.,

DEALERS IN

Railroad Ties, Cedar Posts and Telegraph Poles.

1112 AND 1113 MARQUETTE BLDG,

YARDS:

LAFLIN SQ. OF 22D ST.
AND SPALDING, MICH.

DEARBORN AND ADAMS STS.:

CHICAGO.

The Canton Steel Roofing Co.,

CANTON, OHIO,

Manufactures a Complete Line of Architectural Sheet Metal Goods, Heavy Gauge Galvanized Pipe, Skylights, Copper Work, Graphite Paint, Etc.

The Snow Steam Pump Works,

Pumping Machinery for all Services. High Duty Engines
up to the Largest Capacities.

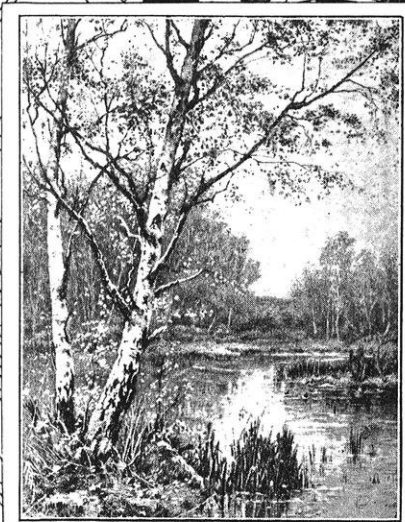
New York Office, 106 Liberty Street.
Philadelphia Office, 109 N. Third Street.
Boston Office, 8 Oliver Street.

BUFFALO, N. Y.

Please mention Wisconsin Engineer when you write.

- Power Plant, Gas-Engine—Elec Eng, Lond, May 1. W May 23.
- Power Plant of the City and Suburban Railway Co., Baltimore, Md. (III)—Power, July, 3500 w.
- Power Plant of the Staten Island Electric Railway—Elec Ry Gaz, Mar 14. P June.
- Power Required by Machines for Working Structural Steel at the Penroyal Iron Works, Electrical Tests of—Am Mach, May 21. 1200 w. M July.
- Power Required for Driving a Pipe-Thread Machine, a Boring Bar and a Roll-Turning Lathe—J. S. Cox, Am Mach, May 7. 250 w. M June.
- Power Station at Toulouse, The Bazacle—Elec, Lond, May 1. 1500 w. M July.
- Power Station Records at Philadelphia—Elec Ry J, Apr.
- Power Station Records at Trenton—Moore, St Ry J, Apr.
- Power Station, The Twenty-eighth Street—Elec Eng, May 6.
- Power Stations—See Storage Batteries.
- Power, The Manufacture of—Engng, July 21. 2890 w. M Sept.
- Power, The Mechanical Transmission of—W. E. Buck, Mech Wld, April 3. Serial Part 1. 2400 w. M June.
- Power, The Production of Steam and—W. Stagg, Gas Wld, May 2. 3600 w. M July.
- POWER TRANSMISSION (III)—Scott, Elec Eng, July 8.
- Power Transmission at Romagnano, Two-phase (III)—Electn, May 15. W June 6.
- Power Transmission in Workshops, Electric—Daniell Adamson, Prac Eng, Mch 20. 3090 w. P May. M May.
- Power Transmission of Fresno, Cal., The Thirty-five-mile Electrical (III)—Lord's Mag, July. 1400 w. M Aug.
- Power Transmission of Polyphase E. M. F.—G. W. Fraser, Can Elec News, July. 4500 w.
- PRATT Truss Highway Bridge, The Strain Sheet and Estimate of Cost for a—A. B. Loomis, Tech, May. 1700 w. M Aug.
- PRESSURE and current, A New Apparatus for Instantaneous Values of—M. Lutowski, Elektrotechn Zeit, Apr 2.
- Pressure, Regulation of—Electn, Apr 10. Elec Eng, Lond, Apr 10. W May 2.
- Pressures, Direct Graphic Determination of Initial, Terminal and Cut-off—C. M. Jones, Elec Eng, June. 2700 w. M Aug.
- PRINTING, Business, Fifty Years in the—Sci Am, July 25. 1700 w.
- Printing, Frames for Blue—Prac Eng, May 15. 800 w.
- PRINTING—L'Ind Elec, July 10.
- PRODUCER Gas and Gas Producers—A. H. Sexton, Prac Eng, June 26. Serial Part 1. 4500 w. M Aug.
- Producer Gas Applied to the Manufacture of Steel, Mond—John H. Darby, Min Jour, May 16. Serial Part 1. 2200 w. M July.
- Producer-Gas-Engine Electrical Plant, A—Albion T. Snell, Electn, May 22. 1700 w. W June 13. M July.
- Producer Gas, Regenerator Effects—Jno. E. Fry, Jr Age, July 2. 1060 w. M Aug.
- PROFILE CUTTERS, A Fixture for Grinding (III)—A. L. de Leeuw, Am Mach, May 21. 1300 w.
- PROGRESS During the Past 50 Years (III)—Sci Amer, July 25.
- PROJECTILES, Apparatus for the Speed of (III)—Sci Am, May 2. 1300 w. M June.
- Projectiles Inside of a Gun, Determining the Motion of—Crehore and Squier, Jour of the U S Artillery, Vol 5 No 3.
- Projectiles, Tests of Cast Steel—R R Gaz, Mch 13. 900 w. M May.
- PROJECTION That is Actually Used, The Method of—Louis Rouillion, Am Mach, Mch 19. 1000 w. M May.
- PROPELLOR Middleton, The Long Island Sound Passenger (III)—Sea, May 21. 600 w. M July.
- PUMP at the Lewiston Water-Works, The New (III)—Charles L. Newcomb, Eng Rec, Apr 4. 1400 w. M May.
- PUMP Cylinders, A Study of the Proper Method of Determining the Strength of—C. W. Kettell, Trans Am Soc Mech Eng, Vol XVII. 2200 w. M June.
- Pump, Duplex Mercurial Air (III)—Wood, Phil Mag, Apr. W May 16.
- Pump, Electric Fire (III)—L'Energie Elec, June 16. W July 25.
- PUMPING, Centrifugal—J. Richards, Eng News, July 2. 1200 w.
- Pumping Engine, Chestnut Hill Pumping Station, Boston, Mass., Record Making (III)—Power, Apr. 3200 w. M May.
- Pumping Mains, The Friction in Several—F. C. Coffin, Eng Rec, April 25. 2200 w. M June.
- Pumping Plant, An Electrical—Charles A. Hague, J N Eng Water Works, Mch. 7000 w. M May.
- Pumping Station, Allegheny City, Pa., New (III)—Fire & Water, Mch 21. 600 w. M May.
- Pumping Station, St. Louis, The Chain of Rocks (III)—Eng Rec, May 16. 1700 w.
- Pumping Station, The Queen Lane (III)—Eng Rec, June 6. 1200 w.
- Pump, Vacuum (III)—La Nature, Apr 25.
- Pump vs. Compressors for Shop Use—Am Eng & R R Jour, June, 1200 w.
- PURIFYING Material, Enrichment of—F. Auerbach, Pro Age, Apr 15. 1500 w. M June.
- Purifying Oil and Fat—Siegroth, Electrochem Zeit, June. W July 18.
- PYROMETERS and their Application—Gas Wld, April 2. 1700 w. M June.
- PYROMETRY and Thermo-Electric Formulas—Holman, Proc Am Acad, Vol 31. W May 16.
- PYROTHINE, Magnetic Properties of—Abt, J Inst Elec Eng, Apr.
- QUADRANT Electrometer, New Form of (III)—Dolzak and Nernst, Elektrochem Zeit, July 5. W Aug 1.
- QUARRY, The Cedar Valley (III)—Samuel Calvin Eng & Min Jour, June 9. 1400 w.
- QUARTZ and PLACER DEPOSITS in British Columbia—C. Clark, Eng & Min Jour, July 11. 2400 w.
- RACE Track of the National Cycle and Athletic Club at Manhattan Beach, L. I. (III)—Eng News, Mch 19. 2000 w. M May.
- RACING of Propellers, Preventing the—Elec Rev, Lond, July 31. W Aug 22.
- RADIANT Energy—N. W. Perry, Elec, Mar 18. P May. Elec, Apr 29.
- RADIATION, Anode (III)—Jones, J of Elec, Mar. W May 16.
- Radiation, Cathode (III)—Sanford, J of Elec, Mar.
- Radiation, Estimate of—Met Work, May 2. 1800 w. M June.
- Radiation, On a New Form of—Prof. W. K. Roentgen, Electn, Apr 24. Elec Wld, May 9. P June. 2000 w.
- Radiation, The X—Elec Rev, Lond, April 10. 2000 w. M June.
- RADIATIONS Emitted by Phosphorescent Bodies, Invisible—Becquerel, Elec Rev, July 15.
- RADIOGRAPH of an Infant—Imbert and Bertin-Sans, Rev Gen des Sc, June 30.
- RADIOGRAPHS—Imbert and Bertin-Sans, L'Ind Elec, May 25.
- Radiographs of Articles—Cosmos, April 18.
- Radiographs, Use of Non-Uniform Magnetic Fields in Connection with—Mestin, L'Eclair Elec, May 20.
- RADIOGRAPHY, A New Principle in—Rollins, Elec Rev, July 1. W July 11.
- Radiography, Dry Plates for—Ward, Sci Amer, June 27. W July 4.
- Radiography, Further Progress in—Oliver Lodge, Electn, Apr 10. 3700 w. M June.
- Radiography, Tesla Apparatus for (III)—Elec Rev, Aug 5.
- Radiography, Tesla's Latest Results in—Elec Rev, Mch 18. 1300 w. M May.
- RAGSTONE with Portland Cement, The Admixture of Kentish—Dr. W. Michaelis, Engng, June 5. 1400 w. M Aug.

THE ENGRAVING
 BOARDMAN COMPANY



Copper Halfstone
 and
 Zinc Etchers

Special Designs
 and
 Drawings



ILLUSTRATORS.

106-108 GRAND AVE.

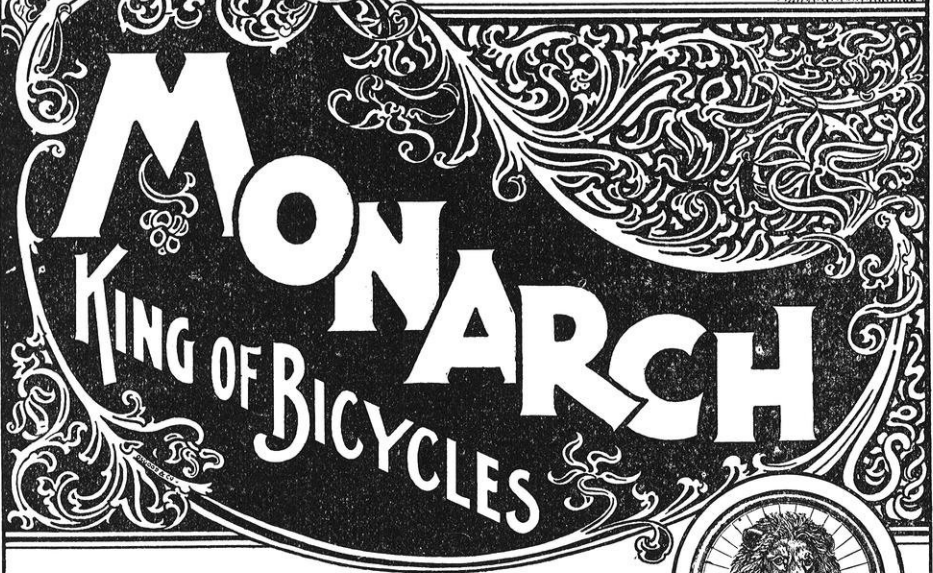
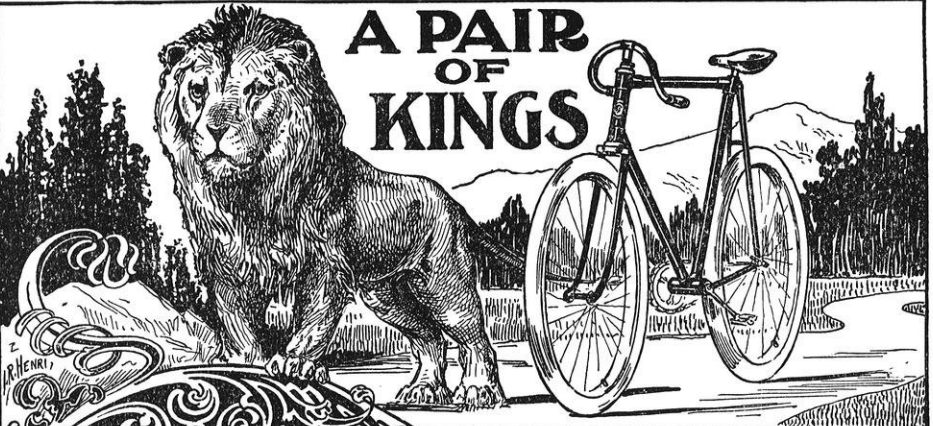
MILWAUKEE WIS.

TEL. 324.

Please mention Wisconsin Engineer when you write.

- RAIL Accident on an English Railway, a Broken—Ry Age, May 9. 1300 w.
- Rail, A New Tramway—Eng Rec, Mch 14. 400 w. M May.
- Rail Bonds, A New Method for Testing—H. P. Brown, St. Ry Rev, Apr 15. 600 w. M June.
- Rail Bonds, Test of—Electn, Mar 20. P June.
- Rail Cleaners for Electric Roads (III)—Die Elek, Mar 21.
- Rail Section, Some Difficulties in Designing—P. H. Dudley, R R Gaz, April 17. 800 w. M June.
- Rail Supports, Third—Ry Rev, May 9. 700 w. 800 w.
- Rail, The Minimum of a—R R Gaz, July 24. 1600 w.
- Rails Break, Why Do—A. R. V. Dormus, R R Gaz, May 8. 2400 w. M July.
- Rails for Common Roads, Steel—Eng News, May 7. 3200 w. M June.
- Rails on Curves, Lubricating—R R Gaz, Apr 3. 600 w. M May.
- Rails, Resistance Measurement of—Kallmann, Elec Zeit, May 21. W June 13.
- Rails, The McKenna Process of Renewing Steel—Robt. W. Hunt, Sib Jour of Engng, May. 3800 w. M July.
- RAILROAD Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines, Should a—Am Eng & R R Jour, June, 2000 w. M July.
- Railroad to Carry Express, Brooklyn Heights—St Ry Rev, May 15. 1000 w.
- Railroad Company, New Orleans, The System of the Orleans—St Ry Jour, Apr. 3800 w. P June. M May.
- Railroad Company, The System of the Staten Island Electric (III)—St Ry Jour, May. 3500 w.
- Railroad Commissioners, National Convention of—R R Gaz, May 29. 4800 w.
- Railroad Corporations in Practical Politics—Cyrus C. Warman, Eng Mag, Mch. 3500 w. M May.
- Railroad, Dayton-Miamisburg (III)—St Ry Rev, July 15.
- Railroad Enterprise in China—R R Gaz, Mch 20. 1600 w. M May.
- Railroad Ethics—H. D. Judson, Ry Rev, May 23. 4000 w.
- Railroad Expenditures for Improvements and Equipment—R R Gaz, May 22. 5600 w.
- Railroad Facilities of New Orleans, Development of the—E. Corthell, Mfr's Rec, July 17. 5800 w.
- Railroad From the Mountains to the Sea—Mfrs' Rec, July 3. 1800 w. M Aug.
- Railroad in the Republic of Colombia, The Construction of a Light Mountain—E. J. Chibas, Am Soc of Civ Engrs, May. 8500 w.
- Railroad Legislation in New York State—R R Gaz, June 5. 1600 w.
- Railroad Legislation, Necessary—Ry Rev, May 2. 1600 w.
- Railroad Management, The Fruits of Fraudulent—J. Selwin Tait, Eng Mag, June. 4300 w.
- Railroad Matters in England—W. M. Acworth, R R Gaz, May 15. 1400 w.
- Railroad Men, The World-Wide Field for American—H. S. Haines, R R Gaz, Apr 17. 1800 w. M June.
- Railroad New Orleans, The Electrical Equipment of the Orleans (III)—Elec Eng, Apr 1. 3000 w. M May.
- Railroad Pooling—M. Knapp, Ry Rev, July 25. Serial Part 1. 4000 w.
- Railroad Signals, History of Electric Locking of—V. Spicer, R R Gaz, May 15. 2200 w.
- Railroad, The Salt Lake and Mercur—W. P. Hardesty, Eng News, July 2. 1600 w.
- Railroad Work, Emergencies in—L. F. Lorce, R R Gaz, June 12. 3600 w. M Aug.
- Railroad Work, The Future of Electricity in—Dr. Louis Duncan, Jour Fr Inst, June. 5800 w.
- Railroads and Bridges (III)—Sci Am, July 25. 3200 w.
- Railroads, A Plea for the Little—C. O. Scranton, Ry Age, July 3. 2000 w. M Aug.
- Railroads, Conditions Affecting the Future of Our—Geo. B. Leighton, R R Gaz, Apr 10. 2200 w. M May.
- Railroads Good Investments? Are British—T. F. Woodlock, Eng Mag, May. 4700 w. M June.
- Railroads of Chicago, The Northwestern and the Union (III)—R R Gaz, May 1. Serial Part 1. 2800 w.
- Railroads of the World, Statistics of the—R R Gaz, July 10. 300 w.
- Railroads, The Future of Elevated—Eugene Klapp, Eng Mag, Apr. 2800 w. M May.
- RAILWAY, A Belgian Light—Ry Wld, June. 1100 w. M Aug.
- Railway Accident, The Snowdon Mountain—Trans, April 10. 1000 w.
- Railway and Harbor, Mallaig—See "Harbor."
- Railway and Its London Traffic, The Southern (III)—Engng, May 29. 1100 w.
- Railway Apparatus, Repair of Electric—W. E. Shepard, Am Electn, May 2. 200 w. M July.
- Railway, A Record Run from London to Paris—J. P. Pattison, R R Gaz, July 3. 800 w. M Aug.
- Railway at Budapest, Underground—Elec Rev, Lond, May 8. W May 30. Elec Tech, June 30. W July 29.
- Railway at Great Falls, Mont., An Electric Inclined—Eng News, Mch 26. 400 w. M May.
- Railway at Lugano, Switzerland, Three Phase Electric—St Ry Rev, July 15. 2000 w.
- Railway Cars, Gas Driven—Elec Rev, Lond, July 24.
- Railway, Central London—Electn, July 17. W Aug 8.
- Railway Clearing House, The English—R R Gaz, May 22. 1500 w.
- Railway Commission, The Work of the Texas State—Eng News, Apr 23. 1500 w. M July.
- Railway Company Must Complete Its Contract, The Street—Elec Ry Gaz, April 10. 200 w. M June.
- Railway Company, Statistics Lake Shore and Michigan Southern—Ry Rev, May 9. 1200 w.
- Railway Construction and for Manufacturing in China, Prospects of—Eng News, July 9. 1000 w. M Aug.
- Railway Construction, A Problem in Street—St Ry Rev, May 15. 1600 w.
- Railway Construction, Prospects for—Ry Age, April 25. 700 w.
- Railway Construction in Asia Minor—Trans, May 29. 1360 w.
- Railway Contacts, Overhead (III)—L'Eclair Elec, July 25.
- Railway Corporations—Ry Rev, May 23. 6000 w.
- Railway, Details of the Fast Run on an American—Eng, Lond, Mch 27. 1100 w. M May.
- Railway Development in Rhodesia—Trans, May 1. 1500 w.
- Railway Economics—Eng, Lond, Mch 13. 1500 w. M May.
- Railway, Electric vs. Steam—Ir and Coal Trs Rev, April 10. 1600 w. M June.
- Railway Employees to the Public, Relations of—Ry Age, May 9. 800 w.
- Railway Facts Going to Waste—G. S. Hodgins, R R Car Jour, June. 2500 w. M Aug.
- Railway Grade Crossings, Ohio State Law Regulating the Interlocking of—Eng News, July 2. 90 w.
- Railway History, A Forgotten Chapter in—G. A. Sekon, Mech Wld, Lond, Mch 20. 2300 w. M May.
- Railway Improvements at Chicago, Illinois Central (III)—Ry Age, May 23. 3500 w.
- Railway in the World, First Three Phase Electric—St Ry Rev, May 15. 450 w.
- Railway Line Between Washington and Mt. Vernon, High Speed—St Ry Jour, May. 700 w.
- Railway Master Mechanics' Assn, Annual Convention—Eng News, June 25. 2700 w. M Aug.
- Railway Matters in England—W. Acworth, R R Gaz, July 17. 1100 w.
- Railway Mechanical Departments, The Use of

A PAIR
OF
KINGS



RIDE A MONARCH
AND KEEP IN FRONT.



MONARCH CYCLE MFG. CO.
CHICAGO.
NEW-YORK. SAN-FRANCISCO. TORONTO.

- Graphical Methods in Keeping the Accounts of—Am Eng & R R Jour, June. 900 w.
- Railway Motors, A Suggestion for Testing Street (Ill)—George T. Blanchett, Elec Ry Gaz, Mch 14. 800 w. M May.
- Railway, Novel Seashore Electric (Ill)—St Ry Jour, May. 600 w.
- Railway of England, Accident on the Great Northern—Loc Engng, May. 200 w.
- Railway of India, The East Coast—Ind Engng, May 16. 1400 w. M Aug.
- Railway—Permanent Way—Eng, Lond, June 5. 2000 w.
- Railway Plant, Dublin Three-Phase (Ill)—Elec Eng, June 24.
- Railway Points and Signals, Hydraulic System for Working and Locking of (Ill)—Engng, Mch 6. 3300 w. M May.
- Railway, Pringle and Kent's Surface Rail Electric—Elec Rev, Lond, July 3. 2000 w.
- Railway Reforms, The Turning Point in—M. E. Ingalls, Eng Mag, July. 2700 w. M Aug.
- Railway Repair Accounts, Street—C. Uebelacker, Elec Wld, June 25. 2000 w.
- Railway Returns, Improved British—Bradstreet's, Mch 21. 500 w. M May.
- Railway Shop Plants, The Arrangement and Construction of—Eng News, July 23. 2500 w.
- Railway Shops, The Burnside of Illinois Central—Eng News, June 18. Serial Part 1. 3500 w. M Aug.
- Railway Signals in Switzerland—Electrotechn Zeit, July 30.
- Railway Statistics, European Electric—Ry Rev, May 9. 500 w.
- Railway System, A Surface Contact Street (Ill)—Elec Wld, Mch 28. 900 w. M May.
- Railway System, K A K Conduit Electric—W Elec, Apr 25. 800 w. M June.
- Railway System of Rouen, The Electric—St Ry Jour, Aug. 500 w.
- Railway System, The Johnson—Lundell—Elec Eng, June 24. 1800 w. M Aug.
- Railway, The Accident on the Snowdon (Ill)—Eng, Lond, April 10. 600 w.
- Railway, The Central London—Eng, Lond, July 10. 1600 w.
- Railway, The Chamounix—Sci Am Sup, May 16. 1600 w.
- Railway, The Dalmaur and Clydebank—Eng, Lond, June 5. 1300 w. M Aug.
- Railway, The Eastern End of the Great Siberian (Ill)—Loc Engng, July. 350 w.
- Railway, The Enlargement of Liverpool-Street Station: Great Eastern Railway—Eng, Lond, April 24. 3300 w.
- Railway, The Guatemala Northern—Eng News, July 2. 500 w.
- Railway, The Supreme Court Commission's Report on the New York Rapid Transit—Eng News, Mch 12. 3800 w. M May.
- Railway Transition Spiral on Old Railway Curves—A. U. Talbot, Tech, May. 1200 w. M Aug.
- Railway Up the Jungfrau, The (Ill)—Sci Am Sup, May 9. 500 w.
- Railway, Washington, Alexandria and Mount Vernon (Ill)—St Ry Rev, July 15.
- Railway Work, Electricity for—See Electricity.
- Railway Working, The Cost of—Ir & Coal Trs Rev, April 10. 1100 w. M July.
- Railway Workshops and Their Equipment—Ir & Coal Trs Rev, April 10. 2500 w. M June.
- Railway Yards and Terminals—T. Appleton, Eng News, July 9. 2000 w.
- Railway Yards and Terminals—W. L. Derr, Eng News, June 18. 1700 w. M Aug.
- Railway Yards, The Construction and Operation of—Eng News, June 18. 1700 w. M Aug.
- Railway—See also Elevated.
- Railway—See Electric.
- RAILWAYS Abroad, Notes on Light—Eng, Lond, April 10. Serial Part 1. 6000 w.
- Railways, A Union Terminal in Chicago's Electric—Eng News, July 16. 1100 w.
- Railways, Chicago's—Ry Age, April 25. 800 w.
- Railways in Asiatic Turkey—Eng, Lond, June 5. 2300 w. M Aug.
- Railways, Irish, and Their Purchase by the State—Ry Wld, May. 3600 w.
- Railways, Light—Builder, June 20. 2000 w. M Aug.
- Railways, Light: Their Advantage, Nature and Working—Ill Car & Build, April 3. 1100 w. M June.
- Railways, Louisville (Ky.) Terminal of the C. C. & St. Louis and the C. & O. (Ill)—Ry Rev, Mch 21. 1500 w. M May.
- Railways, Notes on Austrian and Italian—Ry Wld, Apr. 3700 w. M June.
- Railways of Cape Colony and Natal, The—Trans, May 29. 1400 w.
- Railways of India, Report on the—Ind Engng, July 4. Serial Part 1. 1300 w.
- Railways of India, The—Trans, July 24. 1100 w. July 31. 1800 w.
- Railways of Japan, The—Trans, April 24. 3000 w.
- Railways of Rhodesia, The—Trans, April 3. 200 w. M June.
- Railways of the United States for 1895, Abstracts and Statistics of the—8 An Statistical Rept. 2500 w.
- Railways of the World, Profile of the Principal Mountain—Eng News, Apr 9. 400 w. M June.
- Railways, Rapid Transit Street—R. D. Fisher, Elec Ry Gaz, May 10. 600 w.
- Railways, The Cubic Parabola as a Transition Curve for Street—J. Jenkins, Eng News, July 23. 500 w.
- Railways, The Design of Testing Stations for Street—St Ry Jour, Apr. 4500 w. M May.
- Railways, The North Wales & Liverpool—Trans, April 3. 2700 w. M June.
- Railways, The Survival of the Fittest, Street—Philip Dawson, Elec Rev, Lond, May 15. Serial Part 1. 2500 w.
- Railways, Twenty Years of—H. R. Hobart, Ry Age, June 13. 6200 w. M Aug.
- Railways, Two Years' Extension and Working of Belgium—Eng, Lond, July 3. 3000 w.
- RAIN Baths in America, The Introduction of Public—H. E. Fisk, San, June. 7500 w. M Aug.
- RAMBLER, A—Travels in Baltimore and Washington—Arch, July. 3800 w.
- RAMS, Hydraulic (Ill)—J. Richards, Eng & Min Jour, April 25. 2400 w. M June.
- RAY Effects, Influence of Temperature on X—T. A. Edison, Elec Eng, April 22. 500 w. M June.
- RAY Experiments, Apparatus and Fluoroscope, The Edison X (Ill)—Sci Am, Apr 4. 1100 w. M May.
- RAY Experiments, X—Falk, Elec Eng, Apr 29. W May 9.
- RAY Experiments, X—Ogden, Sci Am, June 13. W June 20.
- RAY "Focus" Tube, The New X (Ill)—Elec Rev, Lond, Mch 13. 700 w. M May.
- RAY Focus Tubes, X—Wood, Phil Mag, Apr.
- RAY in Sparks, New Kind of—Wiedemann, J Inst Elec Eng, Apr. W May 9.
- RAY Light, Edison X—Elec Rev, June 3. W June 13.
- RAY Light Tube, X—Elec Rev, May 27. W June 6.
- RAY Meter, X—Elec Eng, June 10. W June 20.
- RAY, Notes on the Nature of X—Goldhammer, J Inst Elec Eng, July.
- RAY, On the Source of the Roentgen—W. M. Stine, W Elec, Apr 4. 1100 w. M May.
- RAY Outfit, A Roentgen (Ill)—Am Electr, May. Serial Part 1. 3600 w.
- RAY Phenomena Due to Sound Waves, Are Roentgen—Thomas A. Edison, Elec Eng, Apr 8. 1300 w. M May.
- RAY Photographs With a Winshurst Machine, X—Rice, Elec Eng, Apr 22. W May 2.
- RAY, Professor Enrico Salvioni's Work on the X—Salvatore Cortesi, Elec Rev, Apr 8. 2500 w. M May.
- RAY Radiations, Tesla on X—Elec Rev, July 8. 900 w. M Aug. W July 18.
- RAY Source, The Roentgen—Elhu Thomson, Elec Eng, Apr 8. 700 w. P May. M May.
- RAY, The Source of the X—C. E. Scribner and F. R. M. Berty, Elec Eng, Apr 8. Elec Rev,

**FACTS THAT ENFORCE CONVICTION AND
CONFIDENCE.**

Lord's Boiler Compounds

ARE EXCLUSIVELY used by the U. S. Government, and 10 Foreign Navies and Engineering Departments.

ARE EXCLUSIVELY represented and largely sold in every civilized country on the globe; thus enjoying a world-wide reputation and demand.

ARE EXCLUSIVELY recommended in our best modern works on Steam-Engineering.

This unsurpassed library of fifty volumes may be attained as an out-right presentation by all patrons of LORD'S BOILER COMPOUNDS.

Theory Versus Practical Experience.

Recently many speculative theorists have advertised on the market numberless chemical specialties, such as,

TRI SODIUM PHOSPHATE—SODIUM TANNATE—SODIUM FLUORIDE, &c.

each specialist representing his favorite expedient as of unapproachable and surpassing merit.

PRACTICAL EXPERIENCE AND APPLIED CHEMISTRY refutes the extreme claims of these theorists, and while conceding the value of these reagents, yet establishes the truth that their specific values are only best attained when they are subject to intelligent application; their relative superiority when compared critically being entirely dependent upon the character of the feed-water used.

REMEMBER THAT THESE AND MANY OTHER EQUALLY VALUABLE REAGENTS, are invariably used in the formulation of LORD'S BOILER COMPOUNDS. Each compound sold under this trade mark being scientifically formulated to meet each variety of natural water used by our patrons.

AN ANALYTICAL DEPARTMENT CONDUCTED BY (3) THREE EXPERT WATER CHEMISTS, replete with the latest improved chemical apparatus is at the disposal of our patrons, and we are glad at all times to furnish analytical reports, and all other desired information.

WE RECITE AN EXPERIENCE OF 36 YEARS devoted exclusively to the chemical purification of natural waters; and think that our mature and successful career justly entitles us to your confidence exclusive of all competitors.

WE SHALL BE GLAD TO CORRESPOND WITH YOU and our best services are always at your disposal. Address all communications to

GEO. W. LORD,

**ANALYTICAL AND
MANUFACTURING
CHEMIST.**

**316 UNION STREET,
PHILADELPHIA, Pa.**

- Apr 8. Elc Wld, Apr 11. W Elec, Apr 4. 1800 w.
- Ray, The Surgical Value of the X—James Burry. W Elec, Apr 4. 1400 w. M May.
- Ray Tube, Colardeau's X (III)—Elec Eng, June 17.
- Ray Tube Phenomena, X—Gifford, Elec Eng, June 10. W June 20.
- Ray Tube, X—Smith, W Elec, July 25. W Aug 8.
- Ray Tube, X (III)—Elec Rev, Lond, July 17.
- RAYS, Action of Tubes and Metallic Discs on X—Villari, L'Ind Elec, July 25. L'Eclair Elec, Aug 1. W Aug 29.
- RAYS, Analysis of Vegetable Materials by Means of X—Ranwez, L'Ind Elec, Apr 25. W May 30.
- RAYS and Lamps Adapted to Produce Them, Ultra Violet—Herbert Cottrell, Elec Eng, Mch 11. 700 w. M May.
- RAYS and the New Photography, The X—Elec Rev, Lond, Mch 6. 2500 w. M May.
- RAYS, A Theory of the X—Albert A. Michelson, Am J of Sci, Apr. 1000 w. M May.
- RAYS, Behavior of Sugar Toward Roentgen—Ferdinand G. Wiechman, Science, May 15. 700 w.
- RAYS by a Platinum Mirror, on Rood's Demonstration of the Regular or Specular Reflection of the Roentgen—A. M. Meyer, Science, May 8. 600 w.
- RAYS by Means of Phosphorescent Zinc Sulphide, Increase of the Photographic Yield of the Roentgen—Charles Henry, Sci Am Sup, Apr 11. 1100 w. M May.
- RAYS, Crookes Tubes and Experiments with Roentgen—Thomas Duncan, Am Electn, May. 1500 w.
- RAYS, Deleterious Effects of X—Havens, Elec Eng, Aug 12. W Aug 22.
- RAYS, Diffraction of X—Bungetziano, L'Eclair Elec, Apr 25. W May 23.
- RAYS from Platinum, On the Reflection of Roentgen—Ogden N. Rood, Science, Mch 27. 700 w. M May.
- RAYS, Further Experiments with X—Edwin B. Frost, Science, Mch 27. 1300 w. M May.
- RAYS in Consumption, X—Elec Eng, July 22. W Aug 1.
- RAYS in Medical Diagnosis, X—Elec Eng, Aug 5. W Aug 15.
- RAYS in Medicine and Surgery, The X—Charles L. Norton, Science, May 15. 550 w.
- RAYS in Surgery, X—Greeno and Hornsby, Elec Jour, July 15. W Aug 15.
- RAYS, Nature of X—Goldhammer, Elek Zeit, May 21. W June 13.
- RAYS, Novel Experiments with X—Edward P. Thompson, Stev In, Apr. 900 w. M May.
- RAYS, Observations with, X—Argyropoulos, L'Ind. Elec, June 10.
- RAYS, Odylie Rays, X—O'Reilly, Elec Eng, July 8. W July 18.
- RAYS on Germinating Plants, Effects of X—Schober, Elec Eng, July 29. W Aug 8.
- RAYS on Germs, Effect of X—Schraeder, Elec Eng, Aug 19. W Aug 29.
- RAYS on Higher Animals, Action of X—Elec Eng, July 22. W Aug 1.
- RAYS on the Contact of Electricity of Metals, Effect of X—Murray, W May 16.
- RAYS, On the Sensitiveness of Certain Salts to the X—Thos. A. Edison, Elec Rev, Apr 1. 500 w. M May.
- RAYS Passing Through Chemical Solutions, Opaque Objects Made Transparent by—Elec Eng, Apr 1. 500 w. M May.
- RAYS, Phosphorescence and X—Campanile and Stromel, Elec Rev, Lond, June 5. W June 27.
- RAYS, Phosphorescence as the Source of X—Edward P. Thompson, Elec Eng, Apr 8. P May. 1700 w. M May.
- RAYS Produce a Discharge of Electrified Bodies, The Way in Which X—Villari, L'Ind Elec, July 25. L'Eclair Elec, Aug 1.
- RAYS, Recent Researches on the Roentgen (III)—M. Guillaume, Elec Rev, Lond, May 1. 2200 w.
- RAYS, Recent Work on the X—Pop Sc Mo, May. W May 16.
- RAYS, Recent Work with Roentgen—Nature, April 30. 5500 w.
- RAYS, Refraction and Diffraction of X—Gouy, L'Ind Elec, July 25. W Aug 29.
- RAYS, Refraction and Diffraction of X—Gouy, L'Eclair Elec, July 18.
- RAYS, Refraction of X—Gouy, L'Ind Elec, June 10. W July 4.
- RAYS, Researches on the Roentgen—Alfred M. Mayer, Am Jour of Sci, June. 3300 w. W June 27.
- RAYS, Roentgen (III)—Guillaume, La Nature, June 13. W Aug 1.
- RAYS, Roentgen—Phillip M. Jones, Min & Sci Pr, May 16. 2500 w.
- RAYS, Roentgen—D. W. Hering, Am Electn, May. 1600 w.
- RAYS, Roentgen—Henry Morton, Stev's In, Apr. 2400 w. M May.
- RAYS, Roentgen's—Sci Am Sup, Apr 4. 5400 w. M May.
- RAYS, Some Experiments with Roentgen—W. C. Peckham, Elec Wld, May 30. 600 w.
- RAYS, Some Experiments with Hittorf Tubes and Roentgen—Antonio Roiti, Electn, May 29. 3200 w. W June 20.
- RAYS, Source of X (III)—A. A. Michelson and S. W. Stratton, Science, May 8. 500 w.
- RAYS, Source of X—Stcherbakof, L'Ind Elec, June 10. W July 4.
- RAYS, Tesla on Reflected Roentgen—Elec Rev, Apr 1. 3000 w. M May.
- RAYS, The Roentgen—Edwin J. Houston and A. E. Kennelly, J Fr Inst, Apr. 14500 w. M May.
- RAYS, The Source of Roentgen (III)—Alexander Macfarlane, Elec Wld, May 16. 700 w.
- RAYS, The Character and Effects of Cathode—Wright, Forum, Apr.
- RAYS, Theory of the X—Goldhammer, Electn, May 1. W May 23.
- RAYS, Theories of Roentgen—W. M. Stine, Elec Wld, Mch 28. 1200 w. M May.
- RAYS, The Roentgen—J. J. Thomson, Nature, April 23. 2200 w.
- RAYS, The Surviving Hypothesis Concerning X—O. Lodge, Electn, July 17. 2800 w. W Aug 8.
- RAYS, The X—John Trowbridge, Pop Sci M, Apr. 2300 w. M May.
- RAYS, Traversing Ponderable Media, Properties of X—Maltezos, L'Ind Elec, June 10. W July 4.
- RAYS, X—Maltezos, Comptes Rendus, 122, p 1474, July 10. W Aug 1.
- RAYS, X—Electn, July 24. W Aug 15.
- REFLECTORS at the Senate House, Calcutta, Paraboloid Sound—Ind Engng, March 21. 900 w. M June.
- REFRACTORY Material—Am Mfr & Ir Wld, June 19. 800 w. M Aug.
- REFRIGERATING Plant, Test of a—E. L. Spencer and A. W. Wreckoff, Sib Jour of Engng, May. 1200 w. M July.
- REFRIGERATION, Artificial—G. Richmond, Power, Apr. 4500 w. M May.
- RELAY Resistance, Reduction of—W. J. Fry, Paper Assn Ry Tel Supts. Elec Rev, June 24. 1200 w.
- "REXOWN," H. M. S.—Engng, April 10. 1800 w. M June.
- REPEATER, Horton's Telegraph (III)—Elec Eng, Apr 1. Elec Rev, Apr 1. 1000 w. P May. M May.
- REPORTS of the Lake Shore & the Michigan Central R. R.—R R Gaz, May 15. 800 w.
- RESERVOIR at Indio, Cal., A Small Asphalt Lined—Eng News, July 16. 600 w.
- Reservoir Dams with Iron Sheeting—Thomas Thomson, Eng, Lond, May 8. 1800 w. M July.
- Reservoir Linings at Philadelphia, Specifications for Asphalt—Eng News, Mch 12. 1400 w. M May.
- Reservoir, Queen Lane, Philadelphia (III)—Eng Rec, Mch 14. 2200 w. M May.
- Reservoir, Yonker, N. Y., The Fort Field (III)—Eng Rec, July 25. 800 w.
- RESERVOIRS, Discharge Tunnels from—J. Paskin, Eng, Lond, July 21. 2200 w.

Auxiliary Publishers.

Book Publishers.

Job Printers.

Blank Book Manufacturers.

Stereotypers.

Democrat Printing Company,

114-124 South Carroll Street,

Madison, Wisconsin.

The Wisconsin Engineer

Contains the Only Alphabetically Arranged Index
of Current Engineering Literature now Published. As an aid
to reference it will be found invaluable to all engineers.

The Magazine also Contains Valuable
Articles on Engineering Subjects

that will be found of special interest. The Magazine is
issued quarterly by the University of Wisconsin Engineering
Journal Publishing Association.

Madison, Wisconsin.

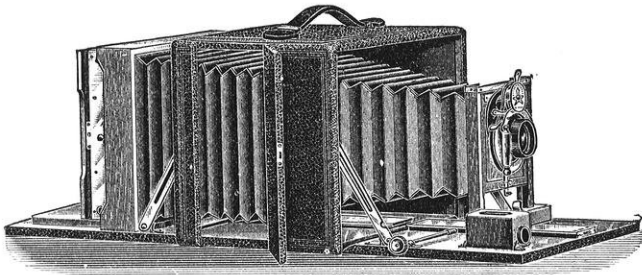
Please mention Wisconsin Engineer when you write.

- Reservoirs—See Water Works.
- RESISTANCE Box—Griffiths, *Elec Eng*, Lond, and *Elec Rev*, June 19. W July 11.
- Resistance Detector for Rail Joints—*Elec Eng*, July 1. W July 11.
- Resistance Due to Electric Rays, Change of—Aschkinass, *Electn*, Apr 24.
- Resistance, Graphic Calculation of Regulator (III)—Stadelmann, *Elektrotechn Zeit*, July 23. W Aug 15.
- Resistance in Absolute Measurements, The Determination of (III)—*Elec Rev*, Lond, July 10. 1800 w.
- Resistance, Measurement of—N. Harrison, *Elec Age*, Mar 14.
- Resistance Measurements, High—Grosselein, *L'Eclair Elec*, June 13. W July 18.
- Resistance, Measurement of High—Picou, *Bul Soc Int des Elec*, May.
- Resistance, Measurement of High—Benecke, *Elec*, June 10. W June 20.
- Resistance, Negative—S. P. Thompson, *Electn*, July 24. W Aug 15.
- RESIDUALS, Notes on—Charles Hunt, *Gas Wld*, May 16. 6400 w.
- RESISTANCE of Alloys, Electrical—Rayleigh *Lond Elec*, June 26.
- Resistance of Bismuth—*Electn*, June 12. W July 4.
- Resistance of Conductors—See Alternating Currents.
- Resistance of the Body, On the Negative Electrical—S. P. Thompson, *Electn*, July 3. 3500 w. W Sept.
- Resistance of the Human Body—Monmerque, *L'Eclair Elec*, May 23. W June 27.
- Resistance, True—Appleyard, *Electn*, July 24. W Aug 15.
- RESTAURANT de Luxe, A (III)—*Arch*, June 12. 800 w. M Aug.
- RETARDERS in Fire Tubes of Steam Boilers, The Effect of—J. W. Whitham, *Trans Am Inst Mech Eng*, Vol XVII. 1300 w. M June.
- RETURN Currents from Railways—Blondel, *L'Eclair Elec*, July 18. W Aug 22.
- REVENUE Cutter No. 3, United States (III)—*Am Mach*, May 7. 1600 w. M June.
- RHEOSTAT, The Elementary Principles of the—William Barter, Jr., *Elec Ry Gaz*, April 25. Serial Part I. 2000 w. M June.
- RIVERS and Canals and How They Serve Their Purposes—S. F. V. Harcourt, *Trans*, July 17. 3000 w.
- RIVER Navigation by Contract, The Proposal to Improve Mississippi—*Eng News*, April 16. 900 w. M June.
- River Regulation by Suspended Fascines in Bavaria (III)—*Eng*, Lond, *Mch* 27. 2500 w. M May.
- RICE Cultures in Southwestern Louisiana—H. H. Childers, *Sci Am*, May 9. 1200 w.
- RINGS Under Various Conditions of Loading, Stresses and Deflections in Circular—*Tr Assn Civ Eng*s Cornell Univ.
- ROAD Carriage Competition, The "Engineer" 1100 Guinea—*Eng*, Lond, April 17. 3000 w. M June.
- Road Motor—See "Motor."
- ROADS of Illinois, Wagon—P. C. Knight III *Soc of Eng*s & Surv—II *An Rept*. 900 w.
- Roads of Wisconsin—G. H. Burgess and J. J. Monahan, *Wis Eng*, June. 1700 w.
- Roads, Pleasure Resort—St Ry *Rev*, April 15. 3000 w. M June.
- ROCKS and Building Stone—Dr. A. P. Coleman, *Stone*, June. 1600 w. M Aug.
- ROCKER, Electrical Trevelyan—Appleyard, *Electn*, June 5. W June 27.
- Rocker, Electrical Trevelyan (III)—Vaughton, *Electn*, May 29. W June 20.
- ROCKS, Rapid Station Work in Horizontal—M. Campbell, *Trans Am Inst of Min Eng*s. July. 5400 w.
- ROCK RIVER and Merrimac Bridges (III)—*Eng News*, July 9. 1600 w. M Aug.
- ROENTGEN, An Interview with—H. J. W. Dam, *Elec Rev*, Apr 1. P May.
- Roentgen's Discovery and the Invisible World Around Us, Professor—J. F. Bixby, *Arena*, May. 6800 w. M June.
- ROENTGEN PHOTOGRAPH of a Whole Human Body—*Elek Anz*, June 25.
- Roentgen Pictures, Stereoscopic—Elihu Thomson, *Elec Eng*, *Mch* 11. 500 w. P May. M May.
- Roentgen Radiance Germicidal? Is the—*Elec*, Apr 22. W May 2.
- ROENTGEN RADIATION—Porter, *Lond Elec Eng*, June 26. W July 18.
- Roentgen Radiations—*Elec Eng*, Lond, May 1. W May 23.
- Roentgen Radiations, Tesla on—*Elec Rev*, Apr 8. 2600 w. M May.
- ROENTGEN RAY Air-Wave Theory—E. P. Thompson, *Elec Eng*, Apr 22. W May 2.
- Roentgen Ray Experiments—Swinton, *Electn*, June 12. W July 4.
- Roentgen Ray Experiments—O. J. Lodge, *Electn*, June 5. 1500 w. W June 27.
- Roentgen Ray Images, Stereoscopic—Mach, *Zeit f Elek*, June 1. W June 27.
- Roentgen Ray Investigation, Tesla's Latest—*Elec Rev*, April 22. 4500 w. M June. W May 2.
- Roentgen Ray, Kinematics of the—W. M. Stine, *Elec Eng*, April 22. 1300 w. M June. W May 2.
- Roentgen Ray Literature—*J Inst Elec Eng*, June. *Proc Lond Phys Soc*, June.
- Roentgen Ray Nomenclature—*Elec Wld*, Apr 4. P May.
- Roentgen Ray, On the Source of—W. M. Stine, *Elec Eng*, Apr 8. P May.
- Roentgen Ray Phenomena Due to Sound Waves? Are—W. A. Anthony, *Elec Eng*, April 15. 1800 w. M June.
- Roentgen Ray Photography—Raveau, *Rev Gen des Sc*, Apr 30. W June 13.
- Roentgen Ray Photographs, Reducing the Time of Exposure for—Meslin, *Rev Gen des Sc*, Apr 30. W June 13.
- Roentgen-Ray Picture of the Chest and Shoulder—Morton, *Elec Eng*, June 17. W June 27.
- Roentgen Ray, Proposed Standard Tube for Producing—Elihu Thomson, *Elec Rev*, Apr 15. *Elec Wld*, Apr 11. *Elec Eng*, Apr 15. P May.
- Roentgen Rays—S. P. Thompson, *L'Eclair Elec*, Apr 18. W May 9.
- Roentgen Rays—Chabot, *L'Eclair Elec*, Apr 11. W May 9.
- Roentgen Rays—Max Osterberg, *Elec Eng*, *Mch* 25. 2800 w. P May. *Elec Rev*, Apr 1. *Elec*, Mar 25. M May. *Elec Pow*, Apr.
- Roentgen Rays—Morton, *Elec Eng*, Apr 29. W May 9.
- Roentgen Rays—S. P. Thomson, *Elec Eng* Lond, and *Elec Rev*, June 19. W July 6 & 11. *Electn*, May 15.
- Roentgen Rays—Hurmuzescu and Benoist, *L'Elec*, Apr 25. W May 16.
- Roentgen Rays—Sahuika, *Elektrochem Zeit*, Apr 15. W May 23.
- Roentgen Rays—Röthi, *Proc Lond Phys Soc*, July. W Aug 29.
- Roentgen Rays—Barr, *Electn*, May 1. W May 23.
- Roentgen Rays—Klingenberg, *Elektrotechn Zeit*, Apr 2. W May 2.
- Roentgen Rays—*Elec Rev*, Lond, 1500 w. May 29. June 12. W May 2. 9. 16. 30. June 6, 13. *Elec Rev*, May 20, 27. M Aug. *Electn*, Apr 10, 24. May 15. *Proc Lond Phys Soc*, Apr. *L'Elec*, May 16. *L'Ind Elec*, Apr 10, 25. *Elec Eng*, May 13. W Aug 22. *Electn*, July 31.
- Roentgen Rays—See also Rays, and Cathode.
- Roentgen Rays, "Anodic" not "Cathodic"—Elihu Thomson, *Elec Eng*, *Mch* 25. 1300 w. P May. M May.
- Roentgen Rays and Ultra-Violet Light on Electric Sparks, Action of—Sella and Majorana, *Elec Eng*, June 10. W June 20.
- Roentgen Rays and Optically Active Substances—Frank Dana, *Elec Eng*, July 8. W July 18.
- Roentgen Rays, A Theory as to Cause of Phenomena Produced by—R. C. Shettle, *Elec Eng*, Lond, June 5. 1500 w. M Aug.
- Roentgen Rays at Low Temperatures—Bleekrode, *Elec Rev*, Lond, June 12. W July 4.

Photographic . .

Supplies and Apparatus.

CAMERAS and KODAKS OF ALL KINDS AT Special Prices.



Treleaven Optical Co.,

82 State Street, Chicago.

KUHLO & ELLERBE,



Engineering
Instruments.



Solid Silver Circles.
Aluminum Standards.

Our Instruments embody every late improvement of practical value. * * * * *



Draughtsmen's Supplies

Of every description.

156 E. Third Street,
St. Paul, Minn.

VAN VELZER &
SLICHTER'S

University Algebra, 732 p. \$2.00
School Algebra, - 1.00
Four Place Logarithmic Table .30

VAN VELZER &
SHUTT'S

Plane and Solid
Suggestive Geometry \$1.25
Plane Suggestive Geometry .75
Solid Suggestive Geometry .75

TRACY, GIBBS & CO.,
Publishers.
Madison, Wis.

Please mention Wisconsin Engineer when you write.

- Roentgen Rays, Best Conditions for Using—Salvioni, *Elec Rev*, Lond, Apr 24. W May 16.
- Roentgen Rays by a Magnet, Deflecting—Lafay, *L'Ind Elec*, Apr 10. *L'Eclair Elec*, Apr 18. W May 9.
- Roentgen Rays by Chemical Compounds, Absorption of—Novak and Sulc, *Am Jour of Sci*, June. W June 27.
- Roentgen Rays, Chemical Action of—Zickler, *Elektrotechn Zeit*, Apr 9. W May 2.
- Roentgen Rays, Determining the Velocity of—Muras, *Elec Rev*, Lond, Apr 24. W May 16.
- Roentgen Rays, Diffraction of—Calmette and Lhuillier, *Elec Eng*, July 22. *L'Ind Elec*, May 10.
- Roentgen Rays, Diffusion and Opalescence with—Elihu Thompson, *Elec Wld*, Apr 25. P June. *Elec Rev*, Apr 22. 900 w. M June.
- Roentgen Rays, Diffusive Reflection of—M. I. Pupin, *Science*, April 10. 3500 w. M June. *Elec*, Apr 15. P June.
- Roentgen Rays, Edison's Researches on—E. J. Houston and A. E. Kennelly, *Elec Eng*, Mar 18. P May.
- Roentgen Rays; Electricity a Mode of Motion. What Are They?—Sydney F. Walker, *Elec Eng*, Lond, Mch 13. 1300 w. M May.
- Roentgen Rays Experiments, Edison's—Edwin J. Houston and A. E. Kennelly, *Elec Wld*, Mch 21. 1300 w. M May.
- Roentgen Rays, Experiments on—Porter, *Elec Eng*, July 15. W July 25.
- Roentgen Rays, Experiments Showing the Permeability of Metallic Salts and Their Solutions by (III)—J. F. Smith, *W Elec*, June 27. 200 w. W July 11.
- Roentgen Rays, Experiments with—Thomas A. Edison, *Elec Eng*, Mch 25. 600 w. *Elec Rev*, Apr 1. M May. P May.
- Roentgen Rays, Experiments with (III)—Alexander Macfarlane, *Elec Wld*, Mch 14. 1000 w. M May.
- Roentgen Rays, Fluorescent Screen for—Leick, *Elektrotechn Zeit*, Apr 2. W May 2.
- Roentgen Rays for Analyzing Vegetable Matter—Rauwez, *Elec Eng*, July 22. W Aug 1.
- Roentgen Rays for Photographic Purposes, Concentrated—Bunner, *Elektrotechn Zeit*, June 11. W July 11.
- Roentgen Rays from Polished Metallic Surfaces, Regular or Specular Reflection of—Rood, *Am J of Sc*.
- Roentgen Rays from the Anode Terminal—Elihu Thomson, *Elec Eng*, Mch 18. *Elec Rev*, March 26. 700 w. P May. M May.
- Roentgen Rays in Tubes Containing Rarified Oxygen—Arno, *Elec Rev*, Lond, May 29. W June 20.
- Roentgen Rays, Luminescence of Solid Bodies and the Action of—Arnold, *Zeit f Electrochem*, May 5. W June 6.
- Roentgen Rays, New Form of Crookes Tube for—Colardeau, *L'Ind Elec*, July 10. *L'Eclair* July 18. W Aug 8.
- Roentgen Rays, Notes on—H. A. Rowland, N. R. Carmichael and L. J. Breggs, *Elec Wld* April 25. 1000 w. M June.
- Roentgen Rays not Present in Sun Light—M. C. Lea, *Am Jour of Sci*, May. 700 w. M June. W May 16.
- Roentgen Rays, On—G. Klingenberg, *Elec Eng*, Lond, Apr 3. P June.
- Roentgen Rays on Bromide of Silver, Electrochemical Action of—Streinitz, *L'Eclair Elec*, May 9. W June 13.
- Roentgen Rays on Diphtheretical Bacilli—Berton, *L'Ind Elec*, July 25. *L'Eclair Elec*, Aug 1.
- Roentgen Rays on Germinating Plants, An Investigation with—H. J. Webber, *Science*, June 26. 500 w.
- Roentgen Rays on Silver Bromide, Electrochemical Action—Streinitz, *Phil Mag*, May. W May 23.
- Roentgen Rays on the Radiometer, Action of—Fontana and Umani, *Proc Lond Phys Soc*, July. W Aug 29.
- Roentgen Rays, On the Reflection of—O. M. Rood, *Elec Wld*, May 9. 600 w.
- Roentgen Rays, Origin of—Perrin, *L'Ind Elec*, Apr 30. W May 9.
- Roentgen Rays, Photographic Action of—Maurain, *L'Eclair Elec*, June 20.
- Roentgen Rays, Photometer for—Meslin, *Elec Eng*, July 8.
- Roentgen Rays, Properties of—Galitzine and Karnojitzky, *L'Ind Elec*, Apr 10. W May 9.
- Roentgen Rays, Proposed Standard Tube for Producing (III)—Elihu Thompson, *Elec Rev*, Apr 15. 500 w. M June.
- Roentgen Rays, Recent Work with—*Am Jour of Sc*, June. W June 27.
- Roentgen Rays, Reducing the Time of Exposure with—*L'Ind Elec*, Apr 10. W May 9.
- Roentgen Rays, Some Experiments with—J. Burke, *Electn*, July 17. 1800 w.
- Roentgen Rays, Tesla on (III)—Nikola Tesla, *Elec Rev*, Mch 11. 2500 w. P May. M May.
- Roentgen Rays, The—J. Thompson, *Nature*, July 30. 6000 w.
- Roentgen Rays, The—Henry Morton, *Engng*, April 17. 2800 w. M June.
- Roentgen Rays, The Source of—C. L. Cary, J. N. Le Conte, and R. W. Lothman, *Elec Wld*, Apr 18.
- Roentgen Rays, The Sources of the—C. I. Cory, J. N. Le Conte and R. W. Lohman, *Elec Wld*, April 18. 2200 w. M June.
- Roentgen Rays, Tubes for—Boas, *Proc Lond Phys Soc*, July.
- Roentgen Rays Under Novel Conditions, Producing—E. W. Rice, Jr., *Elec Wld*, April 18. 900 w. M June.
- Roentgen Rays, Velocity of—Sella and Majorana, *Proc Lond Phys Soc*, July. W Aug 29.
- Roentgen Rays, Visibility of—*Elec Eng*, Lond, May 15. W June 6.
- Roentgen-Ray Tubes—Shallenberger, *Amer Elec Eng*, June. July 11.
- Roentgen-Ray Tubes—Koenig, *L'Ind Elec*, June 10.
- Roentgen Ray Tubes (III)—Chaband and Hurmuzescu, *L'Ind Elec*, May. W June 20.
- Roentgen Ray Tubes—E. Thompson, *Am Electn*, July. 800 w. W Aug 1.
- Roentgen Ray Tubes (III)—*Elektrotechn Zeit*, June 4. W June 27.
- Roentgen Ray Tubes (III)—Colardeau, *L'Eclair Elec*, July 18.
- Roentgen Ray Tubes, Examining the Action of—Mance, *Elec Rev*, Lond, June 12. W July 4.
- Roentgen Ray Tube, On the Best Shape for the—W. M. Stine, *W Elec*, April 18. 600 w. M June.
- Roentgen Ray Tube, Roiti's (III)—*Electn*, July 31. W Aug 22. *Elec Jour*, Aug 15.
- Roentgen Ray Tube, Small—Colardeau, *L'Eclair Elec*, Apr 25. W May 23.
- Roentgen Tubes (III)—Goenig, *Elek Zeit*, May 14.
- Roentgen, Wilhelm—*Elec Jour*, May 15.
- ROENTGEN X-RAYS, The Effect of, on the Contact Electricity of Metals—James R. Erskine Murray, *Electn*, April 24. 1200 w.
- Roentgen X-Rays on the Contact Electricity of Metals, On the Effect of the—J. R. E. Murray, *Electn*, Apr 24. P June.
- ROKEBY Gold Mining Company, Gippsland—Aust Min Stand, June 4. 1200 w.
- ROLLED STEEL, Recent Changes in Structural Shapes of—F. E. Kidder, *Arch & Builder*, July 25. 800 w.
- ROLLING MILL MACHINERY, Electrical Tests of Power Consumed by—E. H. Wise, *Am Mach*, June 25. 1400 w. M Aug.
- ROLLING MILL of the Pittsburg Reduction Co., New Kensington, Pa., The New—*Eng News*, April 9. 1100 w. M June.
- ROLLING MILLS, English and American—*Engng*, May 15. 1800 w. M July.
- Rolling Mills, Remarks on Iron and Steel—John T. Brassington, *Ir & St Trs Jour*, Apr 25. Serial Part 1. 1300 w. M July.
- ROLLING of Ships, The Non-Uniform—*Engng*, April 4. Serial Part 1. 3000 w. M June.
- ROLLING STOCK Details, Diversity of—*Loc Engng*, July. 900 w.
- Rolling Stock, Maintenance of (III)—C. E.

An Accident Policy in 

**THE
STAR ACCIDENT
COMPANY**

 OF CHICAGO, ILL.,

Is the best Accident Insurance in the land because the policy contract is free from technicalities—a simple contract understood by everyone. It has paid over \$650,000.00 for accidental injuries.

For circulars relative to our \$10,000.00 Combination Incontestable Policy, address,

T. S. QUINCEY, Sec'y,
Star Accident Insurance Bldg.,
Chicago.

THE LAWRENCE CEMENT CO.,

MANUFACTURERS OF 

“HOFFMAN” Rosendale
Cement.

M. ALBERT SCULL,
MARION S. ACKERMAN,
GEN'L SALES AGENTS. }

Sales Office:
NO. 1 BROADWAY,
New York City. }

{ EARNEST R. ACKERMAN,
PRESIDENT.

WATER-WORKS FILTRATION

Pressure and Gravity Filter Plants.

Capacity Unlimited.

Results Guaranteed.



WESTERN FILTER COMPANY,
UNION TRUST BUILDING, ST. LOUIS, MO.

Please mention Wisconsin Engineer when you write.

- Ubelacker, Elec Ry Gaz, April 10. 2300 w. M June.
- Rolling Stock, The Construction and Supply of—Ir & Coal Trs Rev, April 10. 1200 w. M June.
- Roman Country House, The—A. D. F. Hamlin, Arch Rev, Vol IV No II. Serial Part I. 2800 w. M July.
- ROMANESQUE Architecture—G. C. Miller, Tech, May, 4800 w. M Aug.
- ROOFING, Tile (III)—Max A. Th. Boehncke, Brick, Apr, 1800 w. M May.
- ROPE DRIVING, Notes on—A. Combe, Ind & Ir, July 31. 2000 w.
- Rope-Driving Practice—W. H. Booth, Am Mach, Mch 12. 1500 w. M May.
- Rope Driving, Some Notes on—Elec Rev, Lond, July 10. 1500 w.
- ROPES, Wire Mining—J. Bucknall-Smith, Min Jour, June 6. Serial Part I. 1500 w.
- ROEEN Electric Railway (III)—L'Ind Elec, Apr 15.
- RUBBER, Artificial Legs and Arms of—Gustav Heinsohn, Ind Rub Wld May 10. 2000 w.
- RUBBER Country, Rivers of the South American—Haythorne Hill, Ind Rub Wld, Apr 10. 1000 w. M May.
- Rubber District, Changes in the New York—Ind Rub Wld, Apr 10. 1000 w. M May.
- Rubber Footwear, Shoe Lasts and Shoe Trees for—Ind Rub Wld, May 10. 2500 w.
- Rubber Industry in New Brunswick, New Jersey, History of the—T. Warren, Ind Rub Wld, Aug 10. 1500 w.
- Rubber Prices and the Insulated-Wire Trade—Ind Rub Wld, July 10. 1400 w.
- Rubber Situation in Madagascar, The—Ind Rub Wld, May 10. 1300 w.
- Rubber, The Difference Between Islands and Upriver—Ind Rub Wld, July 10. 1500 w. M Aug.
- Rubber Trade in Chicago, Condition of the—Ind Rub Wld, Apr 10. 2500 w. M May.
- RUBY Mines—See "Mines."
- RUSTLESS Coatings for Iron and Steel—Wood, Tr A S M E, 1895. W May 23.
- SAFETY Appliance Act and Automatic Couplers—Edit, Ry Mas Mech, June, 1000 w.
- Safety Appliances in Railway Equipment, Progress in Adopting—E. E. Moseley, R R Car Jour, June, 1200 w. M Aug.
- SAINT Pierre-ès-Liens, The Ancient Cathedral of Geneva—Louis Viollier and Laurence Harvey, Jour Roy Inst of Brit Arch, March 19. 13500 w. M June.
- SALISBURY Close (III)—A. B. Bibb, Am Arch, July 11. 1300 w.
- SALT Making—R. G. Collier, Tradesman, June 15. 3700 w.
- Salt Water Drippings, Injury Caused by—Pro Cent Ry Club, Mar. 3000 w. M June.
- SAND House at Argentine, Kansas, Further Details of (III)—Ry Mas Mech, Apr. 150 w. M May.
- Sand-Sifting Machine (III)—J. L. Klindworth, Am Mach, July, 250 w.
- SANDSTONES, The General Properties of—T. C. Hopkins, Stone, July, 2500 w.
- SANITARY Condition of Boston Schools, Report of—Eng Rec, Mch 28. 1600 w. M May.
- Sanitary Engineering and State Boards of Health—J. Harman, III Soc of Eng & Surv, 11 An Rept. 6500 w.
- Sanitary Science, Practical—W. H. Maxwell, San Rec, July 3. 2500 w.
- Sanitary Schools (III)—Dom Eng, June, 1900 w. M Aug.
- SAPPHIRE Mines—See "Mines."
- SCALE, On Determination of the Division Errors of a Straight—Jarold Jacoby, Am Jour of Sci, May, 3400 w. M June.
- SCAVENGING Disposal of Refuse—Charles Mason, San Rec, May 8. 1700 w. M July.
- SCITAGRAPHIC Experiments—W. M. Stine, Elec Eng, Mch 11. 2500 w. M May. P May.
- SCITAGRAPH of Sheep's Brain—W Elec, Mch 28. 500 w. M May.
- SCIENCE and Engineering—T. C. Clarke, Sci Am Sup, July 4. 3500 w. M Aug.
- SCHOOL House, The Model—R. L. Jones, So Arch, May, 3000 w. M July.
- SCHOONER, A Notable Clyde Built (III)—Eng, Lond, April 24. 900 w. M June.
- SCREENS in Devonshire Churches—Past and Present, Road and—Harry Hems, Brit Arch, Apr 24. 9500 w. M June.
- SCREW Steamers, Steam Pumping Arrangements in (III)—Eng, Lond, July 31. Serial Part I. 2300 w.
- SEARCHLIGHTS at Sea, Method of Making a Steady Platform (II)—Tower, Elec Eng, Lond, May 8. W May 30.
- Searchlights in Sea-Coast Defense, Electrical—John T. Thompson, Elec Engng, Mch. 1200 w. M May.
- SEA MILLS of Cephalonia, The—Crosby, Tech Quar, March, 7500 w.
- SEASHORE Electric Railway (III)—Cassier's Mag, July.
- SEA, The Rule of the Road at—Trans, May 1. 1500 w. M July.
- SEATING Machine, Staybolt—J. Randol, Loc Engng, Aug, 2000 w.
- SECOHMMETER, Application of—Heinke, Elektrotechn Zeit, July 30. Aug 6.
- SECTIONAL Contact System—Elec & Gaz, June 10. W June 27.
- SECTIONAL Contact Rail System—Lond Engng, June 19. W July 18.
- SEEING—See Electricity.
- SEINE, The New Bridge Over the—Engng, June 12. Serial Part I. 2200 w. M Aug.
- SEISMOGRAPH—See "Meters, Vibration."
- SELBY Abbey (III)—Builder, July 4. 2500 w.
- SELF-HELPS—C. H. Blackwell, Am Arch, July 11. 2500 w.
- SELF-Induction and Capacity—Elec Rev, Lond, Apr 17. P June.
- Self-Induction in the Armatures of Alternators—Beneschke, Elektrotechn Zeit, June 18. W July 18.
- Self-Induction, New Method of Measuring—Dr. Hugo Andriessen, Elektrotechn Zeit, Mar 12. P May.
- SEPARATORS, Tests of Centrifugal Steam (II)—A. W. Richter, Wis Eng, June, 3000 w.
- SEPTA—See Electrolytes.
- SEPIOLITE—R. Helmbacker, Eng & Min Jour, July 25. 2000 w.
- SEWAGE and Refuse, The Disposal of—San Rec, Mch 20. 1200 w. M May.
- SEWAGE-Disposal Plant, The Vassar College (II)—Eng Rec, June 27. 2400 w.
- Sewage Disposal Plant, A Small—Eng Rec, May 9. 450 w. M June.
- Sewage-Disposal Works, The Bristol, Conn.—Eng Rec, June 13. 400 w. M Aug.
- Sewage, For Country Houses—Geo. E. Waring, Dom Engng, July, 3500 w.
- Sewage Filter Beds at Waterloo, Ont. (III)—Eng News, Apr 2. 900 w. M May.
- Sewage Disposal Works of Natick, Mass., The (III)—Eng News, June 4. 900 w.
- Sewage Filter Beds, Raising Crops on—Eng News, June 11. 1500 w.
- Sewage Purification (III)—Ind & Ir, May 1. 3000 w.
- Sewage Reservoirs, The Natick, Mass. (III)—Eng Rec, April 25. 1800 w. M June.
- Sewage Works, The East Moseley—Mach, Lond, Mch 15. 2500 w. M May.
- Sewage—See Irrigation.
- SEWERAGE System of Indianapolis, The (III)—C. C. Brown, Jour Assn of Eng Soc, Mar, 7000 w. M June.
- SEWERAGE of Victoria, B. C., The—Abs Paper Can Soc Civ Engs, Eng Rec, June 13. 1500 w.
- Sewerage of Melbourne, The—Eng Rec, May 23. 3500 w.
- Sewerage Works, Tables and Diagrams for Facilitating the Computation of Estimates for—S. M. Svaab, Eng News, May 14. 700 w.
- SEWER Details, Winchester, Mass. (III)—Eng Rec, April 25. 1100 w. M June.
- Sewer Discharge and Velocity—Albert Wolheim, Pav & Mun Engng, Apr. 300 w. M May.
- Sewer in Brussels, Belgium, A Concrete Storm (III)—Eng News, Mch 26. 500 w. M May.

Champion

Iron and Steel Bridges, Viaducts,

Bridge

Substructures and Structural Iron Work.

Company.

WILMINGTON, OHIO.

GRAVES ELEVATORS

SAFETY, SPEED
AND ECON-
OMY COMBINED

GRAVES ELEVATOR CO., Rochester N. Y.

New York, 92 and 64 Liberty St.
Atlanta, Ga., Inman Building.

Boston, 53 State St.

Philadelphia, 1215 Filbert St.
Send for Catalogue.

STEAM HELVE HAMMERS.

THE CLEVELAND SHIP BUILDING CO.,

NO. 120 VIADUCT, CLEVELAND, O.

U. S. Mail Chutes

Are a necessity in Office Buildings and
Hotels. Write to the Sole Makers.

The Cutler Mfg. Co., Rochester, N. Y.

PATENTED AUTHORIZED.

American Photo-Engraving Co.

& 15 Vandewater St., NEW YORK.

Photo-Engraving for all illustrative purposes,
by every approved Photo-Process.

Established 1880. Correspondence invited.

Wanted—An Idea

Who can think
of some simple
thing to patent?

Protect your ideas; they may bring you wealth.
Write JOHN WEDDERBURN & CO., Patent Attor-
neys, Washington, D. C., for their \$1,800 prize offer
and list of two hundred inventions wanted.

Wanted—An Idea

Who can think
of some simple
thing to patent?

Protect your ideas; they may bring you wealth.
Write JOHN WEDDERBURN & CO., Patent Attor-
neys, Washington, D. C., for their \$1,800 prize offer
and list of two hundred inventions wanted.

Please mention Wisconsin Engineer when you write.

- SEWER INTERSECTION at Baltimore, Md. (Ill)—C. P. Kahler, Eng News, April 9. 350 w. M June.
- Sewers, Maintenance of a Separate System of—T. H. Jones, Eng News, April 23. 900 w. M June.
- Sewer Pipe in Macon, Ga., Alignment of Tile (Ill)—Eng Rec, Mch 14. 300 w. M May.
- Sewer Tunnel, The Providence—Eng Rec, July 25. 600 w.
- SEWING Machine, The (Ill)—Sci Am, July 25. 3000 w. M Sept.
- SHADOWGRAPHS, Lightning—Knudson, Elec, Apr 22. W May 2.
- SHADOW Pictures by Arc Light Rays—W. W. Kerr, Elec Eng, Mch 25. 700 w. P May. M May.
- SHAFT at Sea, Repairing a Broken Thrust—Steamship, Mch. 1200 w. M May.
- Shaft at the Colliery of the West Bohemian Company Near Pilsen, Sinking a New—K. Anton Weithofer, Col Guard, May 1. 2200 w.
- Shaft Sinking, The Gobert Freezing Process of—A. Gobert, Col Guard, June 12. 2500 w. M Aug.
- SHAFTS by Poetsch's Process at Ounaing Near Valenciennes, France, Notes on Sinking Two—H. F. Olds, Min Jour, May 9. 1000 w. M July.
- Shafts, Honigman's Method of Boring Mine—W. Schulz, Col Guard, May 1. 2000 w. M July.
- SHEAVE-Wheel with Wrought Iron Arm (Ill)—W. H. Osborne, Ir Tr Rev, Mch 19. 700 w. M May.
- SHIPBUILDING, American (Ill)—Sci Am, July 25. 200 w.
- Shipbuilding, British and Foreign—Mach, Lond, July 15. 1300 w.
- Shipbuilding in Germany—C. F. Laeisz, Paper Inst Nav Arch, Eng, Lond, June 12. 2100 w. M Aug.
- SHIPPING and Transit Needs of New York—Arch & Build, June 6. 1100 w. M July.
- Shipping Competition, Foreign—Engng, July 3. 2000 w. M Sept.
- Shipping Facilities, A Revolution in—A. Phenix, Mfrs' Rec, July 17. 5500 w. M Sept.
- SHIP Protection by Discrimination—Sea, Apr 16. 1600 w. M June.
- SHIPYARD, A Great Lake (Ill)—Sea, May 11. 900 w. M July.
- SHIPS—See Geometry.
- SHOP Kinks at Valley Falls, O. H. R.—Loc Engng, May. 900 w.
- Shop Management, Points on—B. F. Fells, Ir Tr Rev, July 30. 1100 w.
- Shop Notes Atchison, Topeka & Santa Fe Ry., Topeka, Kan.—Ry Rev, April 18. 2800 w. M June.
- SHOPS of the Pennsylvania Railroad, The Altoona—Am Eng & R R Jour, June, Serial Part 1. 5800 w. M July.
- Shops, Philadelphia and Reading—Loc Engng, Apr, 2800 w. M May.
- SHOVEL, Railroad Steam—H. E. Riggs, Eng News—July 23. 800 w.
- Shovel Work, A Record of Steam—Eng News, July 23. 800 w.
- SHUNT, Universal (Ill)—Elec Rev, Lond, Apr 10.
- SIBERIAN Railway—Ind & East Eng, June 20. 1700 w.
- SIGNALING, Block—Tr Assn Civ Engs Cornell Univ, June, 1400 w. M Aug.
- Signaling, Mechanical Fog—Eng, Lond, July 10. 1600 w.
- Signaling, Railway Block—J. Pigg, Elec Eng, Lond, July 3. Serial Part 1. 1700 w.
- SIGNALS and Care of Interlocking Apparatus, Distant—Charles Hansel, Ry Rev, Mch 21. 1500 w. M May.
- Signals and Permissive Blocking, Three-Position—R R Gaz, April 17. 400 w. M June.
- Signals Between Stations and Trains in Motion, Agabey's System—Ind Engng, May 9. 900 w. M Aug.
- Signals, Rules for Operation and Maintenance of Interlocking—Eng News, Apr 2. 2400 w. M May.
- Signals, Colors for Night—Eng News, Mch 12. 1800 w. M May.
- Signals, Color for Night—R R Gaz, Apr 3. 2400 w. M May.
- Signal Department Standards (Ill)—Ry Rev, May 2. 1400 w.
- Signals, Electric Controller for Grade Crossing Alarm (Ill)—Eng News, May 21. 500 w.
- Signals on Electric Railways—St Ry Jour, May. 2400 w.
- Signals on the Boston & Albany, Automatic—G. Blodgett, R R Gaz, July 24. 2000 w.
- Signals, Uniformity in Semaphore—Ry Rev, April 11. 400 w. M June.
- Signal Standards on the Pennsylvania Lines West of Pittsburg (Ill)—R R Gaz, Mch 27. 1600 w. M May.
- SILK Covered Wire Testing (Ill)—Elec Rev, Lond, July 31. W Aug 22.
- Silk Fabric Made by Insect Larvae (Ill)—W. G. Johnson, Am Miller, Apr. 1600 w. M May.
- SILVER in Chloridizing—Roasting, The Volatilization of—L. D. Godshall, Eng & Min Jour, May 16. M July.
- Silver Mines in Australia, The Broken Hill—Eng & Min Jour, July 11. 2000 w.
- Silver, Separating Lead from—Tomasi, L'Ind Elec, July 20. W Aug 8.
- Silver—See Lixivation.
- SISAL Industry in the Bahama's, The—D. Morris, Jour of Soc of Arts, Mch 20. 10000 w. M May.
- SKY Scrapers of Rome, The—Rololfo Lanciani, X Am Rev, June. 3800 w. M July.
- Sky Scrapers, The Construction of—C. T. Purdy, Tr Assn Civ Engs of Cornell Univ, June. 6400 w. M Aug.
- SLATE in Great Britain, American—Stone, April. 1300 w. M June.
- SLIDE RULE, The Use of—F. A. Halsey, Am Mach, May 28. Serial Part 1. 1800 w.
- SLEEPERS, The Use of Iron and Steel for Railway—Ir & Coal Tr Rev, Apr 10. 1800 w. M June.
- SMEETING in California, Matte—H. Lang, Eng & Min Jour, July 25. Serial Part 1. 3000 w.
- Smelting, Matte—W. L. Austin, Min & Sci Pr, Mch 28. 3000 w. M May.
- SMELTERS, Flux for the (Ill)—Aust Min Stand, March 5. 800 w. M June.
- SMOKE Prevention from a Mechanical Standpoint—C. Benjamin, Safety V, July. 1500 w. M Sept.
- Smoke Prevention—See Combustion.
- SOLIDS and Vapors—Wilder D. Bancroft, Phys Rev, May—June. 6000 w. M July.
- SOUTH Rocky River Bridge, The (Ill)—Eng Rec, June 13. 1500 w. M Aug.
- SPANISH Brick and Tile, Cork (Ill)—C. H. Blackall, Br Bu., June, Serial Part 1. 2500 w. M Aug.
- SPARK, Globular—J Inst Elec Eng, June. W July 25.
- SPARKING Distance and Ultra-Violet Light—Swyngedaun, L'Eclair Elec, May 23.
- Sparking of Closed Coil Direct-Current Armatures—George T. Hanchett, Elec Ry Gaz, Mch 28. 2200 w. M May.
- SPECIFICATIONS, Concerning—R R Gaz, May 1. 1600 w.
- SPECTRA of the Bunsen Burner and Exhausted Bulbs, The—W. H. Birchmore, Elec Eng, Mch 25. 2300 w. M May.
- Spectra in Exhausted Tubes, On the Cause of Continuous—Elec Eng, July 8. 2700 w. W July 18. M Aug.
- SPECTRO PHOTOMETER, How to Make and Use a Simple (Ill)—W. H. Birchmore, Pro Age, May 1. W May 22. 1100 w. M June.
- SPEED of Electrical Machinery—Wm. Baxter, Jr., Elec Wld, June 20. 1900 w. M Aug.
- Speed, The Problem of—M. J. N. Normand, Eng, Lond, May 22. 7000 w. M July.
- SPRINGS, Coiled—E. T. Adams, Am Mach, May 21. 1300 w. M July.
- Springs, Intermittent—Walter C. Garretson, Sci Am Sup, Apr 11. 1200 w. M May.

THE SICILIAN ASPHALT PAVING CO.,

CONTRACTORS
FOR

Sicilian and German Rock Asphalt Street Pavements.
Trinidad "Lake" Asphalt Street Pavements.
Sicilian Rock Asphalt Floors, Pavements and Roofs

DEALERS IN

Sicilian and German Rock Asphalts for Street Pavements.
Sicilian, Limmer, and Brunswick Rock Asphalt Mastics.
Refined Trinidad Asphalt.

For Estimates and Full Information Apply to

THE SICILIAN ASPHALT PAVING CO.,
TIMES BUILDING, NEW YORK.

ATLAS

*Guaranteed to be superior
to any imported cement.*

USED

EXCLUSIVELY

PORTLAND

IN THE

HAVEMEYER BLDGS.,

AMERICAN SURETY BLDG.,

JOHNSON and PRESBYTERIAN Bldgs.,

NEW YORK CENTRAL

R. R. BRIDGE OVER HARLEM RIVER.

GEMENT

ATLAS CEMENT CO.,

143 Liberty St., New York.

Please mention Wisconsin Engineer when you write.

- SPROCKET Wheels by Broaching, Machine for Shaping (III)—Am Mach, July 30. 500 w.
- SQUARES, The (Alleged) Law of Inverse—B. E. Chollar, Am Gas Lgt Jour, June 1. 1000 w.
- STACKS for Roundhouses, Drop Smoke (III)—R R Gaz, Mch 13. 600 w. M May.
- STADIA MEASUREMENTS, New Data on—L. S. Smith, Wis Eng, June. 3500 w.
- STADION at Athens, The—Arch, Lond, May 8. 1800 w. M July.
- STAGE Effects, Electrical (III)—Theodore Waters, Elec Pow, May. 6000 w. W May 23. M July.
- Stage, The New Liverpool Landing (III)—Eng, Lond, May 29. 1500 w. M July.
- STAGING, Paint Shop—R R Car Journal, May 700 w.
- STAINS, Treatment of Wall—A. A. Kelly, Plumb & Dec, April 1. 1200 w. M June.
- STAMBOC L. Old and New—Richard Davey, Arch, Lond, Mch 20. Serial Part 1500 w. M May.
- STANDARD Block, The N. Y. & Buffalo (III)—Eng Rec, July 11. Serial Part 1. 1500 w.
- Standards and Recommendations, M. C. B. Association—R R Car Jour, April. 1000 w. M June.
- Station, Boston's New Union—Bos Jour of Com, Mch 21. 900 w. M May.
- Station Difficulties, Some—H. M. Kellog, Elec Wld, Apr 18. P May.
- Stations for street Railways, Testing—Conant, St Ry J, Apr.
- Station of the United Electric and Power Company, New York (III)—Power, May. 3000 w. M June.
- Station in Boston, Proposed Southern Union—R R Gaz, Mch 27. 1500 w. M May.
- Station Service Be Improved, How Can Our—F. E. Hoff, N Y R R Club, April 16. 15500 w.
- Station, Syracuse, N. Y. C. & H. R. R. R.—B. L. Gilbert, Ry Rev, April 25. 1800 w.
- Station, The New Baltimore and Ohio in Baltimore—R R Gaz, May 15. 1400 w.
- STATUES and Monuments of New York—N. McDonald, Arch & Build, Apr 4. Serial Part 1. 2500 w. M May.
- STEAMBOAT Adirondack, The New (III)—Am Ship, May 21. 1500 w. M July.
- Steamboat, The Bazin Disc Wheel (III)—Eng, Lond, May 15. 1700 w. M July.
- Steamboat, The Western River—W. H. Bryan, Trans Am Inst of Mech Engrs, Vol XVII. 1800 w. M June.
- STEAM, Economic Utilization of Exhaust—W. J. Baldwin, Heat and Ven, April 15. 2000 w. M June.
- STEAMER, Oil Tank—H. J. Phillips, Engng, April 17. 3000 w. M June.
- Steamer Southend Belle, Thames Paddle (III)—Eng, Lond, June 12. 1500 w.
- STEAMERS Koningin, Wilhelmina, Koningin Regentes and Prins Hendrik, The Paddle (III)—Eng, Lond, Mch 13. 1300 w. M May.
- Steamers, On Signs of Weakness in Tank—Otto Schlick, Paper Inst Nav Arch, Eng, Lond, June 26. 1000 w. M Aug.
- STEAM Fountain That Will Close, An Automatically Closing (III)—John A. Hill, Loc Engng, June. 1200 w.
- Steam Jacket, The Thoroughfare—Charles T. Porter, Am Mach, Mch 19. 1100 w. M May.
- Steam Pipes, Insulating Underground—Edgar Kidwell, Eng, Lond, April 10. 900 w. M June.
- Steam Pipes, The Carbonizing of Wooden Lagging on—Heat & Ven, April 15. 1200 w.
- Steam Plant of the American Surety Company's Building, Broadway, New York (III)—Power, June. 1500 w.
- Steam Plant of the National Electrical Exposition, The (III)—Eng News, April 30. 900 w. M June.
- Steam Plants, Improving Old—Mas St Fitter, May. 1200 w. M July.
- Steam Pump and Water Pipes, The—C. A. Collett, Safety V, June. 500 w. M Aug.
- Steamship, The Economics of Propulsion in the Modern—R. L. Weighton, Prac Eng, Mch 27. Serial Part 1. 3000 w. M May.
- Steamship, The Transatlantic (III)—Sci Am, July 25. 3500 w.
- Steam, Superheated—R. H. Thurston, Trans Am Inst of Mech Engrs, Vol XVII. 2200 w. M June.
- Steel Castings and Malleable Iron—C. H. Benjamin, Digest of Phys Tests, April. 1200 w. M June.
- Steel Casting Process, On the Walrand-Legenisel—H. Hollis, Trans Am Inst of Min Engrs, July. 1700 w.
- Steel in Bridge Pins, The Condition of—A. C. Cunningham, Am Soc of Civ Engrs, May. 2000 w. M July.
- Steel Industry of the United Kingdom in 1895, Bessemer—Ir & Coal Trds Rev, June 12. 1000 w. M Aug.
- Steel Industry of the United Kingdom in 1895, the Open-Hearth—Ir & Coal Trds Rev, June 12. 900 w. M Aug.
- Steel in the United States, The Production of Open-Hearth—Ir Age, April 16. 900 w. M June.
- Steel Making at Birmingham—P. Shook, Ir Tr Rev, July 16. 1300 w. M Sept.
- Steel, Microscopic Flaws in—A. A. Seaton, Engng, Apr 10. 2300 w. M June.
- Steel, Nickel—William Beardmore, Ind & Ir, May 1. 1800 w. M July.
- Steel, Note on Mr. Howe's Researches on the Hardening of—F. Osmond, Ir & St Trs Jour, May 16. 2000 w. M July.
- Steel Points and Crossings, Manganese—Ry Wld, June. 700 w. M Aug.
- Steel Rails, The Manufacture and Consumption of—Ir & Coal Trds Rev, April 10. 1600 w. M June.
- Steel, Shielding Action of—Beck, Wied Ann, Vol 57, p 464. Elektrotechn Zeit, May 7. W May 30.
- Steel-Skeleton Buildings, The Design of—Eng Rec, July 11. 2000 w.
- Steel, Standard Specifications for Structural—Eng & Min Jour, Aug 1. 1500 w.
- Steel, Sulphur in Mild—F. E. Thompson, Ir Age, Apr 2. 3500 w. M May.
- Steel, Tempering—Rev de L'Elec, Apr 30. W June 20.
- Steel, The Development of Open Hearth—Ir Age, Mch 12. 900 w. M May.
- Steel, The Manufacture of Bessemer (III)—Sci Am Sup, April 18. 1100 w. M June.
- Steel Used by Marine Engineers as Revealed by the Microscope, The Causes of Mysterious Fractures in the—A. E. Seaton, Ir & St Tr J, Mch 28. 2000 w. M May.
- Steel Works, The Lackawanna—Ir & Coal Trs Rev, April 3. 1700 w. M June.
- Steel Works, The Latrobe (III)—Engng, May 1. 1600 w.
- ST. ELMOOR and Chaffee County (III)—Min Ind & Rev, July 16. 3500 w.
- STERILIZING of Water by Means of Ozone—Reph, Rev Gen des Sc, July 15. W Sept 5.
- ST. LAWRENCE Water Route to the Sea, The—Eng News, Mch 26. 1300 w. M May.
- STOKER, A German Mechanical (III)—Eng News, July 9. 300 w.
- STOKERS, Experiments with Automatic Mechanical—J. M. Whitham, Trans Am Inst of Mech Engrs, Vol XVII. 3800 w. M June.
- Stokers, Mechanical—Bos J Com, July 4. 1800 w.
- STOLETOW, Prof. A. G.—Electn, July 3.
- STONE, A Story of—In Arch, Apr. 2000 w. M July.
- STONES from Norway and Sweden—Herr Lund, Stone, Mch. Serial Part 1. 1200 w. M May.
- Stones from Norway and Sweden—Herr Lund, Stone, April. 800 w. M June.
- Stones, Missouri Building and Ornamental—C. R. Keyes, Stone, April. Serial Part 1. 1200 w. M June.
- Stones—See Building.
- STORAGE Battery for Fire-Alarm and Police Telegraph Purpose, The (III)—J. L. Hall, Elec Wld, July 11. 700 w. M Aug.
- Storage Batteries for Traction Purposes—Elieson, Elec Rev, Lond, June 12. W July 4.



TRINIDAD

ASPHALTUM
BLOCK AND
TILE WORKS

— of Philadelphia,

The Largest Asphalt Block Works in the World.

Richardson & Ross,

30th and Race Streets,
SEND FOR ESTIMATES.

-

PHILADELPHIA, PA.

TILES FOR SIDE WALKS.

Indiana Bermudez Asphalt Company,

CONTRACTORS FOR —

STREET PAVING

— AND DEALERS IN —

Refined Bermudez Asphaltum.

INDIANAPOLIS, IND.

OFFICE:

19 and 20 Baldwin Block.

WORKS:

East Vermont St., and Big Four Tracks.

Please mention Wisconsin Engineer when you write.

- Storage Batteries for Railway Power Stations—W. H. Williams, Wis Eng, June. 3700 w. W July 25.
- Storage Battery in Telegraph Work—M. Barnett, Elec Wld, June 13. Serial Part 1. 2400 w. M Aug.
- Storage Battery Manipulations on Variable Loads—J. E. Woodbridge, Elec Wld, June 6. 1200 w. M July.
- Storage Battery Plant at Ottawa, C. P. R. Telegraph (III)—W. J. Camp, Can Elec News, May. 1500 w. M July.
- STOREHOUSE Stock, Uniformity in—Ry Rev, May 9. 2000 w.
- ST. PAULS, The Glass Mosaics at—H. J. Powell, Contemp Rev, Mch. 3500 w. M May.
- ST. PETERSBURG, The Churches of—III Car & Build, July 24. 2700 w.
- STREETS, Architecturally Considered, New—Builder, Mch 7. 3500 w. M May.
- STREET CAR, A Universal Sanitary—St Ry Rev, June 15. 1000 w. M Aug.
- STREET Department of Boston, Mass., in 1895, Work of the—Eng Rec, July 4. 2000 w. M Aug.
- Street Improvements at the University of Illinois (II)—J. C. Quade, Tech, May. 1000 w.
- Street Lighting with Arc Lamps—Blondel, Elek Anz, June Nos.
- Street Mains, System of—Elec Rev, Lond, July 17. W Aug 8.
- STREET RAILWAY Apparatus, Repair of—Shepard, Amer Elec, July.
- Street Railway Apparatus, Repairs to—Am Elec, Aug.
- Street Railway Appliances at the New York Exposition—Elec Ry Gaz, May 10.
- Street Railway Power House, Recent Improvements in the Albany—Elec Wld, July 11. 700 w.
- Street Railways, Earnings and Operating Expense of Connecticut—St Ry Rev, Apr 15. 1300 w. M June.
- Street Railways, Elmira (III)—Elec Wld, July 4. 2300 w.
- Street Railways in American Cities—St Ry J, July. 2200 w. M Aug.
- Street Railway Investments, American—St Ry J, July. 1800 w. M Aug.
- Street Railways, Power Over—R. Fisher, Elec Wld, July 25. 800 w.
- Street Railways, Rapid Transit—Fisher, Elec Ry Gaz, May 10.
- Street Railways, Standard Electric Rules Relating to—St Ry Rev, Apr 15. 1000 w. M June.
- Street Railway, Studies in Economic Practice in—C. B. Fairchild, St Ry J, July. Serial Part 1. 4000 w. M Aug.
- STREET WORK, A Rapid Method of Apportioning Cost of Private—Thos. Cairk, Pav & Mun Eng, May. 600 w. M June.
- STRESSES Caused by Moving Trains, A Proposed Device for Weighing—Eng News, April 30. 900 w. M June.
- Stresses Due to the Pitching of Ships—A. Kriloff, Engng, April 17. 3000 w. M June.
- STRUCTURAL Iron and Steel, Specifications for—B. L. Worden, Wis Eng, June. 1500 w.
- SUBTERRANEAN Operations, The Increase of Temperature with Depth of—Col Guard, July 31. Serial Part 1. 1400 w.
- SUBWAYS for Electric Wires—W. C. Burton, Wis Eng, June. 1500 w. W July 25.
- Subway and Tunnel in Philadelphia, The Philadelphia & Reading Railway—R R Gaz, April 17. 900 w. M June.
- Subway and Tunnel in Philadelphia, The Penn. Avenue (III)—Eng News, April 16. 1600 w. M June.
- SUCCESS in Engineering as a Profession, The Elements of—Eng, Lond, Mch 13. 1600 w. M May.
- SUGAR Industry of Formosa—J. Davidson, Cons Rept, July. 4200 w.
- Sugar, Purifying—Audry, Elektrochem Zeit, July 5. W Aug 1.
- SULPHURETS by the Electric Current, Treatment of—Eng & Min J, July 11. W July 25.
- SULPHURIC ACID Process of Refining Lixivation Sulphides—F. P. Dewey, J Am Chem Soc, July. 3400 w. M Aug.
- Sulphuric Acid, Purifying Concentrated (II)—Elektrochem Zeit, July 5. W Aug.
- SULPHUR in Illuminating Gas and in Coal, On the Determination of—Charles F. Maybery, Am Chem J, Mch. 2800 w. M May.
- SUPERHEATING—W. H. Booth, Am Mach, Mch 19. 1600 w. M May.
- SURFACE CONTACT SYSTEM (III)—Elec Eng, July 3.
- Surface Contact System for Paris—Lauriol, Rev Gen des Sc, Apr 15. W May 16.
- Surface Contact System in Paris (III)—La Nature, July 11.
- Surface Contact System in Paris—L'Eclair Elec, May. W June 6.
- Surface Contact System in Paris (III)—Jacquin, L'Eclair Elec, June 6, 20 and 27.
- SURFACE Rail System—Pringle and Kent's System, Electn, July 17.
- SURVEYING, Application of Photography to—J. S. Dennis, Am Soc of Ir Engrs, April, 1895. 2000 w.
- SURVEYS, Inspection of Government Land—L. T. Gregerson, Wis Eng, June. 1100 w.
- SURVEYING Instruments, Trolley Cars and—Eng News, Mch 26. 600 w. M May.
- Surveying Instruments—See Electric Currents.
- Surveying, Outline Scheme for Mine—Edward B. Durham, Sch of Mines Quar, Apr. 4500 w.
- SWISS Railways—See Railways.
- SWITCH and Frog, McPherson's Safety (III)—R R Gaz, Apr 30. 400 w. M May.
- Switch, A Series—Motor Controller and Reversing (III)—Am Mach, May 7. 1100 w. M June.
- Switch, Automatic Time (III)—McLean System, Electn, July 10. W Aug 1.
- SWITCHBOARD—Schwensky, Elektrotechn Zeit, June 4. W June 27.
- Switchboard, Educating Operators in the Handling of the—W. E. Packard, Paper Assn Ry Tel Supts. Elec Rev, July 1. 1100 w. M Aug.
- Switchboard, Horizontal Multiple—Zielinski, Elektrotechn Zeit, June 18.
- Switchboard, The Swartz "Multiple Rival" Telephone (III)—Elec Eng, Mch 18. 500 w. P May. M May.
- Switchboards, Size of Multiple—Hesse, Elektrotechn Zeit, Apr 16. W May 9.
- SWITCH, Central Station Telephone (III)—Mattausch, Zeit f Elek, May 15.
- SWITCHES—See Interlocking; also Signal.
- Switches, Safety (III)—John A. Beeler, St Ry Jour, May. 600 w.
- SWITCHING System—See Junction.
- SYNAGOGUE Roof and Dome, An Iron (III)—Eng Rec, June 20. 500 w. M Aug.
- T**ABLES, Spring—G. R. Henderson, Trans Am Inst of Mech Engrs, Vol XVII. 2000 w. M June.
- TANNIC Acid—See Electric Endosmose.
- TANNING, Electric—Montpellier, L'Elec, May 2. Proc Lond Phys Soc, May. W June 6.
- TANK Installation, A Notable Water (III)—Ry Mas Mech, Apr. 550 w. M May.
- TANKS for Grain, Steel Storage (III)—Am Miller, May 1. 1100 w.
- TAPE, Measuring a Steel (III)—Walter Gribben, Am Mach, Mch 19. 1000 w. M May.
- TAR and Ammonia from Blast Furnace Gases, The Recovery of—A. Gillespie, Jour Gas Lgt, April 7. 3000 w. M June. Col Guard, Mch 20. 3000 w. M May.
- TARIFF in Hungary, The Zone—R R Gaz, April 24. 500 w. M June.
- Tariff System in Russia, The Railway Zone—Eng, Lond, Apr 24. 1000 w.
- TARIFFS, Maximum Legal Passenger—Trans, July.
- "TASMANIA," The Wild West Coast of—F. Harris, Min Jour, July 25. Serial Part 1. 2500 w.
- Tasmania, The Mining Boom in—Aust Min Stand, June 18. Serial Part 1. 6300 w.
- TEAK Trade of Siam, The—Ind & East Eng, June 27. 3200 w.

JAMES BLACK,
President.

CHAS. BRAINARD,
Superintendent.

JOHN S. ROPER,
Secretary.

Grafton Quarry Co.

(QUARRIES, GRAFTON, ILLINOIS.)

Dimension, Footing, Rubble and Rip-Rap Stone.

OFFICE, NO. 415 LOCUST STREET,

ROOM 504.

St. Louis, Missouri.

Art Rooms,

13 W. MAIN STREET.

Art Photography.

Best and Latest Styles.
New and Permanent Prints.
Best Efforts made to Please.

Fine Paintings . .

On Exhibition and For Sale.
Your patronage earnestly Desired.

M. D. Jones,

Photographer and Artist.

Water, Gas and
Culvert Pipe,
Cranes,
Road Rollers,
Special Machinery

FROM

Manufacturers' Designs.

For special information
and prices write to . . .

The Addyston
Pipe & Steel Co.
Cincinnati, O.

Please mention Wisconsin Engineer when you write.

- TELEAUTOGRAPH, Professor Elisha Gray's (II)—Eng. Lond, June 5. 1600 w.
- TELEGRAPH and Telephone Circuits by Light and Power Currents, Disturbances in—Strecker, Electn, June 19. W July 11.
- Telegraph Apparatus, Strength of Armature Attraction in Some Kinds of—H. Dreisbach, Elektrotechn Zeit, Mar 26.
- Telegraph Conference of 1896, International—Elec Rev, Lond, April 10. 1200 w. M June. Elec Rev, Lond, May 22. 2000 w. M July.
- Telegraph Monopoly, The—Eng Mag, May 2. W May 23.
- Telegraph Portable Testing Set—Jas. Bell and S. Wilson, Elec, Lond, Mar 13.
- Telegraph, The—Sci Am, July 25. 2500 w.
- Telegraph—See Postal Telegraph. Storage Battery.
- TELEGRAPHS with Special Reference to Recent Improvements, On Railway—W. Langdon, Elec Eng, Lond, May 1. Serial Part 1. 2500 w. M July. W May 23.
- Telegraph Railway—Langdon, J Inst Elec Eng, June.
- TELEGRAPHIC Disturbance, Electric Railways and—Electn, May 1.
- Telegraphic Isolation, On—Percy A. Hurd, Contemporary Rev, June. 3200 w. M July.
- TELEGRAPHING and Telephoning, Simultaneous—Wilke, Elektrotechn Zeit, May 28.
- TELEGRAPHY, A New System of—Dr. I. Kitzsee, Elek Anz, Apr 26.
- Telegraphy, Australian—Engng, July 10. 900 w.
- Telegraphy, Earth—Stricker, Zeit f Elek, May 1.
- Telegraphy, Government—Delany, Elec Eng, July 22. W Aug 8.
- Telegraphy in Italy, Military—Montillot, L'Elec, June 13.
- Telegraphy, Lord Kelvin and Submarine—Arthur Dearlove, Electn, June 19. 1700 w. M Aug.
- Telegraphy, Mr. Delany on Government—Elec Eng, July 17. 2300 w.
- Telegraphy, Remarkable Feat in—Elec Wld, May 23. 1800 w. M July.
- TELEPHONE at the Springhill Infirmary, Birmingham, Eng, The (II)—Electn, June 26. 500 w. M Aug.
- Telephone Case, The Drawbough—Elec Rev, June 10. 1400 w. M July.
- Telephone Central Station in Paris (II)—De La Taunne, Bul Soc Int des Elec, Mar.
- Telephone Circuits Due to Railway Currents, Disturbances in—Behn Eschenburg, Elek Zeit, July 16. W Aug 8.
- Telephone Circuits, Earthing Device for the Protection of—Ubricht, Electn, May 15.
- Telephone Circuits, Safety Devices for—F. Mertsching, Electn, April 17. 900 w. M June.
- Telephone Company, The New York—Elec Rev, June 24. 400 w.
- Telephone Company's System, Mobile, Ala., The Home (II)—Elec Eng, July 1. 4000 w. M Aug.
- Telephone Conductors Due to Electric Railways, Disturbances in—West, Electn, May 15.
- Telephone Construction in the Rocky Mountains (II)—J. W. Dickerson, Elec Wld, Mich 21. 1200 w. M May.
- Telephone Disturbances and Tramways—West, Electn, May 8.
- Telephone Exchanges and Their Working—Sinclair, Elec Eng, Lond, Mich 27. 1500 w. P June. M May. Elec Rev, Lond, Apr 10. W May 2. Jour Inst Elec Eng, May, June.
- Telephone Exchanges, Naglo Equipment for (II)—J. West, Elec Eng, July 31. Serial Part 1. 1000 w.
- Telephone for Measuring the Dielectric Constant of Conductors, Use of the—Hegdweiller, Elektrotechn Zeit, May 21.
- Telephone in Railway Practice—Ryder, Elec Rev, July 15. W July 25.
- Telephone Line, New Paris-London—Electn, May 29. W June 20.
- Telephone Lines Against Railway Circuits, Protection of—Pierard, Elektrotechn Zeit, Apr 9.
- Telephone Lines from Influence of Strong Currents (II)—Mattausch, Zeit f Elek, June 15. W July 18.
- Telephone Lines, Disturbances Produced in—Wietlisbach, Elektrotechn Zeit, Apr 23. Aug. 20. W May 16. W Sept 12.
- Telephone Lines Due to Electric Railroads, Disturbances in—West, Elektrotechn Zeit, April 30. May 14.
- Telephone Nets, A System of Preventing Induction Noise in—Elektrotechn Zeit, Apr 9.
- Telephone Rates, Regulation of—J. E. Keelyn, Elec, Apr 8. 2000 w. M May.
- Telephone Service, Automatic Night—Zielinski, L'Eclair Elec, Apr 18.
- Telephone System in Denmark, Government (II)—Elektrotechn Zeit, May 14.
- Telephone System, The Development of the—Ind & Fr, April 10. 1500 w. M June.
- Telephone, The (II)—Sci Am, July 25. 1200 w.
- Telephone Transmitters, New Method of Measuring Current Variations in—A. H. Ford, Wis Eng, June. 500 w. W July 25.
- Telephone Wires, Disturbances in—Rheins, L'Eclair Elec, July 25.
- Telephones, Military—Elec Eng, Lond, Apr 17. P June.
- TELEPHONIC Disturbances Caused by High-Voltage Currents, On—V. Wietlisbach, Electn, Mich 27. 4500 w. P June, M May.
- Telephonic Transmission of the Roar of Niagara Falls (II)—Dunlap, W Elec, May 30. W June 13.
- TELEPHONY and Involved Interests—E. F. Frost, Elec Wld, Apr 11. 1400 w. M May.
- Telephony and Telegraphy—S. Amzen, Elec Rev, Lond, Apr 24. Serial Part 1. 2000 w. M June. W May 16.
- Telephony in Austria—Elek Tech, Mar 31.
- Telephony in Finland—Elektrotechn Zeit, June 4.
- Telephony, Long-Distance—L'Eclair Elec, Apr 18.
- Telephony, Twenty Years' Progress in—John C. McMyrn, Elec, Apr 1. 2800 w. M May.
- TELESCOPE—See Astronomical.
- TELEURIDE, Colorado—T. Van Wageningen, Min Jour, July 11. 1700 w.
- TEMPERATURE Entropy Diagram for Steam and Water—Louis M. Nulton, Jour Am Soc of Nav Engs, May. 3500 w. M July.
- Temperatures, The Measurement of Cyclically Varying (II)—H. F. W. Burstall, Pro Age, Mich 16. 4500 w. M May.
- Temperatures, The Measurement of High—Sci Am Sup, June 6. 2000 w.
- TEMPERING, Commercial—H. R. Landis, Jr Age, April 30. 1700 w. M June.
- TEMPLE of Iyemitsee, The (II)—C. T. Mathews, Am Arch, May 30. 2700 w. M July.
- TENEMENT House Competition, The—Eng Rec, June 6. 900 w. M July.
- TENEMENTS, Improved—Geo. W. Da Cunha, Am Arch, June 27. 2600 w. M Aug.
- TENNESSEE Centennial Exposition, The (II)—Tradesman, Apr 1. 700 w. M May.
- TERRA COTTA Is Made, How—Clay Rec, May 14. 2760 w.
- Terra Cotta, Practical Lessons Derived from for the Steel Sky-Scraper Buildings—Clay Rec, Mich 28. 1500 w. M May.
- Terra Cotta, Practical Lessons Derived from the Modern Use of—J. M. Carr, Jour Roy Inst of Brit Arch, March 19. 4300 w. M June.
- TESLA Coil for X Ray Work, New (II)—Elec Rev, July 22. 700 w.
- Tesla's Important Advances—Elec Rev, May 20. 500 w. M July.
- Tesla, Nikola; The Inventions of—Prog of the Wld, June, 1100 w. M July.
- TEST Sections—P. Kruezpoinner, Jr Age, July 22. 2200 w.
- TESTS, Inspection—R. F. Snauling, Am Mach, May 28. 2200 w. M July.
- TESTING Brick and Cement—Clay Rec, June 15. 1700 w. M Aug.
- Testing of Iron and Steel for Magnetic Qualities, Practical—Howe, Elec Eng, June 24. W July 4.

CALIFORNIA in 3 Days

PORTLAND
 SAN FRANCISCO SACRAMENTO
 LOS ANGELES SAN DIEGO
 OGDEN SALT LAKE CHEYENNE DENVER
 OMAHA COUNCIL BLUFFS CHICAGO

Route of the
"Overland Limited"

VIA THE
**CHICAGO,
 UNION PACIFIC
 AND
 NORTH-WESTERN LINE**
**LEAVING CHICAGO
 DAILY**
 VIA THE
Chicago & North-Western Ry.

THROUGH SLEEPING AND DINING CARS TO SAN FRANCISCO AND LOS ANGELES

BUFFET, SMOKING, AND LIBRARY CARS.

PRINCIPAL EASTERN AGENCIES:
 New York: 423 Broadway
 Boston: 5 State St.
 Chicago: 208 Clark St.
 287 Broadway 292 Washington St. 191 Clark St.

CURTIS & SWANMAN, CHIC.

- Testing Iron and Steel for Magnetic Quality—Amer Elec, June.
- TEXTILE Industries in the United States—Sci Am, July 25. 2000 w.
- THAMES and Severn Canal, The (III)—Eng, Lond, May 8. 1700 w. M July.
- Thames Navigation, Lower—Engng, April 24. 2000 w. M June.
- THEATER Lighting, Electric—Feuerlein, Elektrotechn Zeit, May 7.
- Theaters, Opera Houses and (III)—Arch, Lond, May 22. 2800 w. M July.
- THEATRICAL Electricity (III)—W Elec, Apr 25.
- THERAPEUTICS, The Use of Lighting Circuits in—Meylan, L'Elec, May 2. W May 23. L'Elec, July 4. W July 25.
- THERMO-CONDUCTIVITY of Alloys—See Electrical Conductivity.
- THERMO-ELECTRIC E. M. F. in the Arc—Electn, July 10. Aug 1.
- Thermo-Electric Reactions and Currents Between Metals in Fused Salts—Thos. Andrews, Ind & Ir, June 26. 2800 w. M Aug.
- THERMOMETER for Low Temperatures, Electric—Witkowski, Phil Mag, Apr.
- THERMOPHONE—Meyer, Zeit f Elek, May 1. W June 6.
- Thermophone—Puluj, Zeit f Elek, June 15.
- THIRD-RAIL Tests on the Nantasket Beach Road, Elec Eng, June 10. W June 20.
- THORIUM—See "A Rare Metal."
- THORNTON, Wm., Architect—G. Brown, Arch Rec, July, Sept. 4800 w.
- THREE-PHASE Circuit—Rasch, Elektrotechn Zeit, June 25.
- Three-phase Line at Lugano—St Ry Rev, July 15.
- Three-phase Circuits, Loss of Voltage in—Heyland, Elektrotechn Zeit, June 11. W June 11.
- Three-Phase Railway—See Railway.
- Three-Phase System, Effect on the Voltage of Unequal Loading of the Branches of a—Rasch, Elektrotechn Zeit, May 28. W June 20.
- Three-Phase Traction System at Lugano (III)—Routin, L'Eclair Elec, June 13. W July 18.
- TIDES, The Problem of the Tides—J. F. Hayford, Tr Assn Civ Engs Cornell Univ, June. 9500 w. M Aug.
- TIMBER, Durability and Decay of—Arch and Build, April 18. 1400 w. M June.
- Timber Testing, Scientific—B. E. Fernow, Digest of Physics Tests, April. 3300 w. M June.
- TIME—See Azimuth.
- TIN from Tinend Iron, Separating—Claus and Sutton, L'Eclair Elec, Apr 4. W May 9.
- Tin Mines, The Fate—W. H. Bain, Aust Min Stand, May 28. 900 w. M Aug.
- Tin Plate Works, Quarterly List of—Met Work, Apr 4. 2500 w. M May.
- Tin, Quantitative Estimation of—Cecil J. Brooks, Eng & Min Jour, May 23. 600 w.
- Tin Smelting at Pulo Brasu, Singapore—John McKillopp and T. Flower Ellis, Ind & Ir, Mch 20. 1200 w. M May.
- TIRES, The Manufacture of Fabrics for—Ind Rub Wld, June 10.
- TIRES, Wear of, Affected by Form of Rail Head—Prof. P. H. Dudley, Loc Engng, May. 900 w.
- TOBACCO Industry of India and the Far East, The—C. Tripp, J Soc of Arts, Mch 13. 1400 w. M May.
- TOOL ROOMS in Machine Shops—Pro Cent Ry Club, May. 1400 w. M Aug.
- TOOLS, Bed and Cylinder—"Straight Line" Engine Shops, Syracuse, (III)—Herman Landro, Am Mach, Apr 30. 2000 w. M June.
- TOP, On the Chromogeneous—Charles Henry, Engng, Mch 6. 1000 w. M May.
- TORNADO at St. Louis (III)—Engng, July 3. 1700 w.
- Tornado, The Effects of the St. Louis—Julius Baier, Eng News, June 11. 1600 w. M Aug.
- TORNADOES and Cyclones—John Lundie, Elec Engng, June. 1500 w. M Aug.
- TORONTO Water Works, Mr. Mansergh's Report on the—Eng Rec, Mch 14. 2300 w. M May.
- TORQUE and Counter Torque, Electro Motive Force—Am Mach, May 7. 600 w. M June.
- TORPEDO-BOAT Destroyer Janus (III)—Engng, July 24. 800 w.
- Torpedo-Boat Destroyer, The Sante Fe (III)—Eng, Lond, July 31. 1200 w.
- Torpedo Boat, Holland's Submarine (III)—Am Ship, Apr 9. 1800 w. M May.
- TOWER for the Continuous Use of Condensing Water, The Worthington Cooling (III)—John H. Cooper, Jour Fr Inst, June. 2500 w.
- TOXINE Microbes, Action of High-Frequency Currents on—Marmier, L'Ind Elec, July 25. W Aug 29.
- TONNES, Action of High Frequency Currents of—D'Arsonval and Charrin, L'Eclair Elec, July 11.
- TRACERIES and Their Position in Architectural Design (III)—W. S. Hicks, J Roy Inst of Brit Arch, Feb 20. 4800 w. M May.
- TRACK Construction, English Methods of Cable—Alex. McCallum, St Ry J, Apr. 1800 w. M May.
- Track Elevation, N. Y., N. H. & H. R. R. in Boston (III)—Ry Rev, Apr 4. 1200 w. M May.
- Track Laying in the First Six Months of 1896—R R Gaz, July 24. 1200 w.
- Track of American Railways, The Standard—Eng News, June 25. 4800 w. M Aug.
- Track, To Lay Out a Mile Regulation Race (III)—D. L. Brancher, Ill Soc of Engs & Surv, 11 An Rept. 1000 w.
- TRACTION Apparatus, Development of Electric—St Ry Rev, April 15. 1200 w. M June.
- Traction Apparatus in the U. S., The Development of Electrical (II)—H. F. Parshall, J of Soc of Arts, Mch 20. 6800 w. M May.
- Traction, Cable vs. Electric—Elec Ry Gaz, Apr 10. 3000 w. M June.
- Traction Company, The Scranton (III)—Elec Ry Gaz, April 10. 1400 w. M June. P June.
- Traction Company's System, The Bergen County (III)—Elec Eng, June 3. 1800 w.
- Traction, Compressed-Air—Elektrotechn Zeit, June 11.
- Traction Diagrams—Tomlinson, Elec Rev, July 24. 31. Aug 7, 14, 21.
- Traction, Efficiency of Compressed Air—Lundell, Elec Eng, June 10. W June 20.
- Traction, Electric—R Moore, Elec Eng, Lond, July 3. 2800 w. W July 25.
- Traction, Electric Recommended for Glasgow—Ry Wld, May. 1400 w.
- Traction Engines and Roads—Arch, Lond, July 24. 2000 w.
- Traction in Europe, Cost of—Dumout, Mem Soc Ing Civ, Jan.
- Traction, Newspaper Comment on—Ry Wld, April. 600 w. M June.
- Traction Scheme for London—Elec Rev, Lond, Apr 17. W May 2.
- Traction Scheme in Berlin, Proposed Electric—Kallmann, Electn, July 3.
- Traction—See Lugano. Electric Lighting.
- TRAFFIC Association's Defense, The Joint—R R Gaz, May 22. 4000 w.
- Traffic Association Sustained, The Joint—R R Gaz, June 5. 2500 w.
- Traffic on New Railways, A Method of Estimating the Probable Volume of—Eng Assn of the South, April. 5000 w.
- TRAIL CREEK—D. B. Bogle, Eng & Min Jour, July 18. 1100 w.
- Trail Creek District, B. C. (III)—Can Min Rev, July. 10000 w.
- TRAIN Order, Annulling Part of a—J. T. Mackie, Ry Age, June 20. 2000 w. M Aug.
- Train Orders, 19 vs. 31—H. B. Ware, Ry Age, June 27. 1000 w. M Aug.
- Train Resistance—Angus Sinclair, Engng, Apr 3. 1500 w. M June.
- Train Services, The Summer—Engng, July 10. 1600 w.
- Train Service Between London and Scotland, Fast—J. Pattinson, R R Gaz, July 17. 350 w.
- Train Services, The New—C. Rous-Marten, Eng, Lond, July 17. 2500 w.
- TRAMCAR Lighting, Improved—Ry Wld, April. 250 w. M June.



UNIVERSITY.....
 CO-OPERATIVE
 ASSOCIATION.

If You have a want,
 call and we will fill it,
 A full line of Stationery,



Photographic Supplies,
 Athletic Goods,
 and Fountain Pens.

The only Firm in Madison carrying a Full Line of
 Engineering Supplies.

Agents for EUGENE DIETZGEN & CO.,
 and KEUFFEL & ESSER.

T. S. MORRIS, Mgr.

- TRAMCARS, Power-Worked (III)—Engng, May 15. 2500 w.
- Tramcars, Rouen Electric—Ry Wld, April. 2800 w. M June.
- TRAMPS and the Railroads—R R Gaz, June 26. 1000 w.
- TRAMWAY at the Bunker Hill and Sullivan Mines, Wire Rope (II)—Eng & Min Jour, April 18. 600 w. M June.
- Tramway in Sussex, A Rural Steam—Ry Wld, Mch. 1300 w. M May.
- Tramway, The New—Charles Chincolle, Compressed Air, Mch. 700 w. M May.
- TRAMWAYS, American Experiments with Electric Conduit—Ry Wld, Mch. 1400 w. M May.
- Tramways, Compressed Air—Engng, May 29. 3200 w.
- Tramways, Dublin Electric (III)—Elec Eng, Lond, May 15. 5400 w.
- Tramways, Electric, Isle of Man—Ry Wld, May. 2200 w.
- Tramways, Hartlepool Electric—Ry Wld, July. 2300 w.
- Tramways, London Southern (III)—Ry Wld, May. 900 w.
- Tramways of the United Kingdom, The—Trans, April 24. 350 w.
- Tramways, The Consolidation of the London—Engng, May 8. 2400 w.
- Tramways, The Rouen Electric (III)—Elec Rev, Lond, May 22. 3000 w. Elec Eng, Lond, Mch 20. 2600 w. M May.
- TRANSFORMER Curves, An Analysis of—Charles K. Huguet, Elec, May 27. 1600 w. M July.
- Transformer Boxes, Ventilator for (III)—Elec Rev, Lond, July 10.
- Transformer Leakage Current—Jackson, Am Elec, July, Aug. W Aug 1, 29.
- Transformer, Rotary (III)—Hanappe, L'Eclair Elec, July 25.
- Transformer, Sub-station (III)—Elec Eng, Lond, July 10.
- Transformer, The Alternate Current—Tech, May. 5000 w. M Aug.
- Transformers and Induction Motors—Schulz, Elek Anz, June 11.
- Transformers, Alternate Current—Fleming, Jour Soc of Arts, July 10. 3500 w. Elec Rev, Lond, Aug 7. Elec Eng, Lond, July 17. Aug 7.
- Transformers, Best Distances Between—Haas, L'Ind Elec, Apr 25.
- Transformers, Best Distance Between—Pojatzi, Elektrotechn Zeit, May 28.
- Transformers, Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of—Stanley Beeton, C. Percy Taylor, and J. Mark Barr, Electn, May 15. Serial Part 1. 3000 w. W June 6. M July.
- Transformers in Practice, Three Phase Alternate—Berry, Elec Rev, Lond, June 19 and 26.
- Transformers, Influence of the Shape of the Wave on the Iron Losses of—Breton, Taylor & Barr, J Inst Elec Eng, July.
- Transformers, Test on Large Polyphase—D. Korda, Elec Eng, July 18. 1400 w.
- Transformers, Tests of Three Phase (II)—Korda, Elektrotechn Zeit, June 25. W July 18.
- Transformers, The Maximum Efficiency of—Bernard P. Scattergood, Electn, May 29. 1000 w. M July.
- TRANSIT in New York City, The Outlook for Rapid—Eng News, May 28. 2200 w. R R Gaz, May 29. 3500 w.
- Transit, The Cyclotomic (III)—Eng & Min Jour, May 9. 900 w.
- TRANSLATORS, Efficiency of—Wietlisbach, Elek Zeit, July 9.
- Translators, Efficiency of—Breisig, Elektrotechn Zeit, July 23. W Aug 19.
- TRANSMISSION at Lowell, Mich., Long Distance (II)—Elec Eng, May 20, and W Elec, May 23. W May 30.
- Transmission, Direct Current Power—Electn, July 10. W Aug 1.
- Transmission, High-Tension Power—Elec Eng, May 27. W June 13.
- Transmission, Long Distance—Shock, St Ry Jour, June.
- Transmission, New York-Niagara Power—Elec Ry Gaz, May 25. W June 13.
- Transmission of Power—M. W. Danielsen, Age of St, June 13. 1600 w. M Aug.
- Transmission of Power—Eng News, July 9.
- Transmission of Power at Rheinfelden (III)—Rathenau, Elektrotechn Zeit, July 2. W July 25. Elec Eng, Aug 12.
- Transmission of Power by Alternate Currents—J. T. Morris, Engng, July 17. Serial Part 1. 1400 w.
- Transmission of Power from Chevres to Geneva—Guye, L'Eclair Elec, July 25.
- Transmission of Power from Montmorency Falls (II)—Chesney, Cas Mag, May. W May 30.
- Transmission of Power in California, Electrical (II)—W. F. Hassen, Am Electn, July. 1000 w. W Aug 1. Min Jour, May 2. 2800 w.
- Transmission of Power in Mines, The Electrical (II)—C. Köttgen, Eng, Lond, July 3. 1800 w.
- Transmission Plant, A Mexican (III)—J. G. Henry, Jour of Elec, May. 800 w. W Aug 15.
- Transmission Plant, Chevres-Geneva—L'Eclair Elec, May 30. W June 27.
- Transmission Plant, Di-Phase (III)—L'Energie Elec, May 1.
- Transmission Plant, Fresno—Low, Jour of Elec, Apr.
- Transmission Plant, Mining—Jour of Elec, May. W Aug 15.
- Transmission Plant, The Baltic Taftville—(—) H. E. Raymond, Elec Wld, July 4. 3000 w.
- Transmission—See Power, Electrical, Mining.
- TRANSPORTATION from an Operating Stand—D. S. Sutherland, Ry Rev, April 18. 800 w. M June.
- Transportation of Goods in Towns and Cities, The—Eng News, May 14. 2500 w. M July.
- Transportation of Solid Matter by Rivers—Wm Starling, Tr Assn Civ Engrs of Cornell Univ, June. 9000 w. M Aug.
- TRANSVAAL, Problems of the—Karl Blind, N Amer Rev, Apr. 6500 w. M May.
- TRANSVERSE Tests of Beams of Oregon Pine—Wm Hood, Eng News, June 25. 2000 w. M Aug.
- TRAP-DOORS in Mines, The Effect of—Jas. Blicke, Am Mfr & Tr Wld, June 12. 1900 w. M Aug.
- TRESTLES, Economical Designing of Timber—A. L. Johnson, Ry Rev, Mch 21. 2700 w. M May.
- TRIAL of the U. S. S. Raleigh, Forced Draft—C. R. Roelker, Jour Am Soc of Nav Engrs, May. 1400 w. M July.
- TRI-PHASE Currents, Measurement of Power of—Behn-Eschenburg, Elec Eng, June 24.
- Tri-Phase Machinery—Girault, L'Ind Elec, Apr 10.
- Tri-Phase Currents, Measurement of—De La Tour, L'Ind Elec, July 10. W Aug 8.
- Trolley Lines, Earth Connection Safety Device for—Ubricht, Elektrotechn Zeit, May 7. W May 30.
- Trolley Line, Mountain—Elec Ry Gaz, May 10.
- Trolley Line without Poles—Sci Am, June 20. W June 27.
- Trolley, Some Recent Developments of the (II)—Sci Am Sup, Mch 28. 1400 w. M May.
- Trolley System, Series (III)—Elektrotechn Zeit, May 28. W June 20.
- Trolley Wire on Curves, Location of—Foster, St Ry Jour, June.
- Trolley Wire on Special Curves, Correct Location of—C. A. Alden, St Ry J, July. 400 w.
- Trolley Wire, Stringing—Elec Ry Gaz, June 10. W June 27.
- TRUCK and Checkwright, The Saw Relating—Col Guard, April 24. 1000 w. M June.
- TUBING, Strength of—Oberlin Smith, Ir Age, July 2. 1000 w. M Aug.
- TUNGSFEN—Moissan, L'Ind Elec, July 25. L'Eclair Elec, July 25.
- TUNNEL on a Locomotive, Through the Baltimore (II)—Ry Wld, April. 1500 w. M June.

A GREAT RAILWAY.

THE CHICAGO, MILWAUKEE AND ST. PAUL

Owens and operates 6,169 miles of thoroughly equipped road in the States of Illinois, Wisconsin, Iowa, Missouri, Minnesota, South Dakota, North Dakota and the Upper Peninsula of Michigan

FIRST-CLASS IN EVERY RESPECT.

It is foremost in adopting every possible appliance for the safety and comfort of passengers, including an Absolute Block System, Westinghouse Train Signals, Steam Heat, Electric Light, Vestibuled and Compartment Cars, etc

Five first-class trains each way between Madison and Chicago or Milwaukee. All around good service from Madison to St. Paul and Minneapolis, via Portage and La Crosse or Prairie du Chien.

Best service possible to Iowa points, Omaha and all Western points. In fact, they are in it for all points.

For further information address

GEO. H. HEAFFORD,
General Passenger Agent, Chicago, Ill.

...OR...

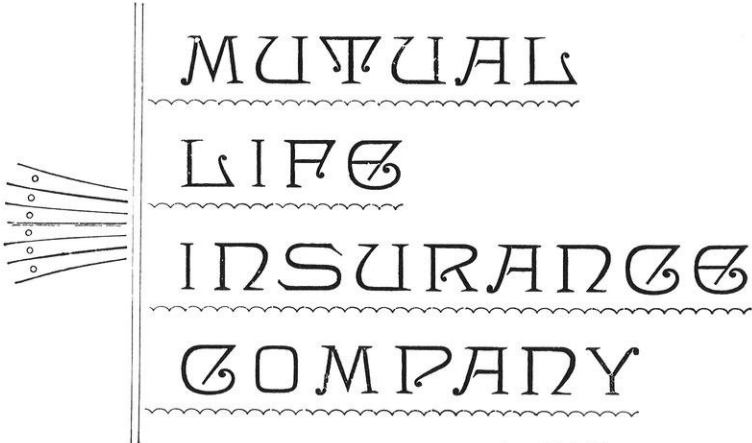
NELSON W. PIERCE,
Freight and Passenger Agent,
MADISON, WIS.

Office, 647-649 West Washington Avenue.

Please mention Wisconsin Engineer when you write.

- Tunnel and Subway in Philadelphia, Philadelphia and Reading (II)—Ry Rev, May 23. 1600 w.
- Tunnel at Hamilton, Ont, The Construction of a Railway (III)—Peter Mogensen, Tech, May. 3500 w.
- Tunnelling by Compressed Air (III)—E. W. Moir, Jour of Soc Arts, May 15. 10500 w. M July.
- TUNNELS, Famous—III Car & BBuild, April 3. 1400 w.
- Tunnel, The Simpson—Eng Rev, May 23. 1300 w. M July.
- Tunnel, Triangulation Preparatory to Alignment of a—(II) William W Redfield, J Assn of Eng Soc, Feb. 1000 w. M May.
- Tunnel—See Subway.
- TRUSSES, La Rue's Formula for Curvature of Chords in Bridge—Eng News, April 30. 900 w. M June.
- TURBINE Installation, Steam—Elec Eng, Lond, May 1. W May 23.
- TURRETS, Electric—W Elec, Apr 25.
- TUYERES—See Moulding.
- TWO-WATTMETER Method as Applied to Tri-Phase Circuits—B. D. Frankenfield, Wis Eng, June. 800 w. W July 25.
- TYPEWRITER, Telegraphic—Elec Rev, Lond, Apr 10.
- TYPHOID FEVER—See Water.
- UNITS, Systems of—William Hallock, Elec Pow, May. 2500 w. M July.
- URANINITE in Colorado, Some Notes on the Occurrence of—Richard Pearce, Min Ind & Rev, May 7. 900 w.
- URANIUM, New Raditions from Metallic—Becquerel, L'Ind Elec, June 10. W July 4.
- Uranium, Preparation and Properties of—Noissar, L'Ind Elec, June 10. W July 4.
- Uranium Salts, Invisible Radiations Emitted by—Becquerel, L'Ind Elec, Apr 10. W May 9.
- Uranium, The Emission of New Radiations by Metallic—H. Becquerel, Elec, July 15. 900 w.
- UTILIZATION of Water Power—Steiger, J Inst Elec Eng, July.
- ACUUM, A Destroying (III)—J. C. Barrows, Sci Am, June 27. 1700 w. M Aug.
- Vacuum Discharge, Theory of—De Heen, Bulletin of Belgium Academy.
- Vacuum Pump (II)—Raps, Elektrotechn Zeit, Apr 16.
- Vacuum Steam Heating System, Pressure Records from a—Eng News, June 11. 500 w. M Aug.
- Vacuum System of Heating. The—C. C. Dennis, Ir Tr Rev, June 18. 2200 w. M Aug.
- Vacuum Tube Lighting, Recent Development in—Elec Eng, Apr 29. 3300 w. M June. Tr A I E E, Mar. 15800 w.
- Vacuum Tube Lighting, The Energy Required in Moore—Elec, May 27. 1200 w. W June 6. M July.
- Vacuum Tubes, Current for—Green, Elec Eng, May 27. W June 13.
- Vacuum—See Lamp. See Lights.
- VALVES of Locomotives, Setting—Fred E. Rogers, Am Mach, July. 1200 w. M Aug.
- VANADIUM—Moissan, L'Eclair Elec, June 25.
- VAPORS Discharge Phenomena in Rarified metallic—E. Weidman and G. C. Schmidt, Elect'n, Apr 24. 1200 w.
- Vapors—See "Solids and Vapors."
- VAULTS, Ribbed—Arch, Lond, May 15. 2300 w. M July.
- VEHICLES, Automobile—Pedro G. Salom, J Fr Inst, Apr. 6800 w. M May.
- VENTILATION—Arch, Lond, July 24. 1600 w.
- VENTILATION, and Heating, Principles and Applications of—A Treatise, B. F. Sturtevant Co., Boston, Mass. 169 Pages. M July.
- Ventilation of Buildings—R. C. Carpenter, Heat & Ven, May 15. Serial Part 1. 3300 w. M July.
- Ventilation of Gas-Heated Rooms—Donald McDonald, Am Gas Lgt Jour, April 13. 7400 w. M June.
- Ventilation of Schools as Effected by Poor Sanitary Apparatus—Heat & Ven, April 15. 2700 w. M June.
- Ventilating—See "Hot Water and Heating."
- VIBRATIONS and Engineering (III)—John Milne, Engng, Mch 13. Serial Part 1. 2700 w. M May.
- VIEW Walls (III)—F. Rickard, Trans Am Inst of Min Eng, July. 12000 w.
- VIPER, The Austrian Torpedo-Boat (III)—Eng Lond, Apr 3. 1800 w. M June.
- VISCOSITY of Dielectrics—Hess, L'Eclair Elec, June 6. W July 18.
- VOLTAGE in Three-Phase Circuits, Loss of—Heyland, Elektrotechn Zeit, July 16.
- Voltage Regulator—Elec Eng, Lond, Apr 17. P June.
- Voltage Snocks, Protection Against—Bozon, Elect'n, July 24. W Aug 22.
- VOLTAIC Arc—Arons, L'Elec, July 18. W Aug 8.
- VOLTMETER Method of Measuring Power, The—Scattergood, Elec Rev, Lond, June 12.
- WARSHIPS, The Battle of the Yalu and its Effect on the Construction of—L. Ferrand, Jour Am Soc of Nav Eng, May. 1000 w. M July.
- Warships, Ventilation in—Eng, Lond, July 31. 1400 w.
- Warships, The Classification of—Engng, July 3. 6500 w. M Sept.
- Warships, The Design of—Edit, Engng, June 5. 3000 w. M Aug.
- WASTE in Country Places, The Disposal of—Harvey B. Bayshore, San, Mch. 1200 w. M May.
- WATCHES, Chronograph—Engng, July 8. 2200 w.
- WATER Analysis—San Rec, Mch 20. Serial Part 1. 1400 w. M May.
- Water Analysis and the Valuation of Color in Portable Waters, Standard Prisms in—Albert R. Leeds, Jour Am Chem Soc, June. 2300 w. M July.
- Water Conduit—See also, "Conduit."
- Water Currents, Effects of Engineering Works on—Cyrus Carroll, Can Eng, May. 2200 w. M July.
- Water Difficulty in Western Australia, The—R. Radclyffe, Min Jour, June 27. 1800 w. M Aug.
- Water for Condensing Purposes, Cooling (III)—W. H. Booth, Am Mach, Apr 2. 1200 w. M May.
- Water for Drinking and Cooking, Pure—S. P. Axtell, Eng Mag, Apr. 3200 w. M May.
- Water-Hammer in a Steam Pipe; the Cause and its Cure (III)—W. J. Williams, Am Mach, Mch 12. 800 w. M May.
- Water Main at Columbus, Ga., Submerged (III)—Eng Rec, June 6. 500 w.
- Water Mains, Laying—J. Decker, Fire & Water, July 18. 1800 w.
- Water Meters Should be Used, Why—Pav & Mun Eng, July. 500 w. M Aug.
- Water Meter, Schönheyde's Positive (III)—Ind & East Eng, July 4. 1400 w.
- Water Motors, Efficiency of Nozzles for Small—Eng News, Apr 23. 1800 w. M June.
- Water Pay, Does Pure—Eng News, June 4. 1200 w.
- Water-Pipe Lying, Inspection of—R. P. Brower, Tech, May. 2000 w.
- Water Pipes, Gutta-Percha—J. H. Morrison, Ind Rul Wld, June 10. 1700 w.
- Water Power Development, The Trenton Falls and Prospect—O. E. Dunlap, Elec Eng, April 22. 1600 w. M June.
- Water Power in Electric Harness, California—Elec Eng, April 22. 1800 w. M June.
- Water Renaissance—John Birkinbine, Pro Eng Club of Phila, April. 3000 w. M June. Iron Age, Mar 26. 1800 w. M May.
- Water-Right, A Utah Attempt to Settle Contested—W. Hardesty, Am Soc of Ir Eng, April. 1895. 1100 w.
- Water-Power, The Utilization of; Especially with a Small Fall—Alph. Steiger, Elect'n, May 29. Serial Part 1. Lond, Elec Eng, May 29. 1700 w. W June 23, 27. M July.
- Water Power, The Value of—Eng Rec, May 9. 1200 w. M June.

The Natural Premium



of Wisconsin.



Over \$1,000,000 Insurance Written
the first six months.



This Company

furnishes protection at reasonable rates. Its policy contracts are pronounced by many of our leading citizens to be the best in the market. We have good territory for good agents.

RASMUS B. ANDERSON,
President.

WM. H. ROGERS,
Secretary and Manager.



Hon. W. H. Upham, Governor of Wisconsin; John A. Johnson, President Fuller & Johnson Mfg. Co.; John Hunner, ex-State Treasurer, and others, members of Advisory Board.

Address, W. H. ROGERS, Sec'y,
MADISON, WIS.

Please mention Wisconsin Engineer when you write.

- Water, The Power of.—C. A. Stone, Milling, June, 1100 w. M Aug.
- Water-Power—See Power.
- Water-Powers with small Fall, Utilization of ———, Elec Eng, June 24.
- Water Purification for Steam—John McNaull, Wilson, Elec Rev, Mch 18. 2800 w. M May.
- Water Purifying, Feed—Ry Age, June 13. 6800 w.
- Water Supply and Typhoid Fever, Cincinnati—San, May, 2400 w.
- Water Supplies, Animal and Vegetable Growths Affecting—Albert R. Leeds, Pav & Mun Engng, June, 1400 w.
- Water Supply—Engng, July 4. 1400 w.
- Water Supplies, Bacteriological and Chemical Studies of Public—Eng News, April 30. 1500 w. M June.
- Water Supply for Jersey City, The Specifications for a New—C. C. Verneub, Eng News, May 7. 2800 w. M June.
- Water Supplies, Filtration of Municipal (II)—Eng Mag, July, 4200 w. M Aug.
- Water Supplies, Filtration of Public—Allen Hazen, Pav & Mun Engng, June, 4500 w. M July.
- Water Supply in 66 American and Foreign Cities, Typhoid Fever and—Eng News, May 21. 1500 w.
- Water Supply, London—Engng, Mch 20. 2000 w. M May.
- Water Supply of Illinois, Chemical Survey of the—A. W. Palmer, Tech, May, 800 w. M Aug.
- Water Supply, Mr. Allen Hazen's Report on the Jersey City—Eng Rec, Mch 28. 1800 w. M May.
- Water Supply of Buenos Ayres (III)—Eng Rec, June 13. 1500 w.
- Water Supply of Liverpool, The Vyrny Works for the—G. F. Deacon, Col Guard, May 8. 800 w.
- Water Supply of Manchester, The Thivemere Works for the—G. H. Hill, Col Guard, May 8. 1000 w.
- Water Supply System of Ogden, Utah, The (II)—W. P. Hardesty, Eng News, May 21. 2000 w.
- Water Supply of Toronto, Mr. Mansergh's Report on the—Eng News, Mch 12. 3000 w. M May.
- Water Supplies, The Purification of Public—G. Roho, San, July, 3000 w.
- Water Supply of Rome, The—H. Seffman, Pro Eng Club of Phila, July, 3500 w.
- Water Supply of Small Towns, The (II)—Percy Griffith, Ind & Ir, April 17. Serial Part 1. 3000 w. M June.
- Water Supply of the Paris Suburbs, The (III)—Eng, Lond, April 3. 700 w. M June.
- Water System of Burlington, Vt., On the Sanitary Condition Past and Present of the—J. N. E. Water Works, Mch, 5800 w. M May.
- Water System of Burlington, Vt., The (III)—F. H. Crandall, J. N. E. Water Works, Mch, 4500 w. M May.
- Water, The Feasibility and Cost of Purifying Badly Polluted—Eng News, Apr 2. 2400 w. M May.
- Waters, The Bacterio-Chemical Examination of Polluted—W. E. Adeney, Engng, May 29. Serial Part 1. 4000 w.
- Water Wheels, A New Method of Governing—H. D. Williams, Sib J of Engng, Mch, 2000 (II)—H. D. Williams, Sib J of Engng, Mch, 2000 w. M May.
- Water Works and Pumping Engines, Lynn Mass, Its Water Supply (II)—Fire & Water, May 30. 3500 w.
- Water Works, Erie, Pa. (III)—Fire & Water, Mch 21. Serial Part 1. 800 w. M May.
- Water Works, Norfolk, Va. (II)—Fire & Water, May 16. Serial Part 1. 700 w.
- Water Works of Lambertville, N. J., Sand Filter Beds for the (II)—C. Hungerford, Eng News, July 2. 1400 w.
- Water Works of Philadelphia, The Queen Lane Division of the—Pro Eng Club of Phila, Aprn, 2800 w. M June.
- Water Works Pumping Plants, Some Recent Installations of Lower Pumps in Small (III)—Eng News, May 28. 1800 w.
- Water Works Reservoir at Vienna, Extension of a Covered (I.)—Eng News, May 21. 500 w.
- Water Works, Reservoir, Asphalt Lining for—L. J. LeConte, Abst Paper Am Water works Assn, Eng News, June 11. 2800 w. M Aug.
- Water Works, Salem, Mass (II)—Fire & Water, April 25. Serial Part 1. 700 w. M June.
- Water Works Scheme, Delhi—B. Parker, Ind Engng, March 7. Serial Part 1. 1700 w. M June.
- Water Works, St. Vatherine's, Ont. (III)—Fire & Water, May 9. Serial Part 1. 1500 w.
- Water Works, The Astoria City (III)—A. L. Adams, Jr Am Soc of Civ Eng, Apr. 1700 w. M June.
- Water Works, The Galveston (III)—Eng Rec, July 18. Serial Part 1. 2500 w.
- Water Works, The Financial Management of—Abst Paper, N. E. Water Works Assn, Eng Rec, June 20. 2500 w. M Aug.
- Water Works, The Lowell, Mass (III)—Fire & Water, April 18. 700 w. M June.
- Water Works, The Syracuse (III)—Eng Rec, Mch 21. 400 w. M May.
- Water Works, Toledo, O (III)—Fire & Water, April 11. 1700 w. M June.
- WATTMETER in Railway Practice, The Recording—Caryl D. Haskins, St Ry Jour, May, 1900 w. W May 23.
- Wattmeter, Universal (III)—L'Eclair Elec, May 30. W June 27.
- WAX for Holding Work on Grinder (III)—Am Mach, April 30. 700 w. M June.
- WAY, Permanent J. C.—Eng, Lond, May 8. —0 w. April 10. 700 w. 700 w.
- Way, Recent Improvements in Maintenance of—Benj Reece, J Assn Engng Soc, May, 5060 w. M Aug.
- WEIGHT and Measures—S. Reeve, Eng News, July 30. 800 w.
- WEIRS, Bear-Trap (III)—W. A. Jones, Jour Assn of Engng Soc, June, 4200 w.
- Weir, Modified Drum (III)—H. A. Chittenden, Jour Assn of Engng Soc, June, 1800 w.
- WELDING, Arc—McCarthy, Electn, May 22. Engng, May 22. W June 13.
- Welded Flanges, Strength of Electrically—Dig Phys Tests, July, Aug 29.
- Welding in England, Electric—John Marsden, Am Mach, Mch 26. 1000 w. M May.
- Welding Machine, Electric Wheel (II)—Ind & Ir, July 31. 1000 w. M Sept.
- WELLS, City Street Lighting—F. P. Morrill, Pro Age, July 1. 2700 w. M Aug.
- WHEATSTONE Bridge for Low Resistances—Reeves, Phil Mag, May.
- Wheatstone's Bridge for the Determination of Low Resistances, An Addition to the—J. H. Reeves, Paper Phy Soc, Electn, Mar 20. P June, West Elec, July 4.
- WEATHER Bureau, The United States—E. T. Peftt, Yale Sci M, June, 1200 w.
- WHEEL, A Steel Framed (III)—Eng News, July 30. 400 w.
- Wheel Record, Comparative—St Ry Jour, May, 400 w.
- Wheels, Some Observations on—George S. Hodgins, R R Car Jour, May, 1800 w.
- Wheel-Teeth, Circular—Ind & East Eng, March 21. Serial Part 1. 3000 w. M June.
- WHITE Lead, Electrolytic—Orne, Eng & Min J, June 27. W July 18.
- White Lead, Electrolytic Manufacture of—Williams, Eng & Min J, May 16. W May 30.
- White Lead, The Manufacture of—G. Robertson, Electn, July 10. 2000 w. W Aug 1.
- White Metals for Bearing Surfaces—Robert Davison, Prac Eng, April 17. 1700 w. M June.
- WILMOTTE Stops for Mine Cages (III)—Col Guard, June 19. 3000 w. M Aug.
- WINDING Engine, Experimental Trials with an Electrically Driven—Col Guard, April 10. 2500 w. M June.
- WINDMILLS, The Pumping Power of (III)—E. Murphy, Am Soc of Ir Eng, Apr 1895. 2500 w.

Electric & Combination Fixtures
ELECTRIC LIGHTING
SUPPLIES.

P. F. HARLOFF, 301 State St., Madison, Wis.

GAS Is the Safest
Is the Cheapest
Is the Cleanest
Is the Coolest
Is the Quickest **FUEL**

IS THE BEST FOR CULINARY PURPOSES.

Do You Cook with Gas? If not, Why not?

Madison Gas and Electric Co.

Watch the **C**ollege Book Store

For Bargains in Books this Fall.

If you have got to buy any Drugs —

Go to **MENGES'**,
 Dispensing Druggist,
 28 West Mifflin St.

PHOTOGRAPHIC CHEMICALS.

Please mention Wisconsin Engineer when you write.

- Windmills, Horse Power of (Ill)—Am Miller, May 1. 400 w. M June.
- WIND Pressures at St. Louis, High—Eng Rec, June 6. 900 w. M July.
- Wind Pressure in Mill Construction, The Treatment for—James L. Greenleaf, Sch of Mines Quar, Apr. 9000 w. M July.
- WIRES, Fuse—Stine, Am Elec, May. W June 6.
- Wires in Boston, Removal of (Ill)—Elec Rev, Mch 25. 3200 w. P May. M May.
- Wires, Insulating Material for—L'Elec, Apr 4. W May 9.
- Wire Patent in England, The Three—Electn, July 3.
- Wire Rods, Apparatus for Treating (Ill)—C. W. Bildt, Ir Age, April 16. 1100 w. M June.
- Wire Rope—See Power.
- Wires—See Glucinum.
- Wiring—J Inst Elec Eng, Apr.
- Wiring, Electric—Engng, Mch 27. 1600 w. M May.
- Wiring, Quick Methods of Testing for Faults in Electric—A. E. Hutchins, W Elec, Mch 21.
- Wiring Indoor, Apparatus for—Uppenborn, Electrotechn Zeit, June 11. W July 11.
- Wiring Interior—Am Elect'n, May and Aug. 1600 w. M July.
- Wiring Rules—Elec Rev, Lond, Apr 10.
- Wiring, System in—J. T. Monell, Elec Pow, April. 2300 w. M June.
- Wiring Table—Scott, Elec Rev, Lond, Apr 17.
- WOLVERHAMPTON Electric Supply System (Ill)—Electn, June 12. 4000 w. M Aug. W July 4.
- WOODEN Posts, Preservation—St Ry Rev, Apr 15. 300 w. M June.
- WOODWORK in Spanish Churches, Carved (Ill)—Builder, April 25. 2200 w. M June.
- WORK in Car Shops, Piece—G. L. Potter, R R Jour, April. 2300 w. M June.
- Works of Böel Brothers, The, La Louvière, Belgium (Ill)—Ir & Coal Trs Rev, Mch 6. 600 w. M May.
- WRECK RAISING (Ill)—Engng, Mch 27. 4000 w. M May.
- WROUGHT IRON—See "Iron."
- Wrought Iron to Be Fibrous, The Conditions Which Cause—W. Durfee, Jour Fr Inst, Aug. 1300 w. M Sept.
- Wrought Iron, The Manufacture of—James Kerr, Ir & Coal Trs Rev, April 17. 1800 w. M June.
- X** RAYS—See Roentgen Rays.
- Y** ACHT Josephine, P. A. B. Widener's New Steam (Ill)—Am Shipbuilder, Apr 2. 800 w. M May.
- YARD Limits—R R Gaz, July 10. 1400 w.
- YOUNG'S MODULUS, The Influence of Heat: of the Electric Current and of Magnetization Upon—Mary C. Noyes, Phys Rev, May-June. 4500 w. W May 30. M July.
- YUCATAN, The Ancient Cities of (Ill)—Sci Am Sup, May 23. 3200 w. M July.
- Z** INC—See Lead.
- ZONE SYSTEM, The—Ind & East Eng, Feb 25. 1800 w. M May.

JOHN GRINDE

A. G. SCHMEDEMAN

EDWARD QUAMMEN

Grinde, Schmedeman & Quammen,

MADISON, WIS.

We carry a First-Class Line of Ready-Made Clothing and Men's
Furnishing Goods.

In Our Tailoring Department We carry everything that is new and
nobby. Call and examine our line.

JOHN GALLAGHER,**Awnings, Tents, Sails, Flags.**

YACHT SAILS A SPECIALTY.

Washington Ave. and Bedford Sts.,

MADISON, WISCONSIN.

Nielson,

Finest Cabinets

\$3 per dozen.

The Photographer,

23 South Pinckney St.

SIDNEY P. RUNDELL,**Hatter and Men's Furnisher,**

7 EAST MAIN STREET.

DAVY'S RESTAURANT,

NOW OPEN DAY AND NIGHT.

Short Orders.

Table Board.

Meal Tickets.

Oysters in all Styles

Please mention Wisconsin Engineer when you write.

University of Wisconsin.



College of Mechanics and Engineering.



Offers Three Systematic Courses——



**CIVIL ENGINEERING,
MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING.**



It Also Affords——



Facilities for extensive experimental research and special training in Geology, Mineralogy, Physics, Astronomy, Commercial Assaying, Electrometallurgy, Chemistry, Electrochemistry, Machine Design, Testing of Materials; and in Steam, Hydraulic, Sanitary, Structural, Railway, Municipal and Geodetic Engineering.



The Library Facilities——

Are very complete, all the important Technical Journals and Society Proceedings in the world being kept on file and always accessible.



For further information send for Engineering Circular
or University Catalogue.

Address,

C. K. ADAMS, President,
Madison, Wis.

Please mention Wisconsin Engineer when you write.

SMALL BOILER FEEDER

HYDRAULIC PRESSURE PUMP

LARGE BOILER FEEDER

MARSH
STEAM PUMPS
STANDARD FOR ALL DUTIES

MANUFACTURED BY **The BATTLE CREEK STEAM PUMP CO.**
BATTLE CREEK MICH.

AIR COMPRESSOR

FOR DEEP WELLS

17,000 SOLD IN EIGHT YEARS

PATENT SELF-GOVERNING STEAM VALVE
PATENT EASY SEATING WATER VALVES
NO OUTSIDE VALVE GEAR

MAXIMUM OF STRENGTH SIMPLICITY AND SERVICE

COMPOUND

LARGE TANK

WRITE FOR CATALOGUE.

GARDNER DIE STOCK

FULL THREAD AT ONE END
FULL THREAD AT OTHER

ALL THE PARTS SUBJECT TO WEAR ARE OF HARDENED STEEL

THE GUIDES ARE OF HARDENED STEEL

THE CHISELS ARE OF HARDENED STEEL

CHARLES H. BESLY & CO.

METAL WORKERS FINE TOOLS & SUPPLIES

10 & 12 N. CANAL ST. CHICAGO ILL.

SIZE CAN BE CUT THE SAME DIE

WITH EACH SIZE IRON & STEEL

HELMET BRONZE

MADE IN WIRE FOR COILED SPRINGS
AND IN SHEET FOR FLAT SPRINGS
THE BEST SPRINGS MADE

Send for 230 Page Ill. Catalogue

CHARLES H. BESLY & CO.

METAL WORKERS FINE TOOLS & SUPPLIES

10 & 12 N. CANAL ST.
CHICAGO ILL. U.S.A.