



LIBRARIES

UNIVERSITY OF WISCONSIN-MADISON

The Wisconsin engineer. Vol. 30, No. 6 March 1926

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

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

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

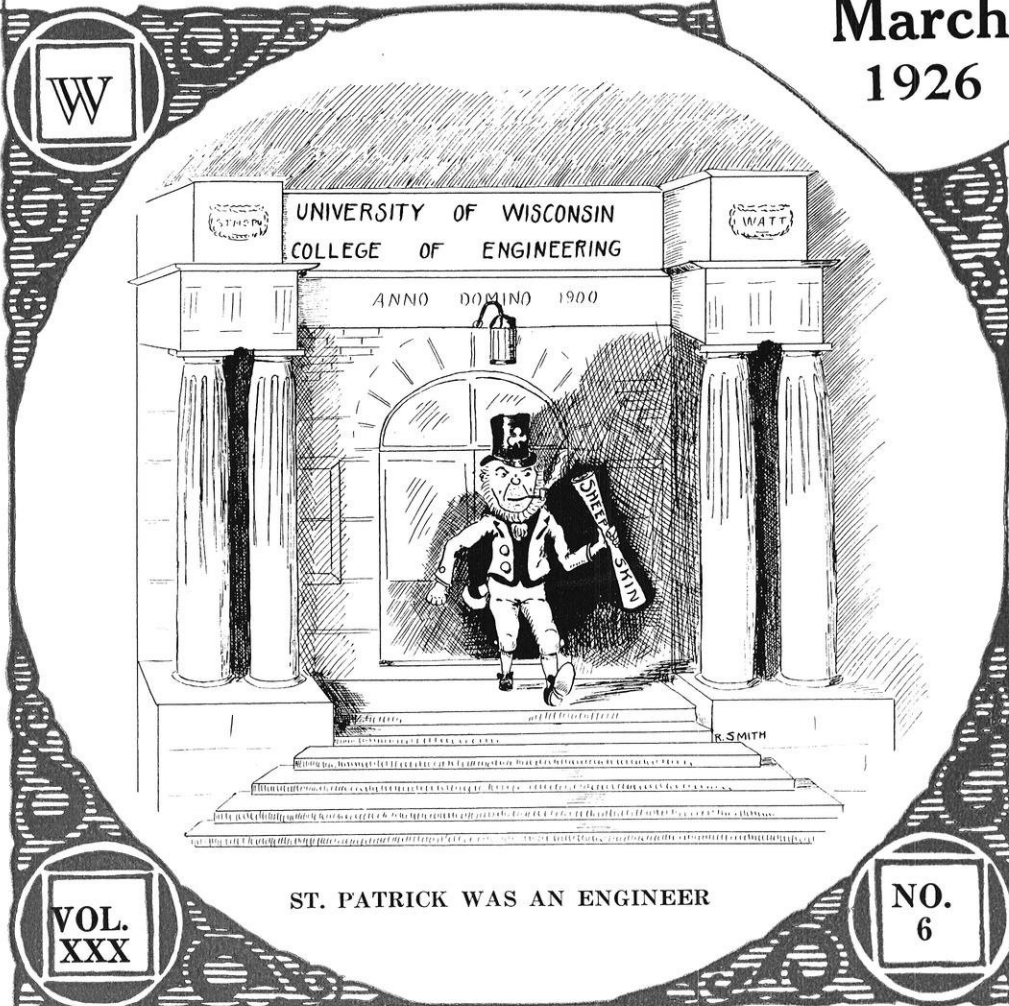
The libraries provide public access to a wide range of material, including online exhibits, digitized collections, archival finding aids, our catalog, online articles, and a growing range of materials in many media.

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.

The Wisconsin Engineer

MEMBER
OF
ENGINEERING
COLLEGE
MAGAZINES,
ASSOCIATED

March
1926



The College of Engineering
University of Wisconsin
Madison



FROM FANCY TO FACT

IN the "Manchester Guardian," one of England's most famous newspapers, there has been a series of American sketches written by a travelling correspondent. His awe at New York's "giant skyscrapers" seems even to have surpassed the wonder which most Europeans feel when they first gaze upon that skyline. "But," he continues, "the electric lift made the skyscraper a fact."

In these words he has expressed very tersely a truth which many of us have come to take for granted.

Nothing could be more fantastic than the sight of those mighty towers climbing up through the many-colored mists of the great city; nothing could be more dream-like. And yet, nothing could be more useless were it not for the thousands of Otis Elevators which are busily plying within those high walls.

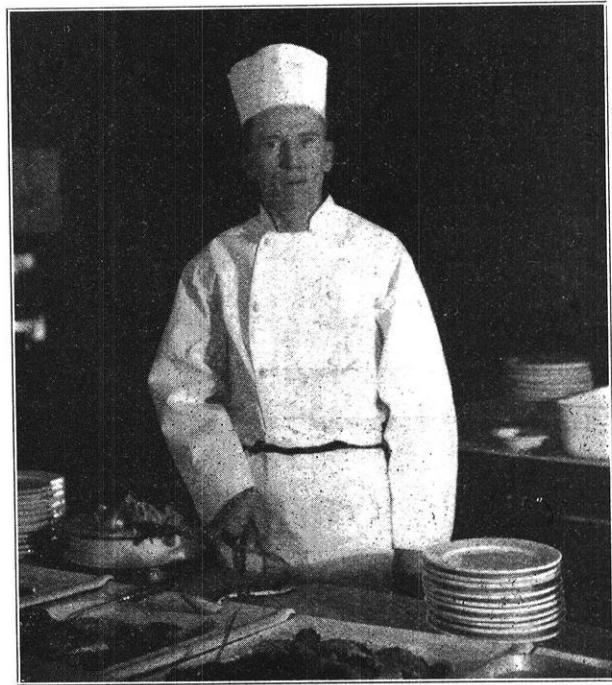
The skill of architects and engineers has created a vision, a mirage wilder than any of the "cloud-capt towers" of fancy. But the Otis Elevator has made the skyscraper a fact.

There are over 17,000 Otis Elevators operating in New York City, ranging from the lowly hand-power elevator to the 800 ft. speed automatic signal control elevator for intensive office building service. All elevators in New York carry more passengers per day than the combined subway, elevated and surface car lines, amounting to ten million people per day.

O T I S E L E V A T O R C O M P A N Y

Offices in all Principal Cities of the World

**WELL-
HE SERVES YOU
AND
HE SERVES YOU
WELL**



UNIVERSITY Y CAFETERIA
HOME COOKING REASONABLE PRICES

740 Langdon

Fairchild 2500

MEET OUR CHEF

PRINTING

GETS THINGS DONE

*It builds sales, creates good-will, wins friends
retains old customers, adds new ones. It taps
hidden reservoirs of business, opens new mar-
kets, carries your message to the four corners
of the world.*

BLIED PRINTING COMPANY
MADISON, WISCONSIN

For
Student Supplies
Job Printing
Stationary
 and *Mimeographing*
 see **NETHERWOOD'S**
 519 STATE STREET

Power Generating and Distribution Equipment

Prime movers of all types, Steam Turbines, Steam Engines, Hydraulic Turbines, Gas and Oil Engines, together with a full line of generators for each type.

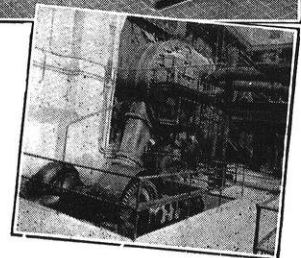
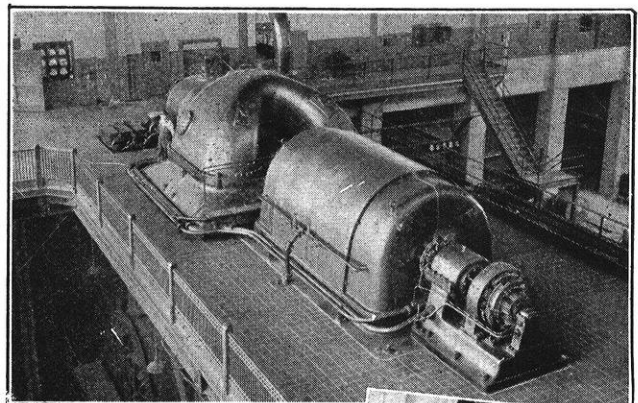
Auxiliary equipment, consisting of Transformers, Motor-generator sets, Converters, Switchboards, etc.

Motors, both Direct and Alternating Current, for every kind of application.

A complete line of high-grade Transmission Machinery; Pulleys, Shafting, Hangers, Couplings, etc.

Send for Bulletins.

ALLIS-CHALMERS MANUFACTURING CO.
MILWAUKEE, WIS. U.S.A.



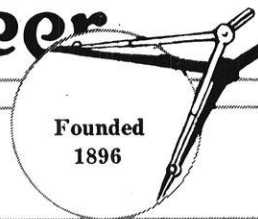
FRANK BROS.
 FANCY GROCERIES AND FRUITS

11163 UNIVERSITY AVENUE

Phones: Badger 5335-2689-71

Please mention The Wisconsin Engineer when you write.

The Wisconsin Engineer



25c
A Copy

Published monthly from October to May, inclusive, by
THE WISCONSIN ENGINEERING JOURNAL ASSOCIATION
306a Engineering Building, Madison, Wis. — Telephone University 177

\$1.50
A Year

CONTENTS

VOLUME 30	MARCH, 1926	NO. 6
Investigation and Research Relating to the Steam Turbine ----	G. B. Warren	187
The Chemical Engineer in the Printing Industry -----	R. L. Drake	190
Repairing of an Old Masonry Arch-culvert -----	L. T. Sogard	192
The Effect of the Motor Bus upon the Street Railway -----	L. F. Van Hagan	194
Engineering Review -----	R. A. Millermaster	197
Campus Notes -----		199
Editorials -----		200
Athletics -----	B. R. Teare	204
Alumni Notes -----	R. W. Swallow	206

BOARD OF DIRECTORS

F. E. VOLK, Librarian of College of Engineering, <i>Chairman.</i>	M. J. WILLIAMS, <i>Manager</i>
N. E. FRENCH, Instructor in Electrical Engineering, <i>Advisory Editor.</i>	R. T. HOMEWOOD, c'27, <i>Editor</i>
R. S. McCAFFERY, Prof. of Mining and Metallurgy, <i>Secretary.</i>	O. L. KOWALKE, Prof. of Chemical Engineering.
	G. L. LARSON, Prof. Steam and Gas Engineering.
	L. F. VAN HAGAN, Prof. of Civil Engineering.

M. J. WILLIAMS, m'27, *Manager*
R. T. HOMEWOOD, c'27, *Editor*
H. C. WOLFE, e'26, *Associate Editor*

L. W. HEISE, m'26, <i>Advertising Mgr.</i>	E. BIRKENWALD, c'27
L. J. CLEVELAND, m'27, <i>Advertising</i>	S. M. CLARK, c'27, <i>Art</i>
H. D. CRAWFORD, min'27, <i>National Adv.</i>	J. LEVIN, c'27, <i>Campus Notes</i>
K. C. DAVIS, m'27, <i>Advertising</i>	R. A. MILLERMASTER, e'27,
R. D. JORDAN, e'27, <i>Circulation</i>	<i>Engineering Review</i>
L. H. MATTHIAS, e'26, <i>Art</i>	B. R. TEARE, e'27, <i>Athletics</i>
	R. W. SWALLOW, e'28, <i>Alumni Notes</i>

Members of Engineering College Magazines, Associated

PROF. L. F. VAN HAGAN, *Chairman*, University of Wisconsin, Madison, Wisconsin

Armour Engineer	Kansas State Engineer	Purdue Engineering Review
Colorado Engineer	Michigan Technic	Rose Technic
Cornell Civil Engineer	Minnesota Techno-log	Sibley Journal
Illinois Technograph	Nebraska Blue Print	Tech Engineering News
Iowa Engineer	Ohio State Engineer	Pennsylvania Triangle
Iowa Transit	Penn State Engineer	Virginia Journal of Engineering
Kansas Engineer	Princeton News Letter	Wisconsin Engineer

Roy Barnhill, Inc., 40 East 34th St., New York, Sales Representative

Copyright 1925 by the Wisconsin Engineering Journal Association. Any article printed herein may be reprinted provided due credit is given. Entered as second class matter Sept. 26, 1910, at the Post office at Madison, Wis., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized October 12, 1918.

*For six years we have
followed but one ideal—
SERVICE
to the Wisconsin
Engineering
Students*



R I C H T E R
+ DRAWING INSTRUMENTS +

ASK
THE MAN
WHO
OWNS A
SET

The WISCONSIN BLUE PRINT COMPANY
26 West Mifflin Street · MADISON · WIS



United States Blue Print Paper Co · 207 Wabash Avenue · Chicago, Ill.
GENERAL AGENTS

Please mention The Wisconsin Engineer when you write

The Wisconsin Engineer

UNIVERSITY OF WISCONSIN

VOL. XXX, No. 6

MADISON, WIS.

MARCH, 1926

INVESTIGATION AND RESEARCH RELATING TO THE STEAM TURBINE

By G. B. WARREN, *Turbine Engineering Department,
General Electric Co.*

It is difficult for us to realize the conditions which have existed in the world before the introduction of machine power. The change which the steam engine brought was so great as to be termed the industrial revolution. The introduction of steam power into the industrial and transportation processes completely changed the character of living. That all of these changes were not for the better goes without saying, but still the help which the application of machine power has given mankind in the struggle for existence has immensely lessened the hardships, and raised the standard of living.

Although water power is an important part of the total electrical power used, the bulk of the electrical energy must be produced from fuel. For this reason the present, and at least the immediate future development of the electrical industry depends upon the development of the steam turbine. Its high efficiency in the turning into power the cheapest known fuel, bituminous coal, its great capacity, and low initial cost per unit of power when installed in the power station, have made it the pre-eminent prime mover.

The present article is a very brief resume of some of the research work which the General Electric Company has been carrying on during the past few years relating to the steam elements of large steam turbine construction.

Fig. 1 shows a cross sectional view of a large General Electric turbine which in this particular instance is a 40,000 Kw-1500 r. p. m., 20 stage machine designed for an initial steam pressure of about 350 lbs. per sq. in., 700 degrees F. initial temperature and 1 in. mercury absolute back pressure.

This machine is broadly classed as an impulse turbine. As can be seen, this particular machine consists

essentially of a shaft upon which are mounted a number of wheels with a single row of buckets or turning blades upon each wheel. In between each wheel and supported in the shell is what is known as a nozzle diaphragm. This is a circular plate or disk having a hole in its center through which the shaft passes; and carrying at its outer circumference, guide blades or nozzles. The shaft passes through a hole in the shell at each end and is supported in bearings. At the points where the shaft passes through the shell and diaphragms it is, of course, necessary to put in some kind of packing to prevent the steam leaking out of the high pressure end, or past the diaphragms, and to prevent the air leaking in at the low pressure end.

In the type of design under consideration the pressure drop or conversion of the potential pressure head and temperature head energy in the steam into the velocity or kinetic energy of the jet takes place in the nozzles or guide blades of the diaphragms. This is shown in Fig. 2 which shows a circumferential view of a series of nozzles and buckets. This expansion and conversion of energy is accompanied by a guiding action of the nozzle partition plates which direct the high velocity jet into the moving bucket passageways. These buckets are moving at substantially one-half the velocity of the jet. The jet, therefore, impinges upon the bucket passageway with a velocity relative to the bucket which is about one-half the value of the absolute velocity which it had when leaving the nozzle, is reversed in direction, and leaves the bucket in a direction opposite to the bucket's motion at a velocity relative to the bucket which is approximately equal to the bucket velocity. It, therefore, leaves the bucket with an absolute velocity which is practically zero in the direction of the bucket's motion. The steam then enters the next row of nozzles, and the process is again repeated

through a further degree of expansion. The dividing up of the expansion into a number of stages is done in order to permit the running of the buckets at approximately half the steam speed, and still maintain wheel speeds which are within the limitations imposed by present materials.

After the steam leaves the last stage wheel, it passes into the exhaust hood which guides and directs it to the condenser.

The fundamental idea back of the research work relating to the steam elements of these turbines has been to search for, to seek to understand, and to find out the magnitude of the various losses which occur, and then to attempt to reduce these losses to the minimum possible values.

The internal losses which may occur in the turbine are shown in the following table:—

1. Nozzle Losses.
2. Bucket Losses.
3. Interstage Losses.
4. Leakage Losses.
5. Rotational Losses.
6. Leaving Losses.
7. Exhaust Hood Losses.
8. Throttle Losses.
9. Moisture Losses and Undercooling Losses.

The nozzle losses in dry steam consist, in general, of friction losses along the side walls, eddy or vortex losses on the down stream side of the exit edge of the nozzle partition plates, and a peculiar end whirl or vortex loss which occurs in the radially inner and outer ends of the nozzle passageway.

The bucket losses consist essentially of the same kind of losses as the nozzle losses, plus a somewhat indeterminate shock loss at the entrance, and extra vortex and eddy losses in case the bucket to nozzle overlap is too great, or in case the bucket area is greater than necessary.

The leakage losses consist essentially of the high pressure packing leakage loss, the diaphragm leakage losses between the stages, and some slight leakage losses around the tips of the blades.

The rotational or windage losses consist of frictional and eddy losses caused by rotating the disks in high pressure steam.

The leaving losses are caused by the fact that the steam must have a certain velocity, which is mostly axial, in leaving the last stage wheel in order that the steam may get out. This velocity carries energy in proportion to the square of its value, and this energy is not available to the turbine inasmuch as all the working parts of the turbine have been passed. It is a loss which

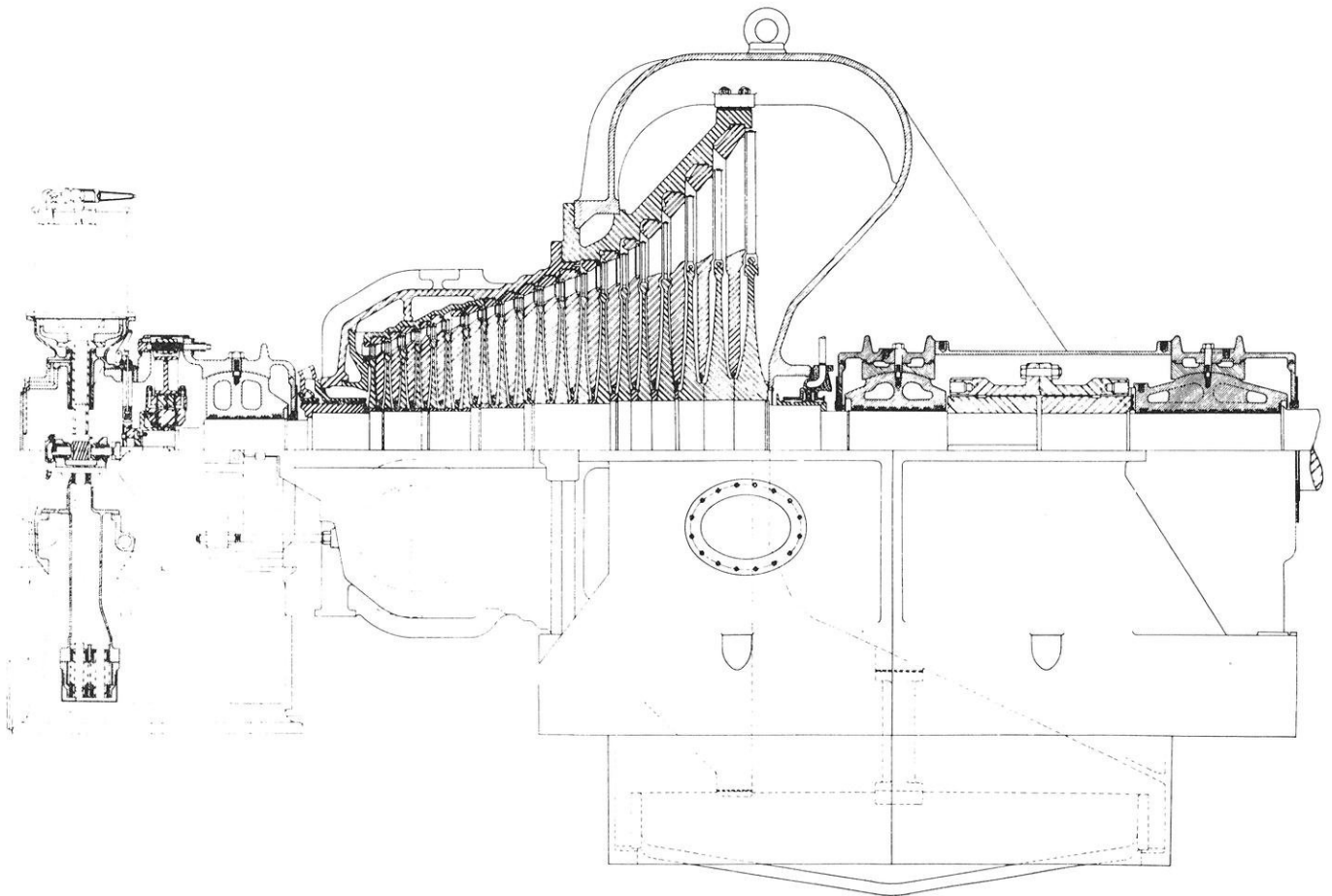


Fig. 1. Cross sectional view of a 40,000 Kw—1500 r. p. m.—20 stage turbine designed for initial steam pressure of about 350 lbs. per sq. in., 700 degrees F. initial temperature and 1 in. mercury absolute back pressure.

must be taken in some degree on all turbines. This loss varies as the capacity, flow, and vacuum; and the size of the last stage bucket influences the velocity which it is necessary to have to get the steam out of the annulus area of the last stage bucket.

The exhaust hood losses are those frictional and eddy losses which occur in the exhaust hood of a machine while the steam is being taken from the last stage bucket and directed to the condenser. This loss manifests itself by a slight drop in pressure in the hood, and therefore makes less energy available to the turbine. In one case on the 60,000 Kw. turbine at Chicago, an exhaust hood design has been used, however, which gives an actual increase in pressure from the turbine to the condenser, secured by means of diffusion of the leaving velocity, and so in this case some of the leaving loss is recovered.

The throttle losses are those pressure drops which are necessary to some extent in getting the steam through the throttle valve, controlling valves, and passageways leading up to the first stage nozzles. These losses are generally of small magnitude.

The moisture or undercooling losses are grouped together inasmuch as they are both the results of steam expanding under a condition of total heat which is less than that of dry saturated steam. More will be said of this a little later.

In attacking the analysis of these losses several different lines of activity have usually been followed. In order to avoid drawing conclusions, wherever possible, the answer to any specific problem has been sought in two or more directions. This frequently leads to a great deal of grief and trouble, because very frequently these different means of investigations do not show the same answer. It can easily be seen that this leads to additional work, and a great amount of analysis in order to reconcile the two or more results, and perhaps additional testing even along still different lines of activity may be necessary. For instance, nozzles are being tested in three ways:—A reaction nozzle testing machine is being used, in which the reaction of a nozzle is being measured in order to determine its efficiency; an air test is used for blowing air through models of nozzles and measuring the losses; and various nozzle and bucket combinations are being run in a single stage turbine built solely for test purposes to determine the action of different nozzle and bucket conditions. In addition to this, a large number of complete combinations of nozzles and buckets embodying different ideas have been built and tested in a full size turbine. The same general scheme of attack is made on the bucket problems. Here hundreds of tests have been run in the air test; that is, blowing air through stationary models of buckets and measuring the results. A large number of different bucket and nozzle combinations have also been run on single wheel tests in the special test turbine to determine their relative performance.

In connection with the leakage losses, models of the packings have been tested to determine the best tooth

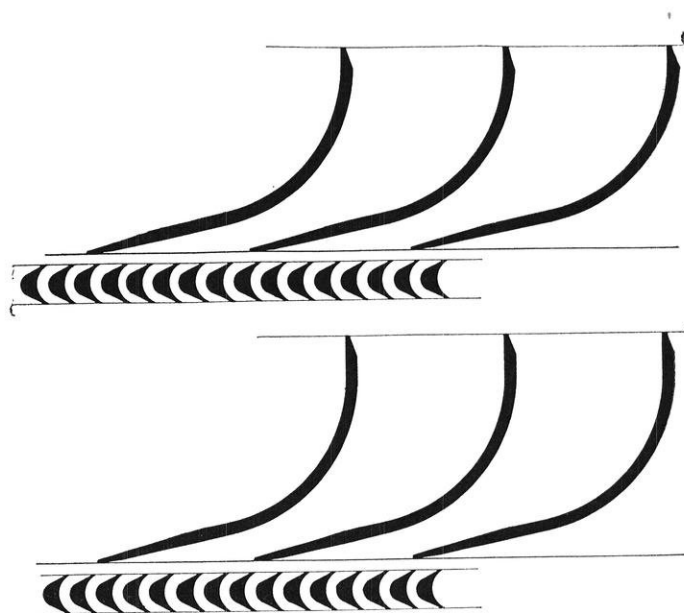


Fig. 2. Circumferential view of a series of nozzles and buckets.

form and the calculation constants in determining the leakage in actual turbines. Tests have been made in the actual turbine to determine the effect of the diaphragm packing leakage upon the steam stream entering the moving buckets. A large number of tests have been made in which buckets of various forms have been run at different nozzle-to-bucket clearances in order to determine the leakage around the bucket.

In order to determine the rotational losses to a more accurate degree the classical tests of running wheels of different sizes in steam with different kinds of bucket conditions, shrouding conditions etc. have been repeated and extended, and attempts have also been made, although not with complete success, to run rotation loss tests on an actual turbine.

In addition to the above, very recently, a single stage full size turbine has been built which can be operated on compressed air, running the wheel with an arc in its discharge in the open, and by means of impact tubes and angle measuring devices on the discharge it has been possible to make a detailed exploration of the character of the stream coming from the bucket. This has been done with the idea of finding what kind of nozzle and bucket combinations gave the most compact and smooth exit stream, thus carrying the least energy away from the wheel, and which energy could furthermore be used with the greatest advantage as initial velocity in the succeeding stage.

The reduction in the final leaving losses is largely a mechanical bucket problem depending upon obtaining for a given capacity the greatest bucket length possible consistent with mechanical safety in the case of very large machines, and consistent with a reasonable cost on smaller machines. However, the bucket shape must be such as to guide the steam in the required direction, and in a uniform stream so as to utilize the area to

Continued on page 212

THE CHEMICAL ENGINEER IN THE PRINTING INDUSTRY

By R. I. DRAKE, *ch'20*

Engineer, W. F. Hall Printing Company

To many of you who read this, the idea of a chemical engineer in the printing industry will come as somewhat of a surprise. A surprise because you have never considered that printing is an industry, or that it is a large enough industry to require the services of an engineer, much less those of a chemical engineer.

But it is an industry and an enormous one at that. It has grown in the last twenty years from the little platten press so often seen in the windows of the country newspaper office, to the enormous rotary presses of today with the capacities of ten thousand copies of eight, sixteen, or thirty-two page signatures per hour. And the limit is not yet in sight.

How many of you as you read your morning paper or pour over your calculus or turn the pages of the latest catalog, have any idea of all of the materials which go to make up the finished product you treat so lightly, or of the multiplicity of operations which gave it birth?

Let us consider first the materials which constitute that magazine which you were just reading. The odds are even that it was College Humor, one of the many publications which this plant prints, binds and mails. There are of course the obvious materials, paper and ink. Then, if you were to tear the cover from the book, you would find it bound with a wire stitch and that the cover was glued on. This gives four raw materials in the finished book as it is delivered. But back of these are still others, unseen, but nevertheless contributing their small share towards the finished whole. These are coal, oil, kerosene, toluol, benzol, acetone, glycerine, copper, nickel, lead, brass and bronze, iron and steel, papers of various kinds, chalk, bleach liquor, leather, celluloid, and many other things too numerous to mention.

Let us consider the processes which enter into the finished article. You will say off hand that there are but two. One the printing and the other the binding. Quite true, but in order to print we must have something to print on. It may be glass, metal, cloth, celluloid, parchment or as in this case, just paper. So if we are going to use paper and use it intelligently, we must know something about how paper is made. At once we are tied up with the various chemical and mechanical processes which go into the manufacture of a sheet of paper.

Next we must have something to print from. This is the printing plate, which is manufactured from lead,

copper and nickel, and in order to use it intelligently we must know something about how it is made. This takes us into the field of metallurgy and electroplating. Back of these still is photography and chemistry.

We have now the plates and the paper, but how shall we transfer the thoughts which have been impressed on the plate, to the surface of this snow-white sheet. Easy you say, just use ink.

Look out for that one.

The Ink

Let's start with the ink. Ink is made from so many things that it rightly requires an entire article in itself. But roughly it consists of a vehicle which may be rosin oil, paraffine oil, kerosene, or linseed varnish or any combination of any of the above; a pigment which may be carbon black or any of a multiplicity of colored pigments all having their own particular properties which make them especially suitable to printing inks; and thirdly, something to make the ink dry.

The study of printing ink vehicles is a specialty in itself and especially the relations existing between the ink and the paper. Little has been done to determine scientifically the best vehicle for the pigment used and at the same time for the paper. More trouble arises in the pressroom due to improper vehicle in the ink than from any other cause.

The study of pigments, dyes and dry colors, requires an experienced color chemist, yet the chemical engineer must meet and solve the problems which arise from this source. Happily most of it is only color matching, yet often troubles arise from separation of the vehicle and pigment, or from color changes due to improper vehicles, or to the color changing due to the mechanical actions of printing.

And finally—the question of the drying of the ink is always a troublesome one. Sometimes the ink “drys” purely by absorption into the paper and then the problem is one of the proper vehicle. But when the paper is “hard sized” or more especially when it is a “coated” sheet the ink must dry entirely by oxidation, which brings in the use of metallic driers and their effect on the various vehicles used. What bigger problem is there than that of printing inks?

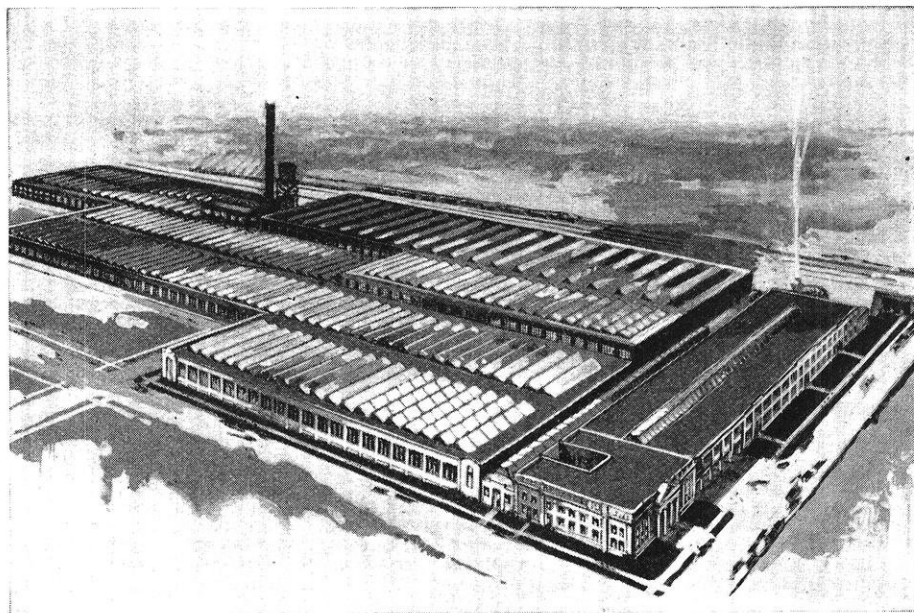
Fine, we have now the ink, the paper and the plates. All we need now is the press and thanks be to St. Patrick, he invented the mechanical engineers to design presses. Wait, we spoke too soon. The mechanical engineer says, “I can design the press, but you have got

to find some material which will carry the ink from the fountains to the plates." Someone mixed glue and glycerine and sugar and water and then molded this mixture about steel shafts, thus making the distributing rollers which carry the ink from the fountain and spread it uniformly over the plates.

Everything is going fine so far. Here, Mr. Bindery Superintendent, are the printed pages from which you are to bind your books. But the bindery superintendent says you'll have to give me something to stick the covers on with and when I want a real wide book, something that will hold the pages together without stitching them. So we make up some glue and give him that to use. And at last our plant is running and we sit down to a well earned rest.

But we spoke too soon. Here comes the pressroom super on the run. And he's looking for us. The complaint, for of course it's a complaint, that's all pressmen know how to do anyway, is that the ink won't dry. Well that ought to be easy, we'll put some drier in it. But wait, the old saying the more haste the less speed sure applies here. We've got to find out what kind of ink he's got, whether it will dry through the addition of a metallic drier and then whether the paper is such a kind that the ink dries by oxidation on the surface of the sheet or whether it dries by absorption into the sheet.

Well we've settled that and now we can sit down for a while. Wrong again. Here's the bindery super with a complaint, of course. There are never any flowers for the chemical engineer until he's where he can't smell them anyway. The bindery super says the glue mix we gave him is so strong that it curls his books up like rockers for the baby's crib. Somebody found out that glycerine will take on and hold moisture so we'll add some glycerine to the glue and that will keep it soft. It works, so the bindery super is satisfied. For the time being at least.



The new plant of the W. F. Hall Printing Company.

No rest for the wicked. Here comes the plant engineer with murder in his eye. "Say you, what's the matter with this coal. I can't keep the steam up nor the ash pits empty and it gums up the stokers and fills up the flues and . . and . . and . . ." So we determine the B. t. u's and ash and moisture and sulphur and set the crushers and run flue gas analysis and finally draw up a contract by which to buy coal. And that satisfies him.

So much for today, we breath with a sigh of relief.

Waste Paper

On the job in the morning and met by the reception committee. One at a time please, gentlemen. The pressroom super says the color of this new batch of ink is off and we can't wait for the manufacturer to correct it; we've got to have ink right away. All right. So we start matching inks for color and shade and we find out that the color isn't the same wet as it is dry and that depending on the quantity we put on the plate we get a top tone and an undertone. Well we've matched the color to the proofs but it's a safe bet our own mother wouldn't know us for we're more colors from head to foot than any circus clown.

The plant manager says that he can sell the waste paper if we will give his men a simple method for differentiating between the various kinds of paper. We tell him that there are only about three hundred different kinds of paper and that he can't possibly expect us to do that. No, but he does want to know the difference between groundwood or mechanical stock, and virgin stock, and a mixture of the two. Well, that's better, though bad enough. But after a while we find that there is a stain which will turn orange in the presence of mechanical wood pulp, and that the color developed is fairly proportional to the amount of groundwood present. So we fix some of it in a bottle with a top like that on our bottle of hair tonic and what fun those men had giving the bales of paper a shampoo, just to see them turn yellow to orange.

Next is the machinist who says that the bearings are running hot on all the presses and what's the matter with the oil. That means flash, fire, viscosity, impurity tests, etc., etc. Samples had to be secured from all the various oil companies and comparative tests made to determine the grade and quality most suitable for our needs. By the time we have finished with that the machinist is back again. Another tale of woe. Certainly. The new bearing metal doesn't seem to be as good as the old stuff, at least it doesn't machine as well.

Continued on page 210

THE REPAIRING OF AN OLD MASONRY ARCH-CULVERT

By L. T. SOGARD, c '24

*Masonry Inspector, Bridge Department
Illinois Central Railroad Company*

MANY years have elapsed since the charter-lines of the older railroads were built and many of the original drainage structures have been replaced by those of more modern construction. However, not a few of the original masonry arches, culverts, and abutments still remain in service and with the purpose in view of making them last many more years, they are being repaired and reinforced at a much smaller expense than replacement would permit.

An example of this type of revivification is an old arch-culvert on the Illinois Central Railroad, near Polo,

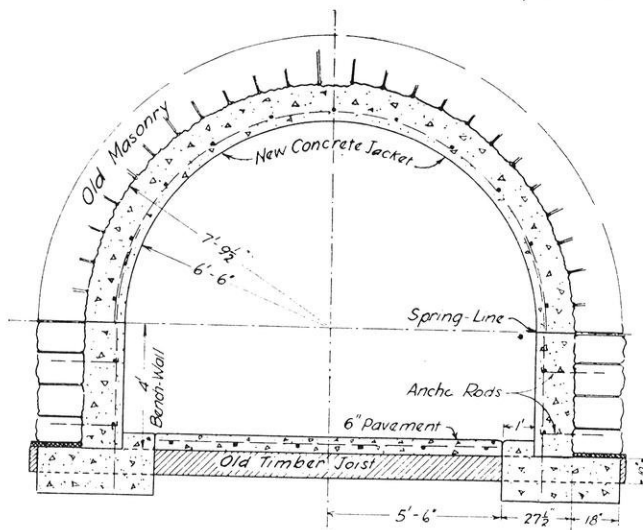


Fig. 1. Cross section of concrete underpinnings and jacket placed for reinforcement.

Illinois. This structure was built in 1853 of local sandstone, and until 1925 the only upkeep was an occasional pointing, consisting of the removal of the old mortar between the joints of the exposed stones to a depth of several inches and refilling with fresh mortar.

Recently it was noted that the stone was deteriorating from the effects of weather and that one end had settled several inches; so steps were taken by the bridge department to apply the "stitch in time". The nature of the repairs consisted of two parts: Underpinning and jacketing.

Originally the structure was built upon a timber foundation, which also served as the floor of the waterway. After a temporary flume had been constructed to carry the stream through the arch, the plank floor of the waterway was removed exposing the timber joists. The earth between these timbers was

removed to a depth of 18 in. below the tops of the timbers, to a distance of 18 in. back under the arch, and out from the arch into the waterway 27 1/2 in., as shown in figure 1. These spaces were filled with concrete to serve as underpinnings for the structure. That portion of the underpinning projecting out into the waterway was carried 6 in. above the tops of the timbers, thus connecting the individual underpinnings between the timbers and making the whole into an integral or monolithic footing.

To prevent scour and undermining at the ends of the arch, an apron, or curtain-wall, was built at each end of the arch. A six-inch concrete pavement, reinforced with longitudinal steel rods and wire mesh, was then laid in the waterway.

The next procedure was the lining of the inside of the arch with a reinforced-concrete jacket 15 1/2 in. thick. This jacket serves a dual purpose by preventing further disintegration of the stone surfaces and by acting as a reinforcement to the old arch. The jacketing was first carried vertically on each side from the floor to the spring-line of the arch,—these vertical walls being known as bench-walls. The forms for these bench-walls were built and braced to be strong enough to support the circular forms for the lining of the arch above the spring-line. In their construction 3" x 6" studdings at 2 foot centers were used and a 3" x 6" plate was placed on top of the studdings. For the lagging, or sheathing, on the forms 2-inch material was used.

Thus far the work proved to be of a common and routine nature; but the lining of the arch offered unusual problems, both in the forming and the placing of the concrete. As the lining of the 60 foot arch

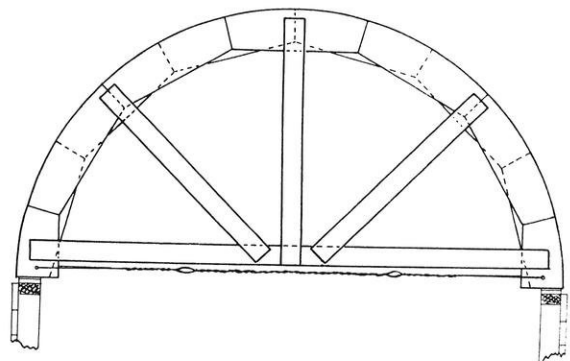
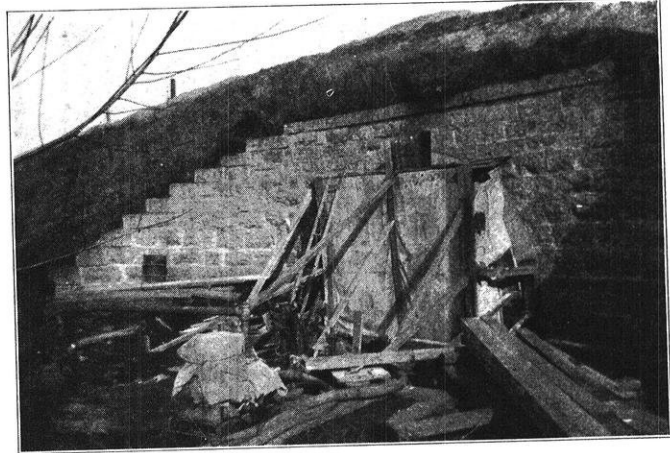


Fig. 2. The vertical semi-circular bulkhead placed on the outside end of the lining.

obviously could not be completed in a continuous run, it was decided to fill it in sections of 5 lineal feet. With this unit of length the filling of the form could be accomplished from the open end of the form and contact with the radial bracing of the circular ribs be thereby avoided. The semi-circular ribs, or studs, were constructed of 2" x 12" material as shown in figure 2. The sheathing was 1" x 4" dressed and matched material cut into 5 foot lengths. The circular ribs were set at 2½ foot centers in the arch, and, before bracing, were carefully adjusted by means of wire turnbuckles so that the inner faces of the arch-forms would match with the bench-wall forms. The ribs were set on paired wedges which not only facilitated their original setting, but also the removal of the circular forms after the concrete had set.

Following the setting of three ribs at the end farthest from the mixer, sheathing was nailed on each side of the semi-circle from the spring-line up to the quarter-point. A vertical, semi-circular bulkhead was placed on the outside end of the lining, but on the inside, the bulkhead was carried up on each side only about two feet above the spring-line (see figure 3.) The concrete was conveyed by wheelbarrows to a box near the open end of the form and from it two men filled the form by shovelling. A third man, working between the ribs and reaching over the lagging along the quarter-point, assisted in the placing of the con-



The ends were covered each night with a canvas to house and protect the work.

crete bulkhead. On the following day the sectionalized bulkhead was removed, two more ribs set, and the sheathing attached up to the quarter-points, as before, lapping it over onto the last rib of the preceeding section. The same process of placing the concrete was duplicated. The actual time required in filling a section was about four hours, but the preparatory work of building and setting the ribs, placing the reinforcing steel, and adjusting the wheelbarrow runways provided plenty of work for the balance of the 8-hour day.

The concrete used throughout the work was of a 1:2:4 mix. In the arch lining the consistency was abnormally dry, especially near the top. This was necessary to make the concrete remain in place against the old arch when rammed into place. A more viscous concrete would have tended to flow and settle away from the old masonry face leaving space between the old and the new into which water might seep from the fill above, with disastrous effects.

The vertical reinforcing bars in the bench-walls were 7/8-inch round, set at 1 foot centers, extending down into the footing 21 inches and up into the arch lining 3 feet, lapping the semi-circular 7/8-inch round bars of the arch. The bars in the bench-walls were set 3 inches from the outer face of the wall and secured to the old masonry by two courses of anchor-rods staggered at 2-foot centers and set 8½ inches into the masonry in holes drilled for that purpose. One-half inch square bars, wired to the vertical bars at 2-foot centers, were used for the horizontal reinforcing throughout both bench-walls and arch.

The work was carried on in the late fall thereby necessitating precaution against frozen concrete. However, by covering one end of the arch permanently and the other end each night with a canvas, the work was entirely housed and protected. A salamander was fired in times of severe weather and the materials and water were heated. Because it can be so readily housed, such concrete work can be carried on late in the season leaving the warmer weather for work of a more exposed nature.

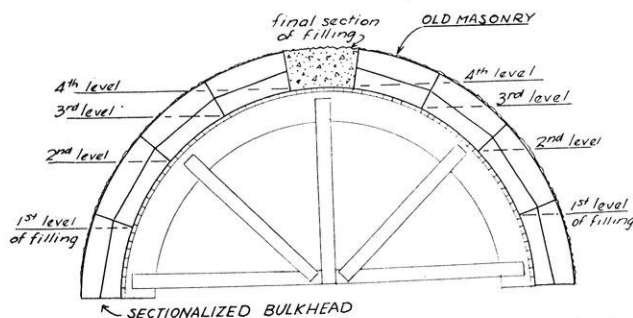


Fig. 3. Sectionalized vertical bulkhead used in jacketing old masonry arch.

crete by tamping and spading. As soon as each side had been filled to the top of the 2 foot section of the vertical bulkhead, another 2 foot section was placed on each side and the form filled to the newly established level (see figure 3.) As the filling was carried on beyond the quarter-point, sheathing was also added to each side of the semi-circle until about a foot of the sheathing remained unplaced at the top. When this stage was reached the remainder of the lagging was placed and the spading and ramming done from the open end. This slowed the rate of filling because there was not enough room for the shovellers to work at the same time as the ramming was being done. The bulkhead was continued on each side of the semi-circle, as described, until only a 2 foot section on the top remained open. Through it the remainder of the concrete was placed, the final batches being made stiff enough to afford a perpendicular face in lieu of a

THE EFFECT OF THE MOTOR BUS UPON THE STREET RAILWAY

By LESLIE F. VAN HAGAN

Professor of Railway Engineering, University of Wisconsin

(A paper presented at the eighteenth annual convention of the Engineering Society of Wisconsin, February 19, 1926)

The effect of the motor bus upon the street railway is something that interests every member of the community, for we all come into frequent contact with our urban transportation system. Engineers in particular are interested because transportation, in all its phases, rests upon a basis of engineering skill and knowledge. Perhaps, in this audience, there are men who, besides having a general interest in the subject, also have a financial interest in street railway property and are wondering about the security of their investments and hoping that the street railway will be able to withstand the fierce competition that it is meeting. Perhaps, there are some here who think that it would be a public improvement if the tracks and overhead construction of the street railway were removed and who hope that the motor bus will be the survivor of the contest. Opinions of people upon this subject are easily affected by their personal interests and biases. We, therefore, find many conflicting predictions about the outcome of this competition between the two systems of transportation.

Bus Replaces Railway In Small Cities

Let me summarize briefly the present situation: First, the motor bus has definitely checked the growth of the street railway system of the country. The diagram which you have before you merely shows, and in specific terms, a fact of which we are all aware in a general way. The growth of the street railway was rapid and steady until 1917, at which time there were 44,677 miles of single track. A decisive check came about 1918, and since that time there has been a slow decline in mileage. A second, and more spectacular fact, is that in a number of small cities scattered over the country the street railways have been scrapped, and bus systems have been introduced in their place.

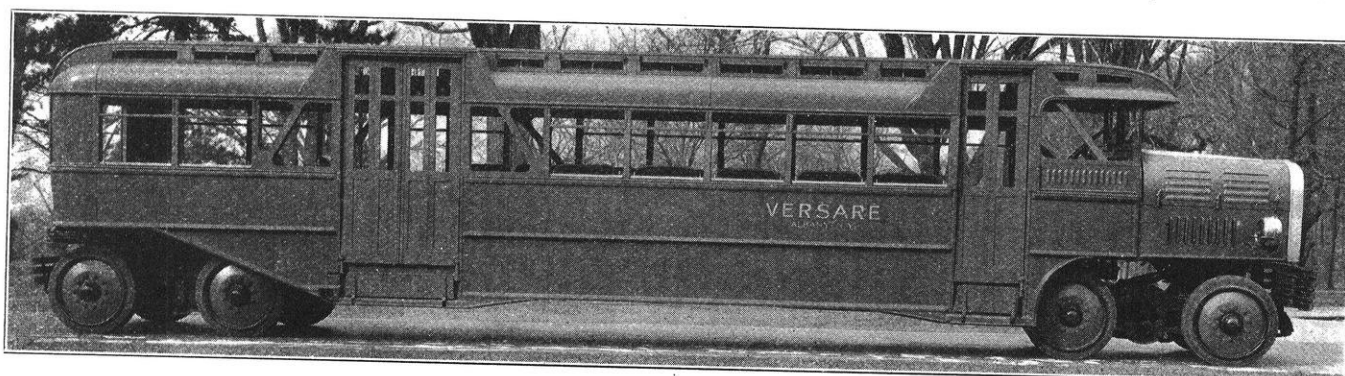
Portsmouth, N. H., Streator, Ill., and Everett, Wash., may be given as examples of this movement. Two other facts should be mentioned. One is that the street railway companies, themselves, are adopting the bus and welding it into their systems. The other is that on July 2, 1924, announcement was made of the merger of the interests owning and controlling the bus companies of New York, Chicago, and St. Louis. The merger plans to expand in other cities of the U. S. and Canada. It announces a policy of co-operation with existing street railway companies rather than one of competition.

On the other side of the picture is the significant fact that a considerable amount of new capital is being spent by the street railway companies for rehabilitation and for extensions. During 1925, 1114 miles of single track were reconstructed. During the first six months of 1924, the reconstruction of 1142 miles of single track, at an estimated cost of \$85,000,000, was authorized. In 1924, the San Diego company completed improvements and extensions that cost \$3,500,000. It was estimated that a total of \$342,000,000 would be spent on maintenance and extensions by the street railways of the U. S. in 1925. The estimate for 1926 is nearly \$300,000,000.

Street Railway And Bus Are Close Competitors

If we analyze the requirements of service in urban transportation, we reach the conclusion that any system that comes into general use throughout the country must give a good account of itself under each of the following heading:

1. Economy of operation
2. Reliability of service
3. Ability to operate on heavy grades
4. Ability to operate amidst heavy street traffic



This bus approximates the best features of the street car. It is 30 feet long, seats 44 passengers, and stands 52 all on one level.

5. Speed
6. Comfort
7. Non-interference with other traffic, with other utilities, or with fire-fighting apparatus
8. Ability to handle rush-hour traffic

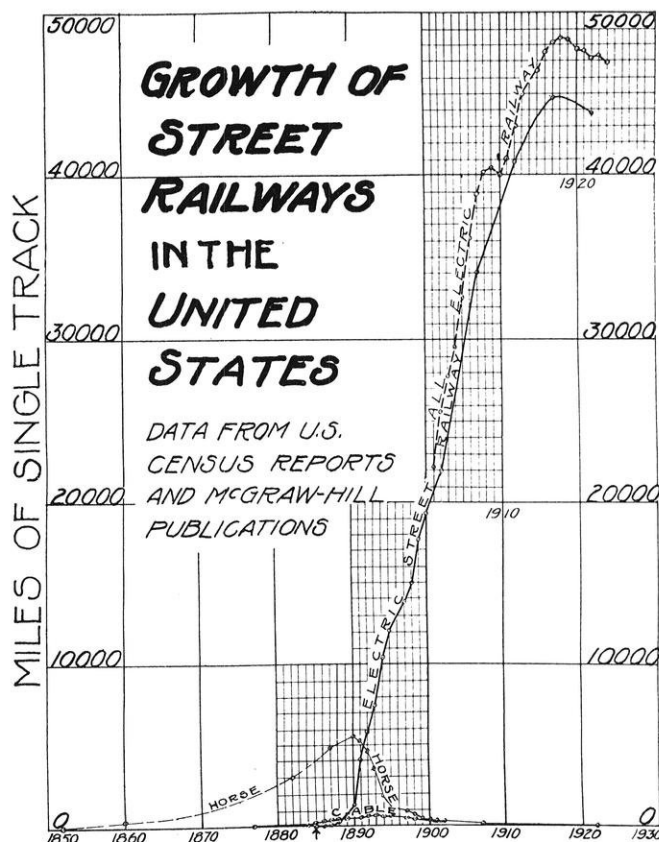
A bit of history may not be out of place at this point. The first attempt at anything like a system of urban transportation was the horse-drawn omnibus, said to have been introduced first at Nantes, France, in 1825. The street railway originated in the United States some years later, probably because poor pavements made the omnibus rough-riding at the best and impossible in bad weather. The growth of the horse-drawn street railway, which made its real start in 1852, was steady until 1890 (see the diagram,) but it was slow. Its advantages over the omnibus were probably small, except where pavement was bad or non-existent. At the peak of its development in this country, the horse railway reached only 5662 miles of single track.

Electric power was applied to the street railway in 1885, at a time when inventors were experimenting with all sorts of power,—rope-haulage, ammonia, steam, hot water, compressed air, and even with internal combustion engines. Like a real champion, electricity won over this field of competitors, chiefly, it would seem, because it was the most economical form of power. The cost of horse operation, according to census statistics, averaged 18 cents a car-mile, whereas, electric operation averaged 13 cents a car-mile. The effect of such a large difference in costs, combined with a strong desire on the part of street railway men themselves to get away from the use of horses, may well be imagined. The change from horse to electric operation was abrupt and complete, as indicated by the curve in the diagram.

For twenty-seven years the electric street railway reigned supreme in its field and then the motor bus came to challenge its supremacy. Let us see how the challenger compares with the old champion. The motor bus has been operated long enough to demonstrate beyond argument its ability to meet many of the requirements of urban service. The motor bus and the street railway are about on a par as regards reliability of service, ability to operate on heavy grades, ability to operate amidst heavy street traffic, speed, and non-interference with other utilities and with fire-fighting apparatus. The street railway has some advantage at present in the matter of comfort. The two remaining requirements, namely, ability to handle rush-hour traffic and economy of operation, furnish most of the ground for debate on this subject.

Can The Bus Handle Rush-Hour Traffic?

There is rather unanimous agreement among both street railway men and bus men that the bus in its present stage of development is not able to handle rush-hour traffic in a big city. The street-car having



Growth of Street Railways in the United States

rails to guide it in turning corners, can be built long and wide. It has a large total capacity, all on one level. Not only do the street cars carry bigger loads than buses, but they are able to take on and discharge those loads more rapidly, when properly designed and used with proper methods of collecting fares. The big buses, on the contrary, are built as two-deckers, and they load and unload slowly.

But, while the bus at present is admittedly unable to handle the rush-hour traffic in large cities, there seems to be no insurmountable mechanical obstacles that would prevent its development to a stage where it *will* be able to do so. As a matter of fact, a bus has just been put on the market that approximate the best features of the street-car. It is 30 feet long, a length which is made possible by the automatic steering of the rear truck, and it seats 44 passengers and stands 52, all on one level. Wonderful advances have been made in motor bus construction in the few years since its introduction, and we may expect to see much further development. In spite of much that has been said to the contrary by various authorities on the subject, it is probably safe to say that if the bus proves to be an *economical* method of transportation, it will be found *physically* able to handle rush-hour traffic.

An Economic Comparison

From the foregoing discussion, it is evident that the outcome of the competition between the street railway and the motor bus depends chiefly upon which is the more economical system. This point is not

easy to decide from data now at hand. Street railway costs are reliable, but bus costs are not for several reasons: First, existing bus systems do not attempt to meet all the transportation needs of a community; they take only the profitable part of the traffic. This relieves them of the necessity of maintaining a large amount of equipment and personell that is needed only during rush-hours and lies idle and unproductive during the remainder of the time. Second, they are not carrying the burdens that have been laid upon the street railway system; their taxes are nominal, and they are not required to pave, clean, and sprinkle the streets. Third, the figures for bus maintenance are high because bus design is in its infancy. Fourth, the accounting methods of the bus companies have been obviously crude and unreliable in most cases.

In order to make a comparison of the relative economy of the two systems, I took the actual figures for investment and expenses of a street railway system that serves a city of half a million people and modified them, after rather careful study, to fit a bus system that would serve the same city. This method results in the inclusion of many items of expense that are generally overlooked in estimating bus costs and gives results that probably approach closely the cost that will be encountered by bus systems that undertake to handle the entire traffic of a large city. I assumed that the bus had been developed to a point where it could handle rush-hour traffic, and that the bus and the street-car would carry equal loads, so that the cost per car-mile and per bus-mile can be taken as a fair basis of comparison. This assumption, as already indicated, is a debatable one. The actual cost per car-mile was 40 cents. The lowest estimated cost per bus-mile was the same—40 cents, while the estimated *probable* cost was 48 cents per bus-mile. These figures include interest upon the investment at $7\frac{1}{2}$ per cent. The figures, of course, are not conclusive. It will be necessary to make studies for cities of various sizes before a complete understanding of the relative economy of the systems can be obtained. But I think that we are safe in this conclusion: The street railway appears to have the advantage in the matter of economy. Certainly, the motor bus has no outstanding and easily recognized advantage in this respect.

It will be recognized that there is a decided difference between the conditions now surrounding the competition between the street railway and the motor bus and the conditions that surrounded the competition between the horse railway and the electric railway. The owners of the horse railway wanted to get away from the horses; but the owners of street railways have been satisfied with their equipment. Electric power was decidedly cheaper than horse power; the rivals of today are more nearly equal in that respect. The change from horse to electric power required increased investment, and that fact, together with the absence of regulation over public utilities and their securities,

made the problem of writing off abandoned property more simple than it is today.

The inability of the greater number of the street railway companies to write off large amounts of abandoned property is an important obstacle in the way of the transition from street railway to motor bus. A company that makes the transition will find itself unable to use a large proportion of its street railway plant and equipment. This will cause a heavy shrinkage in values. Some few companies, whose street railway business is small in comparison with their other activities, may be able to take care of such shrinkage without loss to security holders, but most companies cannot do so. If the attempt is made to load the value of the abandoned property onto the new bus system by the well known process of stock watering, the bus system will find its costs per bus-mile reaching dizzy heights. The big advantage of the bus system lies in the fact that it requires less capital investment than the street railway system, and it cannot afford to sacrifice that advantage.

Where the change has been made from street railway to bus, it will be found that it was brought about by some abnormal circumstances. The common reason is that the company faces the rebuilding of its tracks for one reason or another, and is unable to raise the money. When such conditions arise in cities of moderate size, the transition may be expected. The investment needed for a bus system is about 45 per cent of that needed for a street railway system. This leads one to think that new transportation systems in small cities that have had no system at all will be bus systems, and that in large cities, existing street railway companies will use buses instead of extending their railways into new territory.

There are two remaining points that I wish to mention. The first is the question about the future of the gasoline supply of the world. This is so highly speculative that I do not think that we can discuss it to advantage. I believe, however, that some sort of fuel for internal combustion engines will be available as long as we need it. The price of such fuel will tend to increase, but, to offset this to some extent, designers will produce motors that are increasingly economical in their consumption of fuel.

The second point is that the popularity of motor transportation with the general public, and the desire of city officials and the public to rid the street of tracks and overhead construction and to eliminate the noise of the street cars may play an important part in the final outcome of the contest. People in this day and age are not influenced solely by considerations of economy, and it is not inconceivable that the public may insist upon having the motor bus even though the street railway could furnish service at a lower cost.

Conclusions

My conclusions on the whole subject are these:

(Continued on page 210)

Engineering Review

RAILROAD USING OIL ELECTRIC EQUIPMENT

Continued use of oil-electric cars and locomotives seems to indicate that a definite field has been found for the application of this modern flexible unit.

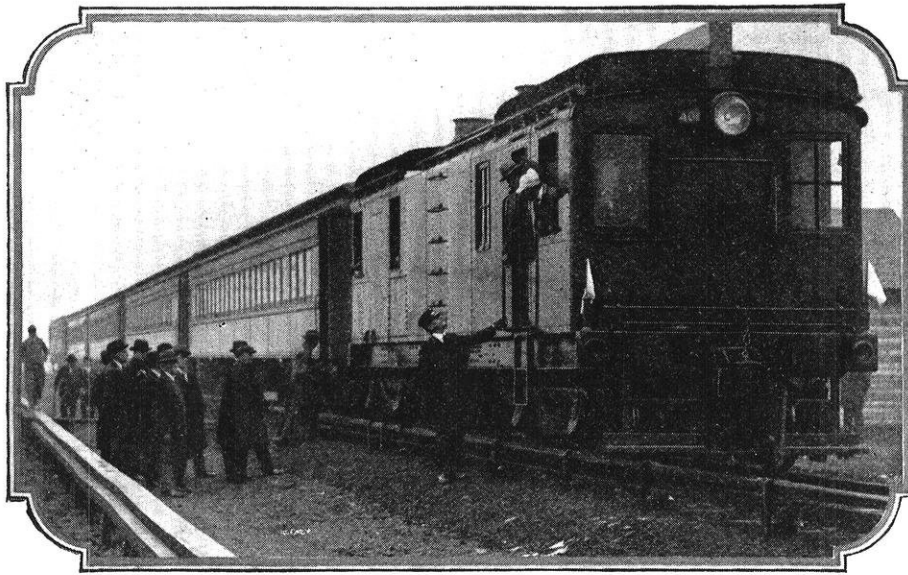
Since being placed in service some time ago on the Trenton branch of the Reading railroad, a gas-electric car has been run approximately 16,000 miles. The service is unusually severe, as four stops are made in the run of 3.7 miles and the average schedule time for the one-way trip is ten minutes. Operation at times is with a standard 110,000-lb. steel coach. Although

hung and drive thru strong, solid, helical gears having a 16:61 ratio, which are totally enclosed and run in grease. The large gear ratio was used to give the high tractive effort necessary for trailer operation. Speeds up to 51 m. p. h. have been attained.

The St. Louis Car Company has built, on order, a gas electric passenger rail car that, on trial, covered the distance from St. Louis to Indianapolis, over the Big Four Railroad,—a matter of 267 miles—in 6 hours, 48 min. The average running time of the Big Four passenger trains over the same run is 6 hours.

This car is one of the largest of its kind ever built in this country. It measures 71 ft. over bumpers, has a capacity of 34 persons, and also a spacious baggage compartment. Two 200 h. p., six cylinder gasoline engines run the generators which are 700-volt, d. c. machines mounted on bases integral with the engine frames. The voltage of the generators is regulated by the current demands of the motors and the engines are designed to operate at their most efficient speed, regardless of the load applied. Twin motors are provided on both the front and rear trucks of the car.

An oil-electric locomotive recently, on a test trip, made the run from the plant of the General Electric Company at Erie, Pa., to New York,—

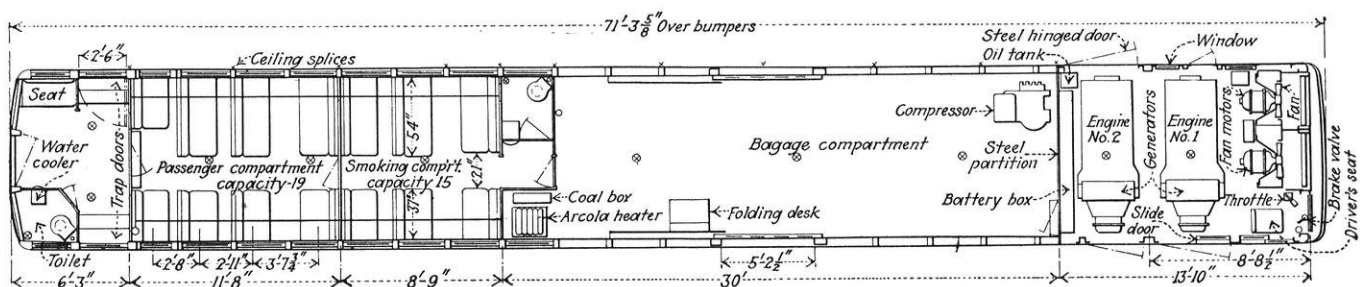


A 100 ton oil-electric locomotive hauling a passenger train.

the grades are as steep as 1.1 per cent, no auxiliary power unit is needed at any time.

The motive power equipment consists of a gasoline-engine driven generator, two motors and control apparatus. The engine is $7\frac{1}{4}$ in. bore, 8 in. stroke, and delivers 250 h. p. at 1100 r. p. m. The generator supplies power to two 140 h. p., 600 volt, d. c. motors located on the forward truck of the car. The motors are axle

a distance of 537 miles—hauling a loaded freight train. This 100-ton locomotive is 46 feet long. The nominal rating of the traction motors at 600 volts is 200 h. p. each, or 800 h. p. for the four motors. The generator is operated by two 30 h. p. internal-combustion engines using low-grade fuel oil. The generator is of the direct-current, compound-wound, commutating-pole type, developing 600 volts. On test, starting from a stand-



Floor Plan of Gas-Electric Passenger Car.

still at the foot of a one per cent grade, with a trailing load of 1,315 tons, the locomotive accelerated up the grade to a speed of 6 miles per hour. Another test showed the locomotive, with two cylinders cut out of one of her engines, balanced perfectly between the motors.

On the trip from Erie to New York no fuel or water was taken on; and the total cost of both fuel and lubricating oil for the 537 miles was only \$26.15. The average fuel cost per locomotive-mile was 4.86 cents. The total kilowatt-hours generated was 3,810, and the fuel cost per kilowatt-hour generated was .685 cent. The fuel cost per 1,000 ton-miles was 12.90 cents

"Compressed Air" and "Elect. Rail. Journal."

BATS MOSQUITOS AND DOLLARS

Written by Dr. A. C. Campbell.—From a Review
by Prof. Byron Bird

Ernest Thompson Seton, the eminent American naturalist, in the introduction to this book, suggests that it might be a greater boon to mankind to exterminate the mosquito than to stamp out tuberculosis, because of the widespread damage they do to mankind. "The fairest and most fertile parts of the earth blessed above others with a sunny clime, become a heritage lost, ruined, in nine cases out of ten, by mosquitos."

As a practical solution to the problem, Dr. Campbell of San Antonio, Texas, who has devoted his entire practice to malarial and typhoid fevers, offers a plan based on these conclusions, the results of twenty-five years of study and experience.

1. That the malarial mosquito is one of the greatest enemies of mankind.

2. That the bat is one of the man's best friends because it so relentlessly destroys the malarial mosquito, that insect being its natural food.

3. That houses properly built to meet the requirements of their singular habits will so increase their numbers thru protection from natural enemies that they will eradicate malaria in the districts in which they so thrive.

4. That each bat roost, in addition to being of hygienic value, will be a small gold mine in itself, by reason of the cash obtained from the sale of the natural high-grade fertilizer, guano, which it will constantly produce.

Near San Antonio a whole district was malarial due to a lake formed by sewage drainage nearby. Construction of these bat roosts greatly improved conditions there and disturbances from mosquitoes have been noticeably decreased. Similar protection for rice lands is held reasonable.

The production of guano is considerable, caves in Texas being known to produce as much as eighty tons yearly. At a price of eight dollars per unit of nitrogen, this return is profitable.

In an attempt to continue the war thru twenty-four hours of the day, Dr. Campbell looked for a day-time enemy of the mosquito. For this purpose, the Dragon

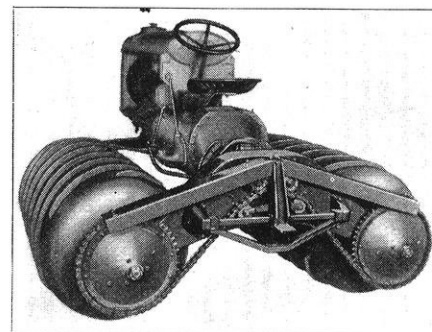
Fly is a valuable ally to humanity. The one difficulty is the finding of a means for breeding them without growing mosquitoes in the same receptacle and at the same time. A proper development of this plan thruout the malarial districts of the world might well be counted upon to bring to mankind a welcome relief from these carriers of disease and sorrow.

Solve problems and then more problems and then more problems. No student can get a good working knowledge of mathematics in any other way, and without such knowledge you would be a cripple in the higher fields of engineering.—Virginia Journal.

NEW PRINCIPLE IN SNOW TRAVEL

A new principle has been applied to the movement of vehicles over snow and ice by a Detroit motor company. The principle is primarily the revolving action of a pair of "torpedo-like" tubes on each side of the body, and running,—hold on the surface being attained by a spiral runner around each unit.

The initial driving power is a well-known make of tractor. Stripped of this motive power the machine consists of the two torpedo drums to which flanges or runners (sometimes called skates) are welded.



This machine will be used for transportation of supplies to northern posts.

These drums, which are chain driven, revolve in opposite directions, the spiral on one being right-handed, that on the other, left-handed. The torpedo-shaped ends of these drums and the spiral flanges engage positively with the snow or ice, and owing to the balanced side-thrust of one against the other, propel the Snow-Motor in a straight course. Steering is effected as in a tractor with a caterpillar drive, by controlling the drive to one or the other of the drums. The action of the drums on the snow is virtually that of a worm and wormwheel, where the worm is formed by the spirals on the drums and the wheel by that frictionless material, snow.

The advantage gained in snow is this. When the drums come to snow they sink in, packing the snow down and at the same time, increasing the bearing surface until it becomes sufficient to carry the weight of the machine. Further, as the weight-bearing surface is increased, so also is the propelling surface increased, for the engaged flange surface becomes greater. The machine will be used in the coming polar flights to handle the transportation of supplies to the northern posts where they will be stored for the explorers.

(Continued on page 202)

Campus Notes

ST. PATRICK TO ARRIVE IN MADISON APRIL 3!

The following message from our most exalted fellow-Irishman was delivered to this office last night by special courier from the shores of the Irish Free State:



Erin, A. D. 1926.

To All Loyal Plumbers and Sons of Erin:

I, St. Patrick, Plumber-in-chief to the Free and Ancient State of Erin, do hereby proclaim to my loyal followers and adherents that on the 3rd day of April, Anno Domini 1926, I shall arrive in your fair burgh of Madison to bestow upon your clear Irish brows the blessing of the Everlasting Shamrock. By the Green Shamrock shall ye know me.

By the Seal of the Shamrock,
(Signed) St. Patrick.

P. S. I shall be deeply greived if lack of due foresight on the part of my Wisconsin Legion permits the recurrence of last year's happenings.—St. Patrick.

It certainly gives us pleasure to be able to state that under the direction of Polygon plans for the reception of St. Patrick are well on their way to completion. R. E. Zinn, ch'27, is general chairman of St. Patrick's day, and has James Verner, m'26, and J. P. Smith, c'26, for assistant chairmen. The publicity committee for the parade consists of E. R. Summers, e'26, B. R. Teare, e'27, and R. T. Homewood, c'27. Prizes for the various stunts, donated by Madison merchants, have been arranged by M. J. Williams, m'27, A. R. Carter, e'26, and Jacob Levin, c'27. A committee composed of G. C. Breitenbach, m'26, O. A. Klema, e'26, and A. W. Walker, grad, has made provision for trucks.

The judges who will award the prizes are H. P. Robinson, ch'27, R. A. Nelson, c'26, and D. A. Mill-

man, min'26. Poster work for the stunts and take-offs will be in charge of B. A. Wiedring, ch'26, D. E. Thomsen, c'27, and L. H. Matthias, e'26; while H. L. Clark, m'26, R. E. Harr, ch'26, and R. J. Soulen, m'27, will direct the organization of the individual stunts. Special police for the occasion will be headed by the triumvirate consisting of Ira Smalling, e'27, N. T. Kelley, c'26, and R. E. Everett, e'27.

INSTRUCTORS DEFEAT PROFESSORS AT BOWLING

The big bowling match is over! After a desperate battle from seven until nine o'clock on Saturday evening, March 6, the professors succumbed to the good bowling of the instructors; the final score was 7108 pins for the instructors, and 6617 for the "profs." Professor Shorey with a grand average of 68.3 was awarded first prize, a bottle of Heinz catsup, with the admonition that he put a little catsup on his "hooks" to make the elusive sphere stay on the alley. Not to be outdone by Professor Shorey, Instructor Cottingham of the structures department came to the front with a score of 58 in one of his games. Cottingham bowled wonderfully erratic games, scoring as high as 92 in some of them.



Mr. Doke, of the drawing department, took as his prize an individual bowling ball made of high quality iron as a reward for his high single game. A set of safety pins was awarded to Professor Barker for three high games totaling 481. The permanent trophy, a battered and worn-out ten pin, was presented to the victorious instructors, and will remain in their possession until the "profs" sufficiently forget their present defeat and issue another challenge.

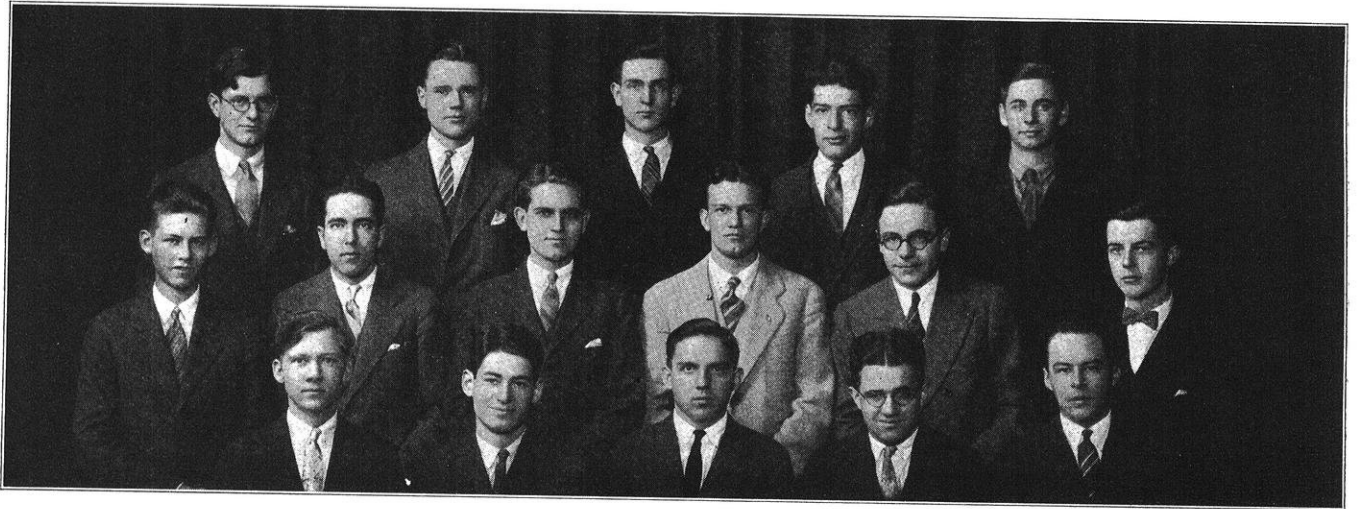
ENGINEERING SOCIETY OF WISCONSIN HOLDS ANNUAL MEETING

The eighteenth annual convention of the Engineering Society of Wisconsin was held in the auditorium of the Engineering Building on February 18, 19, and 20.

(Continued on page 208)



Editorials



Top row: H. D. Crawford, C. E. Johnson, K. C. Davis, L. W. Heise, F. C. Ncumeister.
 Middle row: W. F. Steuber, R. T. Homewood, B. R. Teare, H. W. Wood, R. H. Sogard, M. J. Williams.
 Bottom row: L. J. Cleveland, E. Birkenwald, H. C. Wolfe, J. Levin, R. D. Jordan.

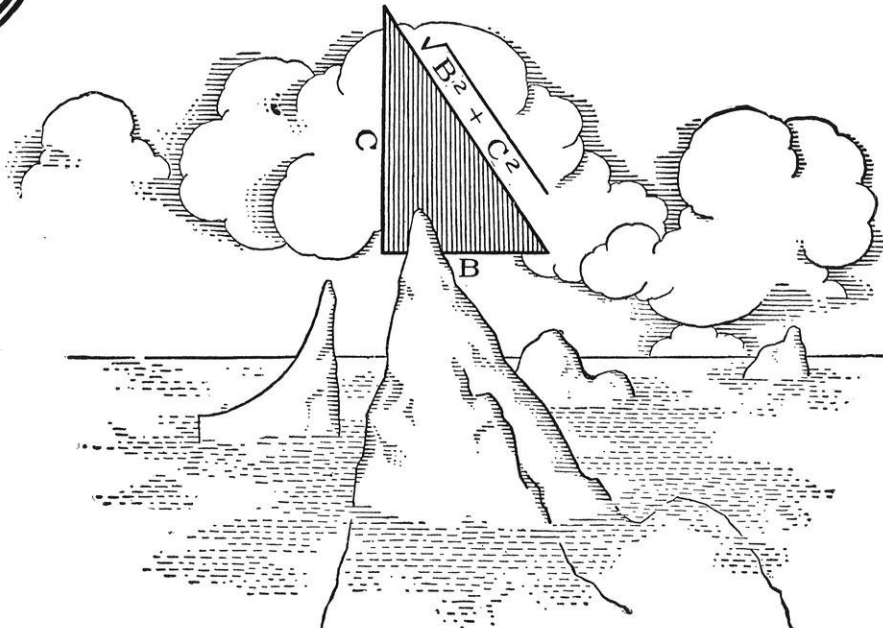
CHANGE OF STAFF As has been the practice for the past two years, the board of directors of the Wisconsin Engineering Journal Association elected the editor and the business manager of The Engineer at mid-year rather than in June. This practice allows the new staff to become acquainted with the work while under the eye of the more experienced staff members who have retired from active editing. The new business manager is Millard Williams, m'27, and the new editor is R. T. Homewood, c'27. The other members of the staff are appointed by these men and the advisory editor, Mr. French. The Engineer, in appreciation of the work done by the staff members during the past year, extends its thanks to all who have been active in making the Wisconsin Engineer possible.

A SCOUTING PARTY SETS FORTH Announcement of the appointment of a "commission" of seven faculty members headed by himself and charged with the duty of making the broadest possible study of the field of education, was made to the faculty of the university by President Frank at the regular meeting on March 1. The task facing this commission is similar to the task that faced a scouting party sent out by the emigrants who toiled across the great plains in the fifties. Those scouting parties set forth to find a high point from which they might survey the land that lay ahead and understand it. They were interested in discovering pasturage, water, game, and the easiest route,—things which might be missed by the slow-moving train that passed along the low levels. Nothing

that the scouting party could do or discover could relieve the emigrants of the labor incident to the great trek, but the scouts might prevent disaster overtaking the train. Our commission is not going to find the royal road to knowledge; it is not going to return with a magic carpet that will enable us to avoid the dust and toil of the trail; but it may return with a better understanding of what lies ahead of us in educational work and some valuable suggestions in regard to direction. The difficulty, at first, is to find the commanding elevation.

The best mathematics multiplying the joys and dividing the sorrows of others.

THOSE WHO WANT LIBERTY MUST TAKE THE RESULTS OF LIBERTY Voices have been lifted up upon our campus in a demand, sometimes plaintive and sometimes resentful, that students be given greater liberty in regard to study and class attendance. Independent souls—presumably those who consider time a fossilized old codger, much out of date, and who find it annoying to come and go at stated and regular times—clamor for something approaching the European system of administering universities, a system in which the student is placed upon his own responsibility in matters of attendance and study. This liberty sounds alluring to our individualist, but is he willing to accept responsibility for the results? It has been stated by a competent observer that the average student in European universities loses the first year in becoming adjusted



Master of Icebergs

—a new kind of college degree

MASTER all the intellectual icebergs you sight at college, and your degree will mean something.

The cold facts you learn, like $a^2=b^2+c^2$, are but the visible tops of these icebergs. Underneath, as with floating ice, lie the other eight-ninths.

Facts are of little importance till you see them in relation to their great underlying principles. The facts of mathematics strike deep into the other sciences. The facts of history strike deep into sociology, ethnology, geography.

That is why an engineer who learned Ohm's Law can develop a great telephone exchange and control its fascinating forces.

Viewed thus, the endless array of dry facts and dull figures that seem to crowd the years brighten and beckon with a challenge—to look deeper, ever deeper.

Published for the Communication Industry by

Western Electric Company

Makers of the Nation's Telephones

*Published in
the interest of Elec-
trical Development by
an Institution that will
be helped by what-
ever helps the
Industry.*

Number 56 of a series

Please mention The Wisconsin Engineer when you write.

to his liberty. Undoubtedly, many men never become adjusted to the point where they acquire an education of substantial breadth and depth. Are those who clamor for liberty of action willing to take their medicine if they fail to win a degree from the university? Ask the next class adviser whom you meet. He will tell you strange tales of students who demand liberty and at the same time want to throw the responsibility for their short-comings upon the university authorities. The students resent restrictions and yet they, and their parents, raise loud complaints about the negligence of the faculty when they get into difficulties. The fact is that the people of the state demand certain results of the university authorities and will not permit those authorities to unload the responsibility upon the student. Fundamentally, the gist of the matter is this: The student can have liberty only in proportion as he is willing to accept responsibility for the results of liberty.

OUR SPECIAL LECTURES

From time to time the College of Engineering and the various engineering societies, as well as other colleges and societies on the campus, bring lecturers here from different colleges and societies, and the business world. The object of these lectures is to give the student a contact with outside men and their ideas. The Engineer believes that this is a good thing, and that these lectures should be sponsored and supported by the faculty and student body, as they now are. But the Engineer also believes that the faculty and the student body should use a little more care and discretion in selecting the men who are to lecture to us. It is a waste of time to spend an hour listening to a man who does nothing but ridicule the work of others with such expressions as, "That's the bunk," and, "I'll bet anyone a hundred dollars." It is almost equally a waste of time to listen to a man who may have something worth while to offer, but who presents his lecture in such a poor and incoherent manner that the student receives no benefit whatever. We believe in hearing all sides to everything, and we do not believe that a man is wrong because he is different; but there are so many good lectures available that it is needless for us to give a man an hour of our time and receive nothing in return.

ENGINEERING REVIEW

(Continued from page 198)

A NON-DESTRUCTIVE TEST FOR WIRE ROPE

A test which could be applied to steel hoisting rope to show whether it is in safe condition or not and which would not require the cutting of a sample from the rope, would be of great value. Every industry and operation which depends on wire rope for hoisting and haulage purposes is anxious to learn of some method for determining the condition of ropes in service.

For some time the Bureau of Standards has been investigating the possibility of applying some form of magnetic test to wire rope to determine its condition, as it is known that breaks in the individual wires,

worn places, etc., as well as the stress on the ropes, affect its magnetic permeability. The development of a practical test is a difficult matter because of many variables which must be considered.

In order to design intelligently apparatus for the non-destructive testing of wire rope, it is necessary to know the nature and magnitude of the effects involved. One of the causes of deterioration is wear; and the Bureau has recently completed an investigation of the effect of wear on the magnetic properties and tensile strength of steel wire such as is used in the manufacture of iron rope.

The Bureau found that wear increases the magnetic permeability for low magnetizing forces, and decreases it for high values, in other words opposite readings are obtained depending on the magnetizing force employed. A load on the wire produces a similar effect, though it is much less in magnitude, and is probably caused by a redistribution of the internal stresses in the wire. This change in magnetic properties is accompanied by an increase in tensile strength.

WOODEN OVERCOAT COMBATS ZERO WEATHER

When the "Chateau," a mammoth hotel at Lake Louise, British Columbia, was in part destroyed by fire, construction work was begun at top speed to rebuild the greater part of this hostelry. But winter crept on and it was apparent that work would be brought to a complete stand-still on account of the extreme cold. Up in that section of Canada, the thermometer often falls to 40 degrees below zero,—not exactly the kind of atmosphere to make the blood surge thru a carpenter's hands.

To meet this it was decided to build a large wooden over-coat for the new section. This wooden shell was built as soon as the steel-work was well under way. It was built five feet out from the steel frame and enclosed the entire building. The structure was 300 ft. long and 52 ft. wide. Its height was the equivalent of ten stories. On the inside of this shell was hung nearly two miles of 1¼ in. pipe. This pipe was connected with temporary boilers and the steam turned on. The construction work was then carried on at full speed with no regard for winter handicaps.

DO YOU KNOW THAT

The United States uses one million tons of reinforcing steel each year?

The nation's annual highway bill is \$1,350,000,000?

Each of the giant 30-inch cables of the Delaware River Bridge contains 18,000 wires?

The volume of building construction in the United States approximated \$6,500,000,000 in 1925?

The world's longest tunnel for hydro-electric purposes—thirteen and one half miles long—was recently opened in California?

Leland Stanford University, California, has begun the construction of an electrical testing plant which will have the only 2,000,000-volt installation in existence?

MEAT

Goeden & Kruger
Inc.

*Jones, Vail and Lowman
need your support, too.*



TAKE ALONG A KODAK

Wherever You Go!

The pictures you take in college
will be highly prized in after col-
lege days.

We'll help you make a selection
and coach you to get the best
results. Our stock is large and
each number is a new model.

The **PHOTOART**
HOUSE

WM. J. MEUER PRESIDENT

The Only Solely Photographic Store in Madison.

KENNEDY'S Dairy Products

Recognized Everywhere

for

PURITY

and

DEPENDABILITY



Kennedy Dairy Co.

Perfectly pasteurized

**MILK, CREAM, BUTTER, BUTTERMILK,
COTTAGE CHEESE, MILCOLATE.**

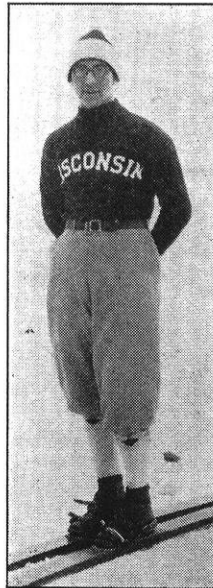
Velvet Ice Cream

Please mention The Wisconsin Engineer when you write.

Athletics

ENGINEER SKI CHAMPIONS

The most outstanding individual performance in winter sports this year has been made by two engineering students, Hans Troye and Knute Dahl. These men hail from Norway, where there is real ski jumping, and came here to enroll as freshman electricals with advanced standing.



Knute Dahl Hans Troye
(Courtesy Athletic Review)

Coached by Kay Iverson, winter sports mentor, they have shown real ability, and have placed among the very first in all the meets entered.

Most remarkable is Troye's winning first place in the national class B ski jumping tournament held at Duluth, Minnesota. Here were entered the best jumpers in the country; some of them

had competed in the 1924 Olympic games. His form in jumping was considered exceptionally good, and gained him a first, as well as placing him in class A, with the 15 best jumpers in the country. At this same meet, Dahl won fourth in the national 12 miles cross country race, and brought more honor to Wisconsin.

Jumping with an injured knee, Troye placed tenth at Grand Beach, Michigan, and gained seconds at meets held in Madison and Milwaukee, as well as first in the university ice carnival ski meet. Dahl placed an easy first at the cross country meet held at Oconomowoc, and at the Cook County meet placed fourth, showing fine speed.

Most of these meets have drawn the very best ski performers in the country, and therefore it is really an achievement to win the places as Troye and Dahl have done. Indeed, the University and our college may well be proud of these men and what they have done.

HOCKEY

A fitting comeback to the tie and defeat at Ann Arbor was given to Michigan by the Badger hockey team, when the Wolverines played at Madison. The scores for these two games were 2 to 1 and 2 to 0.

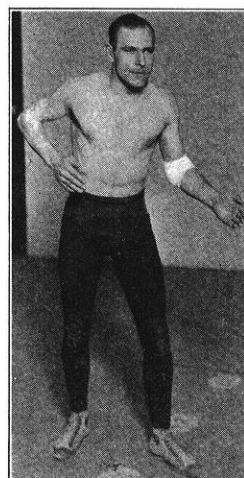
The week before the Cardinal had made two pretty wins from Carleton College, 2 to 1, and 4 to 2, and Carleton has a very good team, hockey being one of the foremost sports there. The games were fast and furious and featured by excellent playing. Especially good work was done by Whiteside, senior civil, who scored unaided in the first game, after a clean recovery of the puck. In the second game the northerners attempted to avenge the first game, but the speedy, accurate playing of Bill Lidicker, junior civil, prevented any success at this. Lidicker made three of Wisconsin's four goals, as well as playing a brilliant defense game. Although the Carleton team had fast offensive play coupled with accurate shooting, their close shots failed to materialize in both games due to the good work of Ruf, junior civil, the goal tender for Wisconsin, who made some remarkable stops. Carrier, sophomore mechanical, in his first year of varsity competition, is rapidly improving, and has shown up well in games.

In the Michigan games these same engineers played well again, and although Michigan presented a fast and somewhat heavier team, the results were no different, two wins for Wisconsin. The games were both fiercely fought and rough, but the superior ability and excellent training given the Badgers by coach Kay Iverson, was too much for the Wolverines.

The victories of the puck squad gave them the right to challenge Minnesota, the game to decide the conference championship. The previous games played with Minnesota resulted in ties, neither team having a marked advantage, with plenty of rivalry between teams.

WRESTLING

Showing top-notch form, the Badger wrestling team proved itself a match for any team in the conference, when by a score of 13 to 11 it defeated the fighting Illini team, one of the best in the conference, and undefeated for five years. Free from all but minor injuries, the men were in the pink of condition, and Coach Hitchcock used one of the best combinations tried so far. On the following week, the grapplers won a most decisive victory from the team with similar standing in the other group, Northwestern, the score being 14 to 0. This meet was not won as easily as the score would



Splees,
Junior Electrical

(Continued on page 208)

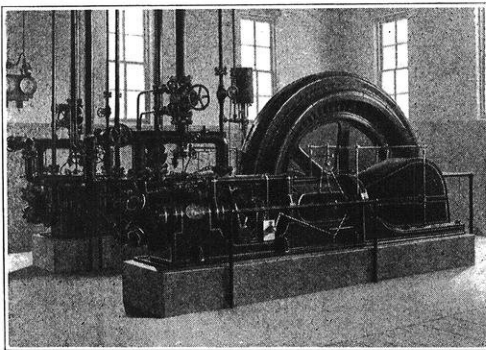
YOU SAVE MORE

Engineers save more by trading at the Co-Op than any other students because their original purchases for drawing instruments, slide rules, and general supplies are higher. The higher the cost the bigger the rebate—besides there's the assurance of getting only first quality goods.

506 State Street

THE CO-OP

E. J. GRADY, Mgr.



LONG BEFORE AUTOMOBILES

Vilter Ice Machinery was being built and units which were installed 35 years and more ago are still in daily service.

Today Vilter Ice Machinery is made in over 200 different sizes and types, in modern well equipped shops, by an organization that has been a large contributor to the many economic savings and conveniences made available through the functioning of refrigerating and ice making plants.

Technical Bulletins on request.

THE VILTER MANUFACTURING CO.

906 Clinton Street

Established 1867

Milwaukee, Wis.

BADGER CAB CO.

(UNDER NEW MANAGEMENT)

PHONE BAD **312** GER

148 S. BLAIR ST.

PROMPT ATTENTION GIVEN TO ALL PHONE ORDERS FOR MILITARY BALL

"DON'T TAKE A CHANCE—TAKE A BADGER"

WILLIAM MUSIL (Mgr.)

Please mention *The Wisconsin Engineer* when you write.

Alumni Notes

CHEMICAL ENGINEERING

Carter Anderson, ex c'24, was married to Miss Millard Bunnel, November 8, 1925. They reside in Chicago, where Mr. Anderson is employed as a chemical engineer.



Charles A. Mann, ch'09, is now head of the Chemical Engineering Department of the University of Minnesota, and since he has taken charge, this department has been given ranking with the leading colleges and Universities of the country. As when in school, Mr.

Mann still continues his work in outside activities. Besides being a faculty member of the Board of Directors of the Engineers Book Store and faculty advisor for the Chemists Student Council, he is a member of the symphony orchestra and present district deputy of his college fraternity.

CIVIL ENGINEERING

Ralph B. Abrams, c'22 was married to Miss Ruth Krauskopf on October 31, 1925. They are living at 7671 Rogers Ave., Chicago.

George H. Burgess, c'95, formerly chief engineer and later chairman of the Valuation Committee of the Delaware and Hudson Company receives a large part of the credit for the History of the Delaware and Hudson Company, which has just come from the press. The book, which is a highly creditable bit of historical research, is an intensely interesting account of railway development in this country.

Howard Dessert, c'04, vice-president of the Mosine Land Log and Timber Company, has recently been appointed chairman of Wisconsin department's American Legion France Convention Travel Committee. He will head the effort to obtain a large delegation of Wisconsin veterans to the Paris convention which is to be held in 1927.

Malcom S. Douglas, c'22, was married to Miss Eleanor Devine, September 11. Mr. and Mrs. Douglas are at home at Orono, Me. where Mr. Douglas is professor of engineering in the state University.

Charles R. Fisher, c'11, of Reedsburg, became the father of a daughter, Margaret Louise, on December 18, 1925.

Art Fredricks, c'24 was married on September 22, 1925 to Miss Frances Foreser. They will reside in Monroe where Mr. Fredericks is employed as highway engineer.

Elroy Luedthe, ex c'23, was married to Miss Lucille Talmadge on July 15. They are at home in Milwaukee, where Mr. Luedthe is employed as a civil engineer.

Julius M. McCoy, c'25, has been with the La Cross Division of the State Highway Commission since January 1.

Ewald D. Steinhagen, c'11, became the father of a son, James Daniel, on February 3. Present address is 721-51 St., Milwaukee.

The following civils were back for the seventeenth annual convention of the Engineering Society of Wisconsin held here February 18, 19, and 20.

H. H. Brown, c'17, Engineer, Milwaukee.

C. C. Congdon, c'21, City Engineer, La Cross.

R. M. Connelly, c'16, City Engineer, Appleton.

W. A. Collins, c'24, Assistant City Engineer, Beloit.

M. W. Forkelson, c'04, Highway Commission.

D. S. Fowler, c'17, County Engineer, Watertown.

R. W. Gamble, c'16, Superintendent of Street Construction, Milwaukee.

A. L. Hambrecht, c'10, Division Engineer of Highway Commission, Madison.

E. B. Kimdell, c'25, Highway Commission.

H. J. Kuelling, c'08, Consulting Engineer, Milwaukee.

O. F. Muggee, c'23, State Board of Health.

A. J. Rabuck, c'23, Engineer, Milwaukee.

L. M. Schendle, c'16, Consulting Engineer, Appleton.

J. R. Schwada, c'16, City Engineer, Milwaukee.

R. M. Smith, c'13, City Engineer, Kenosha.

R. Striegl, c'21, Junior Engineer U. S. Engineering Department, Milwaukee.

F. W. Ullius, c'11, Sewerage Engineer, Milwaukee.

O. W. White, c'25, University Extension Division, Madison.

K. L. Zander, c'23, Assistant City Engineer, Kenosha.

ELECTRICAL ENGINEERING

James Aston, e'98, for the past five years metallurgical engineer in charge of research with A. M. Byers Company has been appointed Professor of Mining and Metallurgy and head of the department of Mining and Metallurgical Engineering of Canegie Institute of Tehnology.

Chase Donaldson, e'20, became the father of a son, Paul Robert, on October 9, 1925. Mr. Donaldson is living at 821 40th St. Milwaukee, Wisconsin.

Earl S. Henningsen, e'12, was recently made assistant engineer of the alternating current engineering department of the General Electric Company. In this new position, Mr. Henningsen will devote his attentions, primarily, to the administrative and mechanical problems and will have charge of the department in the absence of H. G. Reistm, engineer in charge.

Harold W. Hohn, e'23, was married to Miss Ruth Nelson, October 21, 1925. Mr. Hohn is electrical engineer for the American Gas Company at Philidelphia, in which city they are now living.

Alfred Hudson, e'25, is with the General Electric Company at Schenectady, N. Y. His address is 137 Park Ave.

Herman E. Kranz, e'14, announces the arrival of a daughter, Marion Evelyn. Mr. Kranz is living at 6505 34th St., Berwyn, Illinois.

A. H. Martin, e'09, was here for the convention of the Wisconsin Society of Engineers held February 18, 19, and 20. He is a Construction Engineer of Prairie du Chein, Wisconsin.

William R. McCann, e'15, is now with the Atmospheric Nitrogen Corporation at Syracuse, N. Y. In a letter to Professor Bennett he mentions that he would like to get in touch with any of the class of 1926 who might be interested in that work, especially those who have had thorough training in either Machine Design, Mechanics of Materials, or Thermo-dynamics.



For that Formal--

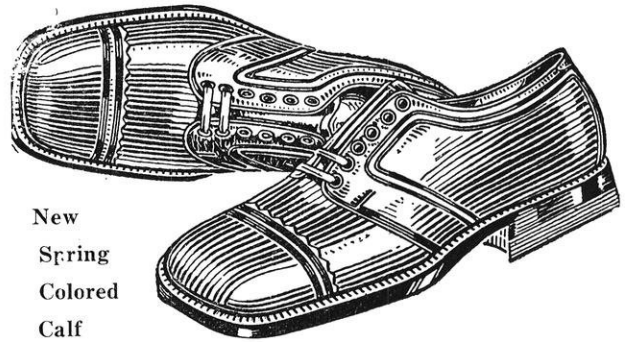
Flowers from
Rentschler's are
always most ac-
ceptable.

Rentschler
FLORAL CO

Store at 226 State
Open evenings till eight

Walk-Over

STURDY SPRING OXFORDS
FOR MEN



New
Spring
Colored
Calf

Balaban's Walk-Over Boot Shop
611 STATE ST.

SNEAK THIEVES STOLE

\$1,500

FROM FRATERNITY AND
ROOMING HOUSES LAST SPRING

Guard against such losses
this spring by keeping your
money in a BRANCH
CHECKING ACCOUNT.
Join the 95% of the Stud-
ent body who do business
here.

STUDENT BANKING HEADQUARTERS
BRANCH BANK of WISCONSIN
State at Gilman

CUT PRICES ON HIGH TOP BOOTS

16" RUSSET DRESS BOOTS
AND MOCCASIN BOOTS

Corduroy Breeches -----	\$3.25
U. S. Army Shoes, Leather and Com- position Sole Special -----	\$3.75
Regular Khaki Breeches -----	\$1.75

Madison Army Store
FULL LINE OF WHIPCORD
BREECHES

126 E. Main St. Badger 7719

John H. Michael, e'24, has changed his address to 586-63 Ave., West Allis, Wisconsin.

Vernon W. Palen, e'25, who is with the New York and Queens Electric Light and Power Company states, in a letter to Professor Watson, that he has gained much valuable experience and that the work is ideal for students "just out of college." The work consists of relay settings, electrolysis, voltage complaints, designs of layout, and many other special problems. There are about fifteen engineers in this department and in the summer there will be an opening for several more newly graduated engineers.

Cecil P. Parsons, e'22, became the proud father of a son, John Steve, on June 13, 1925. Mr. Parsons is living at 1101 Elm St., Beloit, Wisconsin.

Ross W. Rogers, e'12, is now residing at 400 N. Oak Park Ave., Oak Park, Illinois.

Harry C. Thayer, e'25, was married on November 25, 1925, to Miss Elsie Mayer of Schenectady, New York. They took a four day honeymoon at Albany, New York.

MECHANICAL ENGINEERING

C. M. Conradson, m'83, manufacturer of machinery at Green Bay, Wisconsin, is the writer of an article on Special Machine Tools for Best Work which appears in the January number of the Michigan Manufacturer and Financial Record. We are told that for years he was associated with the Gisholt Company of Madison, Wis. During the war he was sought by the British Government for his direction of lathe construction and given a very great order for production under his own eye at Eau Claire, Wis. Mr. Conradson's most recent piece of designing is a machine which will finish a flywheel in 90 seconds. He admits that he is at variance with the standard tool designers but maintains that he is right.

I SELL THE BEST SEE!



A. W. Edwards, m'25, is now manager of the branch office at Cincinnati for Trane Company, where Mr. Edwards says he is no longer a Student Engineer but is a Sales Engineer. His new address is 20 Greenwood Bldg., Cincinnati, Ohio.

E. Gleason, m'10, was here for the convention of the Wisconsin Society of Engineers held February 18, 19, and 20.

John F. Gross, m'16, became the father of a daughter, Dorothy on November 7, 1925. Mr. Gross is living at 98 S. Grandview Ave., Crafton, Pittsburg, Pennsylvania.

Frank J. Roberts, m'11, became the proud father of twins Catherine Florence and William Francis on August 25, 1925. Mr. Roberts' home address is, 532-58 St., Wauwatosa, Wisconsin.



W. Shoemaker, m'26, (Feb.) is now with the Industrial Engineering Department of the Holeproof Hosiery Co. His new address is 647 Astor Street, Milwaukee, Wisconsin.

MINING ENGINEERING

Stewart Turneure, min'21, son of Dean Turneure, was married on December 18, to Mrs. Karl Cushing Kenny of Hancock, Michigan. Stewart is teaching geology at the Houghton School of Mines.

Throughout the development of civilization, language has been not only the essential vehicle but also the greatest stimulant for thought.—H. H. Higbie.

CAMPUS NOTES

(Continued from page 199)

About 200 engineers from all parts of the state were in attendance at this meeting.

The officers elected for the ensuing year are as follows: president, C. M. Baker, state sanitary engineer; vice-president, C. E. Heebink, c'o8, city engineer of Beloit; secretary-treasurer, C. I. Corp, professor of hydraulic engineering; trustees, Joseph Schwada, c'11, city engineer of Milwaukee; W. C. Kirchoffer, c'97, C. E. '01, consulting engineer in Madison; J. T. Donaghey, state highway engineer; and Alva Hillis, city engineer of Marinette.

One of the progressive steps taken by the organization at this meeting was the permission granted to the trustees to publish the proceedings and transactions of the Engineering Society of Wisconsin in a joint quarterly publication with the sister societies of Iowa and Illinois, the members of each of these societies will thus benefit by the technical contributions of the whole.

The seventy new members added this year bring the total membership to 320.

"To select well among old things is almost equal to inventing new ones."—Trublet.

ATHLETICS

(Continued from page 202)

seem to indicate, however, for each match was closely contested, and three ran for overtime periods.

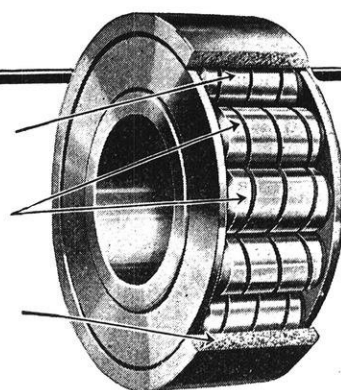
Naturally, engineering students have had their share of the honors this season. Captain Lyle Zodtner, a senior chemical, has always been a speedy dependable wrestler, and won his match by a large advantage in the Illinois meet. "Bill" Splees, a junior electrical is one of the best men on the squad, and in addition won his "W" last year in the sport. He bested his Northwestern opponent in a hard fought overtime match. "Mike" O'Laughlin, also junior electrical and "W" man from last year is a scrappy fighter, and has added his share to the honors. It is the first year of varsity competition for "Wally" Cole, soph chemical, but he is an outstanding man and will probably place in the conference meet. He won his matches in both the Illinois and Northwestern meets. Max Brackett, senior electrical, has shown up well, especially when he won the decision in his class in the Northwestern meet.

These are by no means the only engineers active in wrestling, for about a third of the number out are engineers. Others are: 115 pound class, Tanner, Stetson, Groth, Schmidt, Meusen; 125 pound class, Roberge, Zola, Randecker; 135 pound class, Millard, Suehs; 145 pound class, Bagnall, Feldhausen, Sewell; 175 pound class, Fiebrantz, Horsfall.

Throughout the year the team has been steadily improving and at all of the meets has shown real Wisconsin spirit. No team could wrestle better than the Cardinal at Illinois and Northwestern, and the performance of the team has been much better than the percentage column would seem to indicate.

Don't Expect Hyatt Performance From Any Old Bearing

- 1 Sturdy steel rollers held in a strong cage support the bearing loads on a full line contact with a rolling motion instead of the rubbing friction of plain bearings.
- 2 Right and left spirals insure a constant circulation of oil over all bearing surfaces. No part of the bearing can possibly run dry.
- 3 The steel races inside which the rollers operate are of the proper hardness and toughness to keep wear to a minimum, thus insuring dependable operation for years without bearing adjustment or replacement.



HYATT Roller Bearings—built of finest quality steel—operate faultlessly under the most severe conditions.

They easily absorb overloads so often imposed on industrial equipment, and return economies—even under adverse circumstances—in the form of lower power and lubricant consumption and frictionless, carefree service.

Thirty-five years' experience manufacturing dependable roller bearings is at your disposal, when you specify Hyatt.

One third of a century of study and development of bearings for countless industrial, automotive and agricultural applications is behind every recommendation made by Hyatt engineers.

When you specify Hyatt Roller Bearings you are assured of a lifetime of carefree, economical service. Don't expect like service from just any old bearing that happens to fit the hole. HYATT ROLLER BEARING COMPANY, NEWARK, N. J.

HYATT

ROLLER BEARINGS

CHEMICAL ENGINEER IN PRINTING INDUSTRY.

(Continued from page 191)

That means microscopic examination and before we got through a chemical analysis had to be run. But we satisfied him.

And here's the pressroom super again. His story is that the color plates which he ran yesterday don't match up when he tries to run his second and third colors. What's wrong? We don't like the looks of that one. He guarantees that the form is properly set up and that all the plates are in register from the guide side, yet when the opposite corner is reached the corners don't match. That looks as if the paper had stretched between the time of applying the first color and the second color. And that's what it is for if we measure the amount of overlap across an entire sheet we find on plotting the results that it is a straight line and that its equation is $y = mx + b$. So far so good. We can easily determine that paper stretches under the influence of heat, but that does not account for the entire change and finally it comes down to the moisture content of the paper. We also discover at this time that paper is classed as a hygroscopic substance and therefore the moisture content of the air in the pressroom will affect the paper.

And here we are in the middle of a beautiful mess, that of applying humidity control to a building containing ten acres of floor space under one roof. That is too deep a problem to be solved in one day so we will have to satisfy the pressroom super with the statement that we are working on it and that we believe we can solve his problem.

The bindery superintendent is back again. He says that his glue we made for him has quit gluing. It won't hold the covers on his books at all. We'll just take a trip back to the bindery and look this over. We think he is kidding us. Glue not sticking; the very idea. But he is right. It doesn't stick and what is more it doesn't look like glue anymore. It's dark brown in color, has no tack, and looks for all the world, when it is cold, like an art gum eraser. Something has been added to it that doesn't belong there but an emphatic denial from the glue maker kills that idea. Maybe the glue added to itself; seems as if, when we were in school, we heard something like that happening to certain compounds. What was it called? Oh, yes, polymerization. After running a few sample tests we find that that is exactly what happens and that there is a critical temperature over which the glue must not be heated. And that means the installation of temperature control and recording instruments on all of our glue pots. So ends another day.

The next morning brings us down bright and early. This is getting interesting. Every day is different, every day brings its own problems, something new to tackle. We've got a good one today for the pressroom super informs us that the rollers on some of his presses

are cracking badly and that he has had to replace several sets already. What's wrong? Well it may be the composition of the roller itself or it may be something in the ink. Rather than try to analyze a mixture of glue and glycerine, etc., we will try the ink and see if there is something in it which attacks the rollers. That seems to be a good hunch for the first thing we discover is that certain inks do this and that others do not. From that it is easy to find that the inks which make the trouble are those which contain certain dyes as toning colors. That is, to overcome the reddish tint of a cheap carbon black, an oil soluble dye is used which combines with the glue causing it to harden and finally crack. The solution, here, is to stop using those inks or to make an ink which does not contain the so called free dye toners. Both can be and are done. But as this is more of a problem for the printing ink maker, we will not go any further with the trouble at this time.

These few experiences give only a slight insight into the many and varied problems which confront the chemical engineer who enters the printing industry. We have not touched upon the problems arising in the laundry, the overlay room, where chalf overlays are made to increase the sharpness of details of the printing plates; nor of the paper departments where the testing and grading of the paper is a daily problem.

Throughout this article, little or nothing has been said regarding the problems which arise from an endeavor to improve the existing processes, to reduce the cost of some, to improve the product of others. Nor has anything been said of the tremendous field of pure research which is open. That in itself is a challenge to any real engineer.

The complexity of the problems which arise daily are an incentive to any engineer and the fact that the field is as new as the virgin forest gives one the thrill of the unknown; makes one feel as all pioneers feel when they find a new territory to explore, a new country to conquer.

EFFECT OF THE MOTORBUS ON STREET RAILWAYS

(Continued from page 196)

First the street railway is not going to be put out of business suddenly and completely as the horse car was. Companies that are well managed and fairly treated by public authorities will continue to give services and to make money for many years to come. Second, small companies that have not built up proper reserves for maintenance and rehabilitation are going to go out of business with loss to the holders of their securities when the time comes to make heavy repairs. Third, the motor bus will probably be the favorite with the public, and for this reason will probably have preferential treatment. In any specific case, this may be enough to throw the balance in its favor and lead to its adoption. It will tend to accelerate the transition.

Brock Engraving Co.

Engravers for

The WISCONSIN ENGINEER

Fourth Floor State Journal Building

Madison, Wis.

PANTORIUM CO.

Cleaners and Dyers

SUITS CLEANED AND PRESSED

at

\$1.00

Pressed only — \$.50



538 STATE STREET

Service B. 1180

Office B. 1598

\$5.00 in advance gives \$6.00 credit

You do not have to wait until the end of the season to get low prices here.

Our NO SALE POLICY

guarantees reasonable prices twelve months in the year.

This store is headquarters for Straford, Michaels Stern and Adlers of Rochester Clothes.

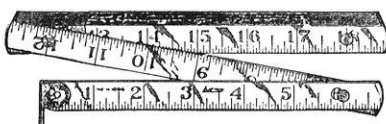
IT WILL PAY YOU TO VISIT

Madison's largest and Most UP-TO-DATE CLOTHING DEPARTMENT

2nd Floor

If you are interested in real fine clothing and furnishings it will pay you to inspect our showing.

The Crescent
CLOTHING CO
Specialists in Apparel for Men & Boys



LUFKIN

TAPES -- RULES -- TOOLS

INSURE YOUR MEASUREMENTS

On Sale Everywhere

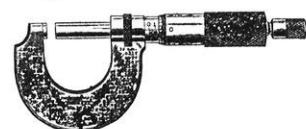
Send for Catalog

THE LUFKIN RULE CO.

SAGINAW, MICHIGAN

New York

Windsor, Can.



Please mention The Wisconsin Engineer when you write.

STEAM TURBINE RESEARCH AND INVESTIGATION

(Continued from page 189)

the best advantage and with the minimum loss of energy in the bucket and in the space immediately behind the bucket. A large number of tests have been made by blowing air through full sized models of portions of the last stage buckets, and as a result buckets have been designed which have an extremely low loss, and almost perfect guiding properties.

The exhaust hood losses have been determined by building comparatively small models of these hoods and blowing air through them in a prescribed manner which has been carefully worked out to simulate the conditions existing in the actual machines. Furthermore, the stream flow in the hood and the distribution of steam in the exit have been studied.

A more detailed description of the method of carrying out the nozzle reaction tests can be found in a paper presented to the Mid West Power Conference at Chicago¹ and a more complete description of the air test methods in a paper presented to the A.S.M.E. by Mr. H. L. Wirt².

There is another loss or group of losses which take place in a turbine which were mentioned briefly in the first part of this article. These are the losses which result from the action of the undercooling of the steam.

During the past four or five years great pains have been taken to attempt to analyze these losses, and for that purpose a large number of tests have been made, and a great amount of theoretical analysis undertaken. The effect of steam with various amounts of moisture content and superheat on the action of nozzles, single stages of steam turbines, and complete combinations of a number of stages has been studied. For this test work a special form of electric steam superheater has been developed which will permit the obtaining of very high degree of superheat with large quantities of steam, and the very accurate regulation and controlling of this superheat. Furthermore, methods of introducing moisture into steam to stimulate the conditions of moisture which are actually obtained in the turbine have been developed. The condition of the moisture in the exhaust of a turbine has been studied by means of windows located in the exhaust hood; the interior has been lighted by special lamps; and cleaners have been arranged for the windows on the same principle as the wind shield cleaner on automobiles. Furthermore, the action of moisture in a jet of air of high velocity has been studied in the air test. It has been found in all of these tests that the efficiency of a stage decreases approximately 1% for each 1% of moisture which exists in the discharge of the stage. A part of this loss, if the expansion is near the saturation line and is started initially or slightly superheated, is without a doubt due to the undercooling which results from the extremely rapid expansion and the failure of the steam to condense. The rest of the loss is due to the mechanical action of the high velocity jets upon the moisture particles.

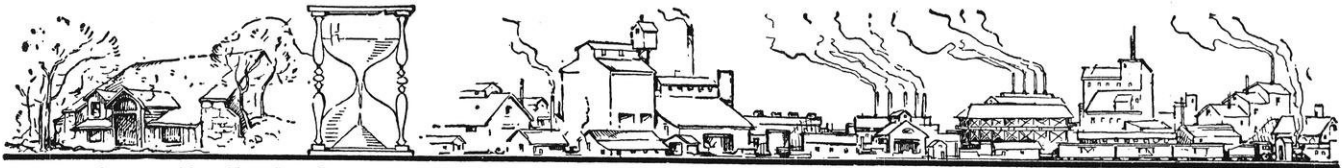
It so happens that for the range of expansion which normally exists in a turbine these two losses have approximately the same order of magnitude, and the overall result is about the same irrespective of the division between the two. That is, the more undercooling which exists the more undercooling loss, but the less condensation and less mechanical loss due to moisture, and vice versa.

The way in which the moisture causes a mechanical loss in the nozzles and buckets is as follows:

In the case of moisture passing through a nozzle the moisture particles are from 1000 to 20,000 times as dense as the steam in the nozzle passageway. The acceleration of the steam in a nozzle passageway is about a million times the acceleration of gravity. The moisture particles, having no energy of their own, must be accelerated by the drag of the steam. It can easily be seen, therefore, that it is impossible for the moisture particles to be accelerated as rapidly as the steam. The result is that, even if the moisture is in comparatively coarse drops upon entering the nozzle, the high relative velocity between the moisture particles and the steam will instantly break the coarse drops into millions of finer drops which can be accelerated more rapidly. Even so, however, calculations and tests both indicate that in an ordinary nozzle the moisture never moves at a velocity which is much more than $\frac{1}{4}$ the steam velocity. The result of this is that when there is moisture present the steam has to pass around and in between millions of tiny globules at velocities from 5 to 10 times the highest wind velocities ever recorded in an atmospheric tornado. It can easily be seen that an extremely high internal friction is thus brought about inside the jet itself. Furthermore, the fact that this moisture is not moving with the velocity of the steam, but at a much slower velocity, and since the moving buckets of a turbine are moving much nearer the velocity of the steam, it follows that when the jet gets into the buckets that the moisture will hit the buckets on the back, or rather the buckets will come up and hit the moisture, and it will be accelerated to the bucket velocity with a very low efficiency. Then, when it leaves the buckets, it will be thrown off with substantially the bucket velocity, dashed against the stationary members of the turbine with further loss in energy, all of which action causes considerable loss. It is the elimination of this great loss due to moisture which gives somewhat more than $\frac{1}{2}$ the total gain which can be obtained by increased initial superheat or by resuperheating the steam after a portion of its expansion through the turbine. Such superheat reduces the

1. Reference: "A Machine for Testing Steam Turbine Nozzles by the Reaction Method"—by G. B. Warren & J. H. Keenan. January 26—29, 1926.
2. Reference: "The Turbine Designer's Wind Tunnel"—by H. Loring Wirt, Dec. 1—4, 1924.

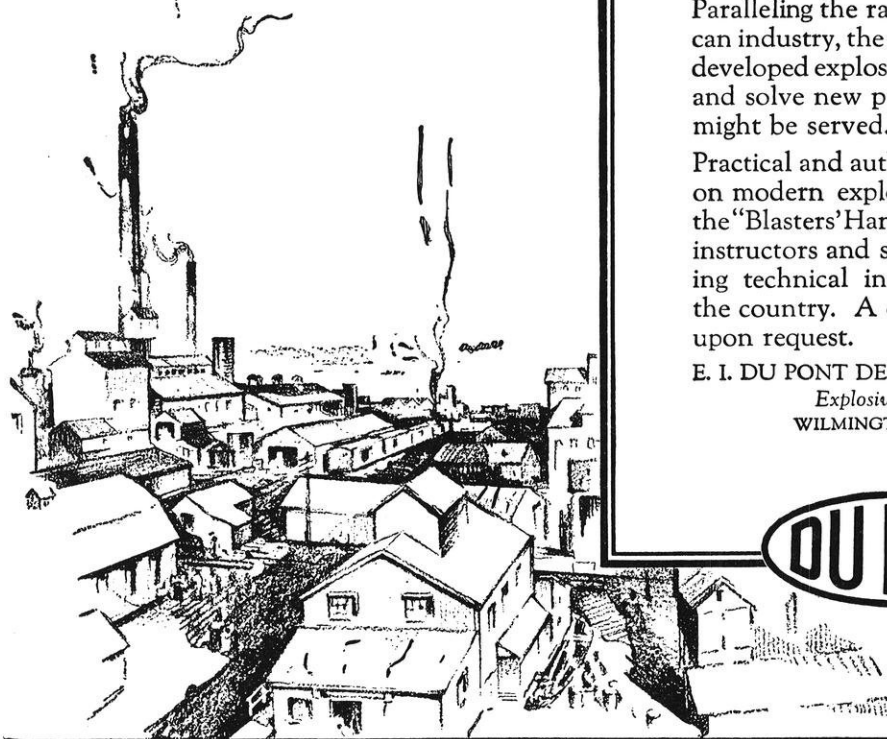
(Continued on page 216)



MAKERS OF POWDERS SINCE 1802



The oldest du Pont
powder mill—
built in 1802



Leadership

Leadership is measured by service.

For nearly a century and a quarter, the du Pont name has signified leadership in explosives manufacture on this continent.

Paralleling the rapid growth of American industry, the du Pont Company has developed explosives to meet new needs and solve new problems that industry might be served.

Practical and authoritative information on modern explosives is embodied in the "Blasters' Handbook"—now used by instructors and students in many leading technical institutions throughout the country. A copy will be sent free upon request.

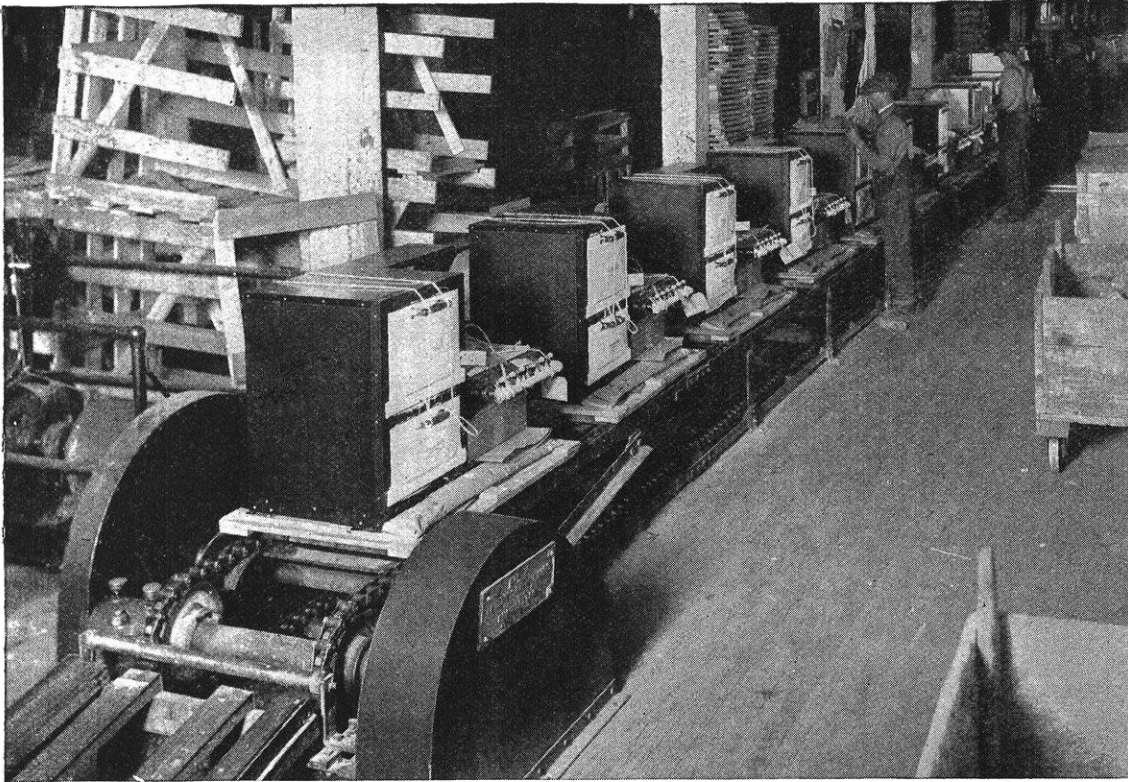
E. I. DU PONT DE NEMOURS & CO., Inc.

Explosives Department
WILMINGTON, DELAWARE



Partial view of Repauno Plant,
one of the largest explosives
plants of the du Pont Company.

123 YEARS OF LEADERSHIP IN THE SERVICE OF INDUSTRY



Progressive Assembly Conveyor, Cribben & Sexton Company, Chicago

Pioneers of Industry

Material handling, in itself a great industry, serves practically all other industries in the mechanical handling of raw, semi-finished and finished products such as: Coal, coke, ashes, sand, gravel, warehouse freight, cement, gypsum, glass, pottery, canning and packing produce, lumber, fertilizer, foundry sand, boxes, barrels and progressive assemblies. Its use is almost as limitless as the use of power.

Coincident with the expansion of the use of conveying machinery and power operations, the chain industry is also expanding. Indeed, improvements in chain have made possible many of the developments in conveying and power transmission.

Chain is also serving another great industry, that of concrete construction and road building, as the drive on Rex Mixers and Pavers.

Rex Conveyors, Rex Chain, Rex Pavers, and Mixers, built by the Chain Belt Company, have played a large part in the development of these three industries, conveying, chain, and concrete construction. This company also believes that they are still only in their infancy.

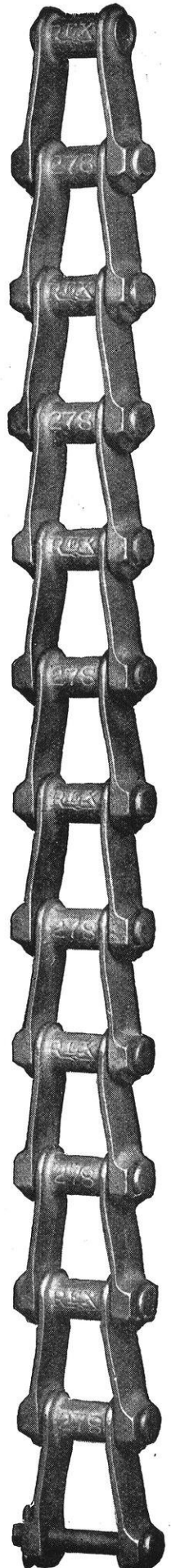
Whether you are a student, a graduate engineer or a manufacturer it might be well to inquire what they may hold for you. We will gladly send information to anyone interested.

REX
CONVEYORS
CHAIN BELT COMPANY

736 Park Street

Milwaukee, Wisconsin

Please mention The Wisconsin Engineer when you write.



Standardized Concrete



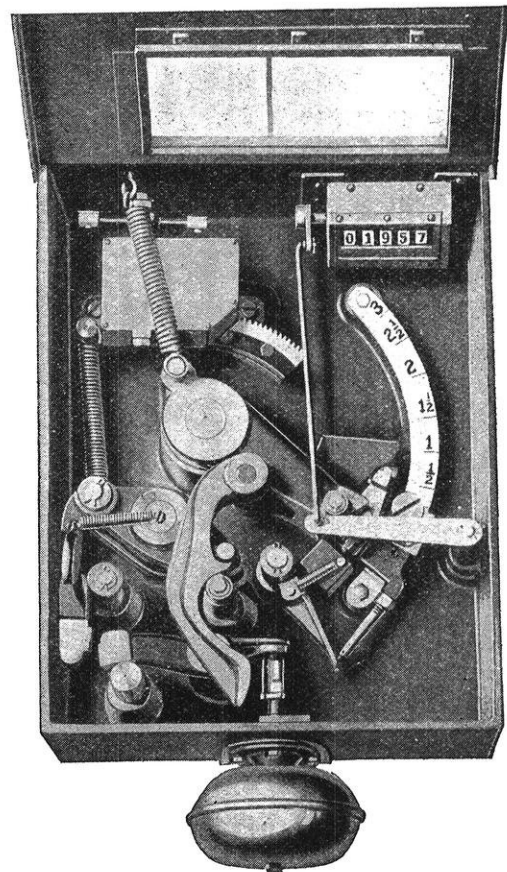
This illustration of the Koehring escapement type batch meter shows the method by which the discharge chute is automatically locked as soon as the charge enters the drum. The discharge chute cannot be moved until the regulated mixing time has elapsed, when it automatically releases the discharge lever and signals the fact with a bell. The meter also registers each batch that enters the drum.

Patent Nos.
1,321,460; 1,282,558, 1,338,761.

THE Koehring Company long ago foresaw the value of standardizing concrete,—foresaw and provided for it before the tremendous volume used in constructing roads and permanent structures made standardized concrete a vital necessity.

One of the most important means of insuring a uniform strength and quality of concrete is the Koehring Batch Meter,—a positive means for timing each batch and measuring the thoroughness of mix. This device, upon being set for the specified mixing period, automatically locks the discharge chute as soon as the drum receives the materials; the discharge chute cannot then be operated until the full specified mixing time has elapsed.

Every state highway department requires, in its specifications for concrete highway construction, the use of batch meters. This



Koehring development is an integral unit on practically every paving mixer today,—a Koehring contribution to the industry.

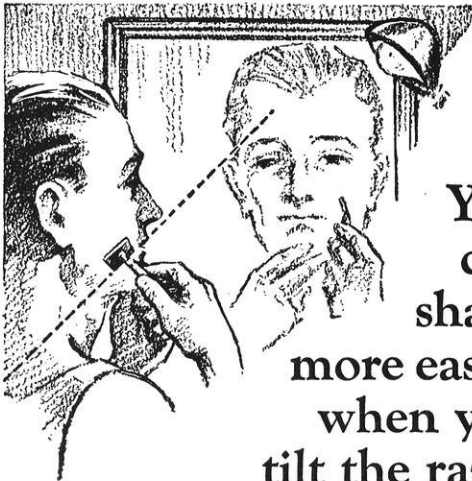
The Koehring mixer, with the Koehring batch meter, Koehring five action re-mixing principle, and the Koehring automatic water measuring tank, provides the most positive mechanical means yet developed for producing standardized concrete of unvarying uniformity.

KOEHRING COMPANY

PAVERS, MIXERS—GASOLINE SHOVELS, CRANES, DRAGLINES
MILWAUKEE, WISCONSIN

KOEHRING

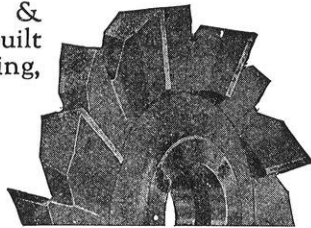
Please mention The Wisconsin Engineer when you write.



**You
can
shave
more easily
when you
tilt the razor**

WHEN you shave you tilt the razor so that the blade will shear off the hairs. It cuts a great deal more smoothly that way than if you drew it straight down on your beard.

The Brown & Sharpe engineers built this easier cutting, shearing principle into a milling cutter by "tilting" the cutting edges of the teeth, with the result that they shear easily into the metal.

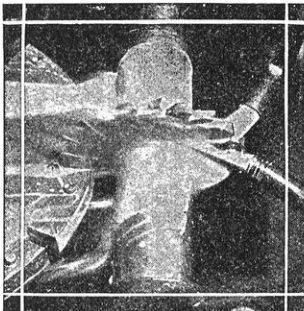


Note the alternate spiral angles of the "staggered" teeth and their substantial backing.

To further improve the efficiency of the cutter they alternated this "tilt" or spiral angle and "staggered" the teeth. Also, the teeth were well undercut and furnished with a rugged backing. The result is a cutter with plenty of chip clearance that will take easily and rapidly deeper cuts, especially in steel.

This cutter is called the Brown & Sharpe Staggered Tooth Side Milling Cutter. It will remove a large amount of metal without de-

structive vibration and chatter, the enemies of high production milling.



Deep cuts in steel like the above are conclusive evidence of the superiority of Brown & Sharpe Staggered Tooth Cutter Design.

There is considerable information about cutters and their design in the New No. 30 Small Tool Catalog. A copy will be sent free at your request.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R.I., U.S.A.

TURBINE RESEARCH

(Continued from page 212)

amount of moisture in the turbine, and the number of stages which operate in the moisture region.

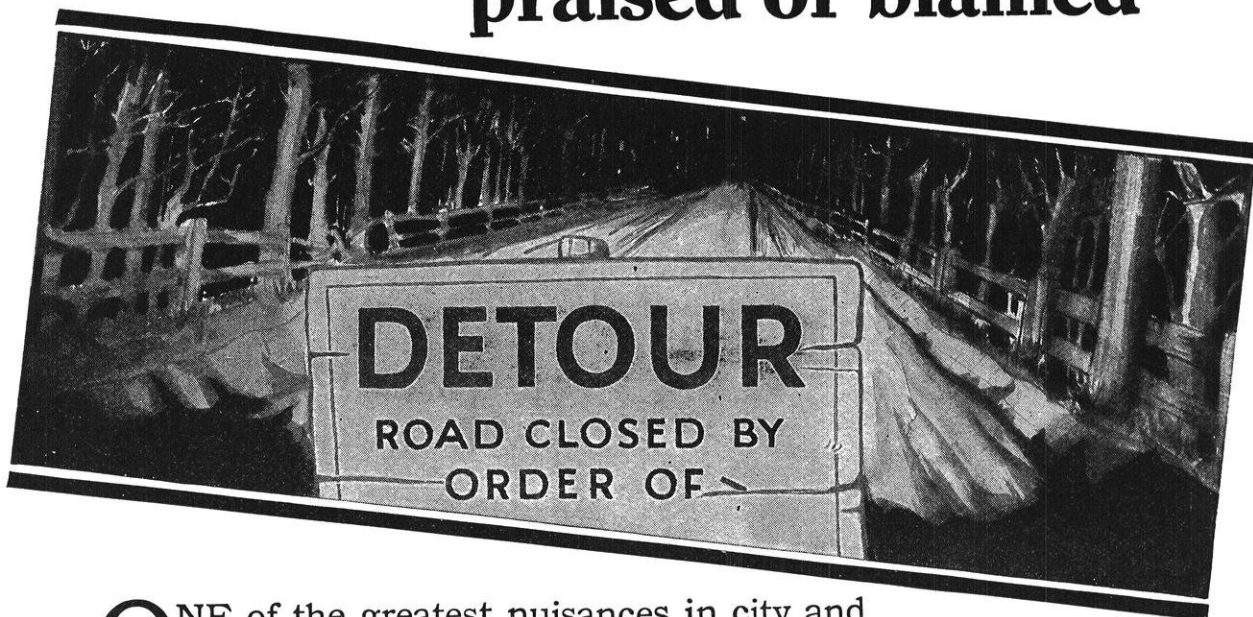
For years men have dreamed of extracting the moisture formed in a turbine at the different stages. A large number of patents relating to this have been taken out during the past 25 years but no perfect scheme has been devised. Active tests have been carried out for the past three years relating to this, and now are beginning to show a certain amount of success. Some of these devices have been incorporated in turbine; in fact, the best thing which was found was a construction which was put in based upon logical reasoning several years ago, and later taken out because no adequate means was at hand for determining its effectiveness. The evidence seems to point to the fact that the extraction of moisture is somewhat easier when steam is being extracted for feed water heating. If this is true, then it means that the gain due to the regenerative or steam extraction cycle will be slightly greater than shown by theoretical calculations, not taking into account the extraction of moisture.

It has been possible to give only a general idea of a few of the things that are being carried on. An earnest effort is being made to lay a broad foundation for turbine design based upon scientific investigation, and to perfect each detail of the turbine design and construction. It is not wise, however, to expect too much in the way of immediate improvement resulting from such research work. The turbine art has been given great amounts of study and thought by the best engineers of both this country and Europe. Purely on the basis of logical reasoning and a relatively small amount of research testing, the turbine has been developed into an extremely efficient and highly effective machine. To introduce improvements to a machine so perfected is a task, the difficulty of which one can scarcely realize until one has tried it. Furthermore, it is almost impossible to introduce any given improvement into a machine without making a compromise in either it or other features in the turbine. As we learn more and more about each of the individual elements, and how they effect one another when used in combination, we feel positive, however, that in the future it will be possible to evolve a turbine combining the greatest degree of reliability and the maximum possible sustained efficiency throughout the life of the machine, together with the lowest possible first cost commensurate with the efficiency and the high degree of reliability which is demanded by the industry.

*It's not the work of one man
That brings us to the goal,
It's the everlasting team work
Of every bloomin' soul!*

—Kipling.

Some day YOU future engineers will be the men to be praised or blamed



ONE of the greatest nuisances in city and country life today is the incessant blocking of streets and highways for repairs and repaving. You hate detours just as much as the next man—and it won't be long before you can do a big job toward minimizing them.

In the meantime, whenever you are confronted by a "Road Closed" sign, make a mental note of why it is there. You'll soon be decidedly amazed to discover how rarely a brick-paved road requires a detour.

When the choice of pavements falls to you, keep that fact in mind—do your part to give us detourless roads.

VITRIFIED
Brick
PAVEMENTS



A Book for Road Scholars

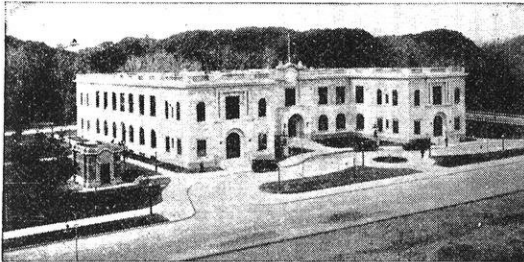
If "The Construction of Vitrified Brick Pavements" is not already a textbook in your courses, let us send you a personal copy. It is an accurate and authoritative handbook of 92 pages which you will want to preserve for reference after graduation.

OUTLAST THE BONDS

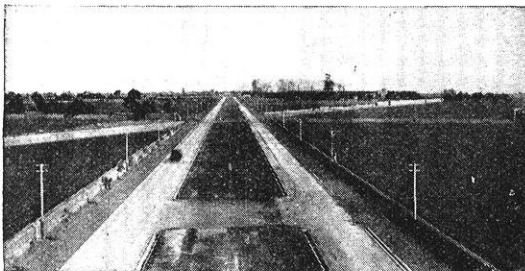
NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, ENGINEERS BLDG., CLEVELAND, OHIO.

Please mention The Wisconsin Engineer when you write.

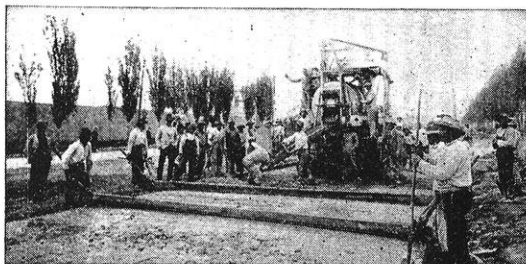
The Incas would not know the Peru of today



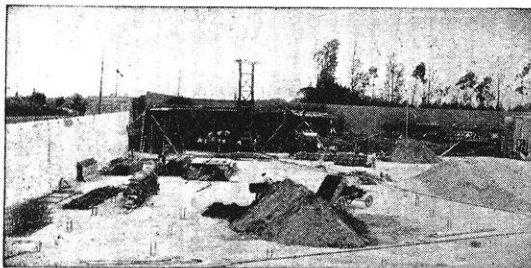
Construction activities of The Foundation Company in Peru are changing the old order. The layout for the modernization of Lima, Cuzco and thirty other cities is comprehensive and has been carefully planned with this progressive republic.



The Office Building of the Ministry of Public Works would do credit to any community. It represents the public interest in facilities for efficiency in government. Thirty new public schools will be the equal of those of any country.



Highways and Streets are being paved to meet the needs of motor traffic in the cities and between them. Asphalt or concrete are used depending on location and necessity. This familiar looking paver is only a part of the modern equipment seen in Peru.



The New Water Supply System—including underground collecting galleries high in the hills, concrete reservoirs, and conduits of concrete or iron—will soon supplant the well constructed, but entirely inadequate, vitrified clay pipes of the ancients. Sewers and Disposal Plants will guarantee the health of the people.

The modernizing of Peru is a typical construction project of this organization.

THE FOUNDATION COMPANY

CITY OF NEW YORK

Office Buildings • Industrial Plants • Warehouses • Railroads and Terminals • Foundations
Underpinning • Filtration and Sewage Plants • Hydro-Electric Developments • Power Houses
Highways • River and Harbor Developments • Bridges and Bridge Piers • Mine Shafts and Tunnels

ATLANTA
PITTSBURGH
CHICAGO

SAN FRANCISCO
LOS ANGELES
MONTREAL, CANADA

MEXICO CITY
LIMA, PERU
CARTAGENA, COLOMBIA

LONDON, ENGLAND
BRUSSELS, BELGIUM
TOKYO, JAPAN

BUILDERS OF SUPERSTRUCTURES AS WELL AS SUBSTRUCTURES

GOOD LIGHTING OF INDUSTRIAL PLANTS SECURES SAFETY AND EFFICIENCY.

The Code of Lighting for factories, mills and other work places of the State of New Jersey makes excellent recommendations of daylight for the proper lighting of industrial buildings.

Adequate daylight facilities through large window areas, together with light, cheerful surroundings, are highly desirable and necessary features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the viewpoint of maximum plant efficiency.

Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employee.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

Shades may be eliminated and most efficient lighting obtained by the use of Factrolite Glass.

If interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

220 Fifth Avenue,

St. Louis.

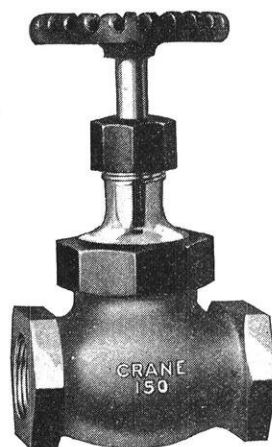
New York.

Chicago

No. 7.

Please mention The Wisconsin Engineer when you write.

CRANE VALVES



Your future and ours

Crane recognizes that the future of engineering depends upon you engineering students of today. Everywhere Crane men desire to keep in constant touch with your new ideas and fresh viewpoints. The manufacturer and the engineer must always march together, and the sooner the acquaintance begins the swifter will be the progress of both. You will be cordially welcomed at the Crane Exhibit Rooms, located in 103 cities in the United States, where the latest developments in piping materials are on display. For mutual information, Crane men are glad to discuss the technical points of valves fittings and specialties.

CRANE

Address all inquiries to Crane Co., Chicago

GENERAL OFFICES: CRANE BUILDING, 836 S. MICHIGAN AVENUE, CHICAGO

Branches and Sales Offices in One Hundred and Fifty-five Cities

National Exhibit Rooms: Chicago, New York, Atlantic City,

San Francisco and Montreal

Works: Chicago, Bridgeport, Birmingham, Chattanooga, Trenton,

Montreal and St. John, Que.

CRANE EXPORT CORPORATION: NEW YORK, SAN FRANCISCO, MEXICO CITY, SHANGHAI

CRANE LIMITED: CRANE BUILDING, 386 BEAVER HALL SQUARE, MONTREAL

CRANE-BENNETT, LTD., LONDON

CR CRANE: PARIS, BRUSSELS



Timken Steel for Timken Bearings

The world's largest producer of electric furnace steel is the Timken Roller Bearing Company. A complete steel mill is part of the marvelously self-contained Timken Bearing plant.

Timken Tapered Roller Bearings are produced on a scale so large, because of their large importance throughout manufacture, construction, mining, agriculture, transportation, and every field in which machinery is used.

Timken Bearings are being designed into every sort of machinery to eliminate excess friction, to save labor, power and lubricant, to increase quantity and quality of output, and to lengthen machine life.

These economies are so important to all the industries that 132,000 Timken Bearings are being added daily to the 150,000,000 Timkens already successfully applied.

Each day—each year—Timken Bearings become of still greater interest to all concerned with machinery. As a potential engineer you have a direct interest in obtaining the valuable little book on Timken Bearings. It will be sent free on request.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN *Tapered Roller* BEARINGS

Please mention The Wisconsin Engineer when you write.

PREPARE FOR YOUR JOB

The Explosives Engineer

*Is Devoted to the Technology of Drilling, Blasting,
Loading and Transportation of Coal, Ore and Stone*

THE EXPLOSIVES ENGINEER, now in its fourth year, is taking a higher place every month in the industrial press of the country and of the world. Its circulation is spreading wherever there is mining, quarrying, or construction. Each issue contains practical, usable information for the man who expects to take his place in the explosives consuming industry.

In February, for instance, there is an authoritative article on blasting in the construction of the Philadelphia subway. Another article describes a new seismograph which, with explosives, is used in determining geological structures. From his twenty-four years of explosives' experience around mines, the

author of "Advice to Coal Blasters" has compiled some practical blasting information. "Road Building Above the Clouds" tells why and how Continental Divide highways are drilled without the aid of modern equipment. There is a portrait and a biography of S. A. Taylor, the next president of the American Institute of Mining and Metallurgical Engineers. And, of course, a Blaster Bill cartoon and the usual bibliography of all articles on drilling and blasting and a list of new patents, digested from the technical press of the world. You can see it in the college library, but you will want a complete file of your own. Send in your subscription on the coupon.

THE EXPLOSIVES ENGINEER

WILMINGTON

Published Monthly

DELAWARE

NEW OFFER—LESS THAN THREE CENTS A MONTH

THE EXPLOSIVES ENGINEER,
941 Delaware Trust Bldg.,
Wilmington, Delaware.

SUBSCRIPTION RATES

United States—3 yrs.	-	\$1.00	1 yr.	50c
Other Countries—3 yrs.	-	2.00	1 yr.	\$1.00

I am enclosing \$1.00 for a 3 years' subscription to The Explosives Engineer, to begin with the current issue, if it is not already exhausted. (This rate applies only to the United States.)

Name.....

College.....

Course..... Class.....

City..... State.....



Please send me entry application and rules of the National Safety Competition for The Explosives Engineer Trophy, conducted under the auspices of the United States Bureau of Mines. Check if desired.



Steel Sheets that Resist Rust!

The destructive enemy of sheet metal is *rust*. It is successfully combated by the use of protective coatings, or by scientific alloying to resist corrosion. Well made steel alloyed with Copper gives maximum endurance. Insist upon

KEYSTONE Rust-Resisting Copper Steel Sheets

Black and Galvanized



Keystone Copper Steel gives superior service for roofing, siding, gutters, spouting, culverts, flumes, tanks, and all uses to which sheet metal is adapted—above or below the ground. Our booklet *Facts* tells you why. We manufacture American Bessemer, American Open Hearth, and Keystone Copper Steel Sheets and Tin Plates.

Black Sheets for all purposes
Keystone Copper Steel Sheets
Apollo Best Bloom Galvanized Sheets
Apollo-Keystone Galvanized Sheets
Culvert, Flume, and Tank Stock
Formed Roofing and Siding Products
Automobile Sheets—all grades
Electrical Sheets, Special Sheets
Deep Drawing and Stamping Stock
Tin and Terne Plates, Black Plate, Etc.

Our Sheet and Tin Mill Products represent the highest standards of quality, and are particularly suited to the requirements of the mining, engineering, and general construction fields. Sold by leading metal merchants. Write nearest District Office.

American Sheet and Tin Plate Company

General Offices: Frick Building, Pittsburgh, Pa.

DISTRICT SALES OFFICES

Chicago Cincinnati Denver Detroit New Orleans New York
 Philadelphia Pittsburgh St. Louis

Pacific Coast Representatives: UNITED STATES STEEL PRODUCTS CO., San Francisco
 Los Angeles Portland Seattle

Export Representatives: UNITED STATES STEEL PRODUCTS CO., New York City

**John A. Roebling's
Sons Company**
Trenton • New Jersey

**Roebling
Wire Rope**

is used where equipment is purchased on the basis of lowest ultimate cost over a long period of years. Send your rope problems to us for solution.

OKONITE OKONITE-CALLENDER PRODUCTS

WE are well equipped to manufacture large and small single and multiple conductor cables insulated with rubber, varnished cambric or impregnated paper for any service, any commercial voltage and with any type of covering or armor.

FLEXIBLE CORDS AND CABLES

All types, all services

WIRES FOR RAILROAD SERVICES

Signals, Locomotives, Cars

POWER WIRES AND CABLES

SPLICING MATERIALS

The Okonite Company

The Okonite-Callender Cable Co., Inc.

Factories, PASSAIC, N. J.

PATERSON, N. J.

Sales Offices: New York, Chicago, Pittsburgh, St. Louis, Atlanta, Birmingham, San Francisco, Los Angeles, Seattle, Wash.



Pettingell-Andrews Co., Boston, Mass.
 Novelty Electric Co., Philadelphia, Pa.
 F. D. Lawrence Elec. Co., Cincinnati, O.



Canadian Representatives: Engineering Materials Ltd., Montreal
 Cuban Representatives: Victor G. Mendoza Co. Havana

Please mention The Wisconsin Engineer when you write.

Q The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents, or are they forced into narrow grooves?

This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company after graduation and within the past ten years.



Engineer!

Arrest that Bolt



JOSEPH SLEPIAN

THE Sales Department was talking in emphatic and easily understood language. It was saying, "We want action."

At Westinghouse, action in many cases is another word for research. And research works toward selected goals. In this case the goal was for new apparatus to make unchained lightning more respectful of power plants, lines and equipment.

Today, as a consequence, the electrical industry is the beneficiary of the "Autovalve Lightning Arrester", perfected to a degree of efficiency, long service and universal utility never dreamed of before. Behind that picture you find Joseph Slepian. With two degrees from Harvard, he started training in our East Pittsburgh Shops in 1916. A year later he entered the Research Department.

This was the lightning arrester situation which Slepian took into the research camp: There were two different types of apparatus. One, called the multi-gap, was used chiefly on poles of distribution circuits. When lightning struck, it frequently

caused transformer troubles and damaged equipment. For high-voltage application there was the cumbersome electrolytic arrester. Its performance was good enough. But it required constant attention; was costly of upkeep; and could not be used on poles.

When Slepian perfected the Autovalve Arrester, the demand was so great that orders could not be filled. It was entirely new. One type of apparatus solved the whole problem—no more costly care. It stands up indefinitely, whether used on poles or on the ground—sufficient reasons for yearly sales exceeding \$2,000,000.

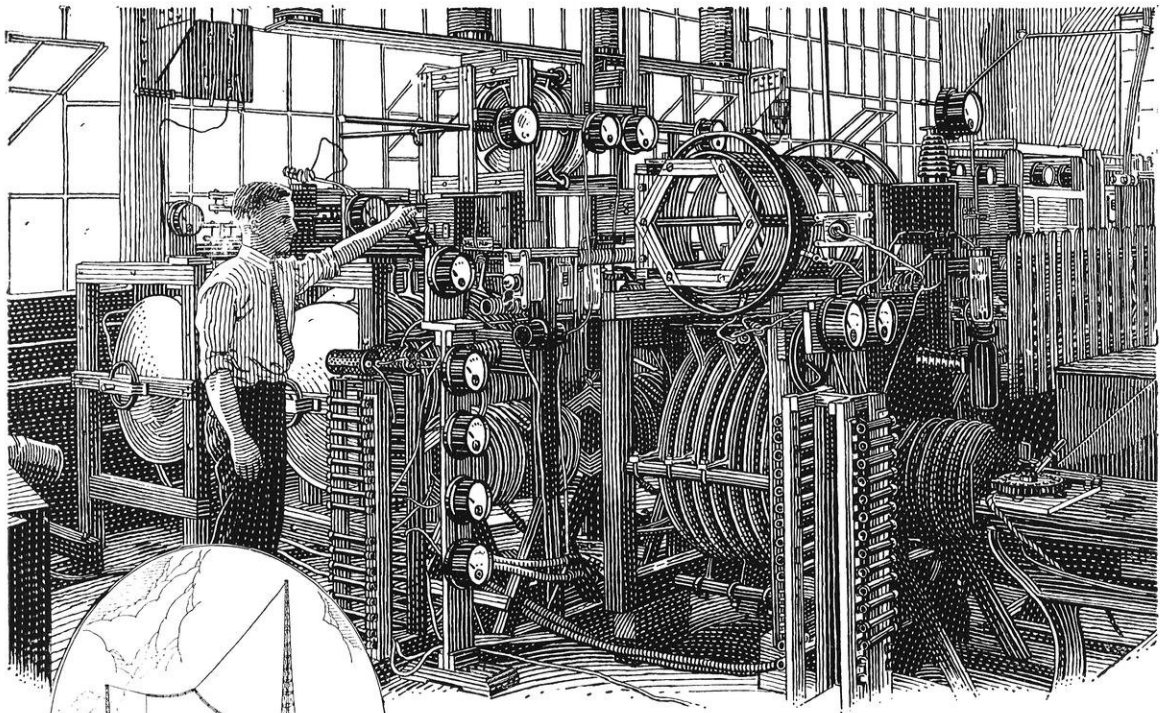
Such results may depend as much on a phase of an engineer's past training as on his immediate research. Take the radio horn which gives the natural tone to Radiola sets. It was Slepian's mastery of mathematics, in which he specialized at Harvard, which contributed toward that big advance in the early days of loud-speaker popularity.

The man with "hidden reserves" is constantly finding them called upon to "climb peaks and cross mountains" in institutions like Westinghouse.

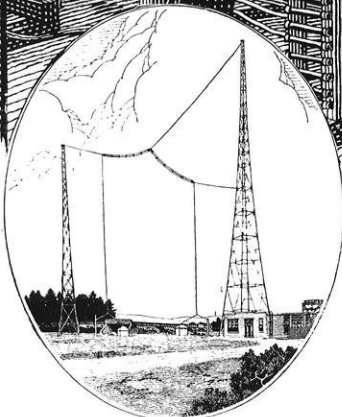
Westinghouse



Please mention The Wisconsin Engineer when you write.



One of the power amplifier stages of the world's first super-power transmitter



Antenna of super-power transmitter

The World's Loudest Voice

On the rolling plains of South Schenectady, in several scattered buildings, is a vast laboratory for studying radio broadcasting problems. Gathered here are many kinds and sizes of transmitters, from the short-wave and low-power sets to the giant super-power unit with a 50- to 250-kilowatt voice.

Super-power and simultaneous broadcasting on several wave lengths from the same station are among the startling later-day developments in radio. And even with hundreds of broadcasting stations daily on the air throughout the land, these latest developments stand for still better service to millions of listeners.

Only five years old, yet radio broadcasting has developed from a laboratory experiment into a mighty industry. And alert, keen young men have reaped the rewards.

But history repeats itself. Other electrical developments will continue to appear. And it will be the college man, with broad vision and trained mind, who will be ready to serve and succeed.



From the studio of WGY in Schenectady, six miles from the developmental station, there may be controlled a great number of transmitters, one of which is the first super-power transmitter in the world.

WGY, together with its associates, KOA of Denver and KGO of Oakland, is the General Electric Company's assurance to the American public that radio broadcasting shall be maintained upon the highest standards.

A new series of G-E advertisements showing what electricity is doing in many fields will be sent on request. Ask for booklet GEK-1.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

Please mention *The Wisconsin Engineer* when you write.

95-138DH