The Wisconsin engineer. Volume 40, Number 6 March, 1936

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

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

The Wisconsin Engineer

Engineering Society of Wisconsin

Convention Issue

MARCH 1936

Member, Engineering College Magazines, Associated

With the Contributors . . .

△ The Engineering Society of Wisconsin enjoyed a very successful 1936 Convention here February 20 and 21. This issue brings some convention highlights that will interest both student and practicing engineers.

△ The editor urges all readers to spend a moment with the editorial page — of special importance is a message for every E. S. W. member.

△ Let Mr. Hans Dahlstrand show you how ingenious the modern engineer can be when given "A Few Engineering Problems."

△ Reginald Saue, m'36, and Edward Gross, m'36, turned in an E.A. 102 report on "A Civic Auditorium for Madison" that would brighten the eyes of every person in Madison. If you're old enough to read, don't miss it.

△ One of our c'34 grads, Melvin Stehr, can tell you some pretty interesting things about some work he has just finished.

△ This month's "Static" is for shysters only. Take a look and see why.

△ Did you say the engineers ran only two dances a year? Well, run your eyes over that page about Military Ball, then.

△ You can browse around the E. S. W. Convention a bit if you turn to page 116.

△ In the lead article, Messrs. L. M. Buhr and E. F. Brownell show E. S. W. members and civil engineering students how they conducted a real piece of flowage surveying.

«« *Any article printed herein may be reprinted provided due credit is given. Entered as second class matter September 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, 1918.*

Subscription Prices:
$1.00 per year **Single copy 15c**

The WISCONSIN ENGINEER

Published monthly from October to May, inclusive, by the Wisconsin Engineering Journal Association, 219 Engineering Bldg., Madison, Wis.

Member Madison Association of Commerce

△

Telephone University U. 236
Founded 1896

VOLUME 40 MARCH, 1936 NUMBER 6

CONTENTS

EDITORIALS

E PLURIBUS UNUM. There are now one thousand registered professional engineers in Wisconsin. Can they be united into one organization strong enough and virile enough to represent them effectively in matters affecting their interests? That is the question that now confronts the leaders of the profession.

The Engineering Society of Wisconsin has had twenty-eight years of honorable existence. It professes to be a society for engineers of all kinds; but—it has only 113 paid-up members at present. It cannot honestly claim to represent and speak for the profession, and until it can support such a claim effectively and convincingly, it can have but small influence.

Whether the small membership is the fault of the society or the fault of the individual members of the profession cannot definitely be determined. Perhaps the efforts to increase the membership have not been properly planned; perhaps engineers are so individualistic that they cannot be corralled.

It is certain that sooner or later a state society for professional engineers will be formed. If E. S. W. does not step into the leadership, others will. It would seem obvious that the psychological moment has arrived for activity upon the part of the society to make itself in fact the state society of engineers.

ON BOOKS AND READING It is a well-known and regrettable fact that engineers have neither the time nor the inclination for reading. It is regrettable because during their college years they should be getting to know the authors and the books that could bring them many pleasant hours in the future. The ordinary engineer is inclined to spend his free time at the movies, at sporting events, or in the company of the girl friend—all pleasant enough pastimes, to be sure, but not likely to pay the dividends in the form of relaxation and a broad outlook that well-chosen books can bring.

"He who has the truth at his heart need never fear the want of persuasion on his tongue."

—Ruskin

These other interests need not be given up; that would be very unwise; but they can be somewhat budgeted in their time to allow the young man an hour or two a day, or better yet, a whole evening, in the company of a good book. In the busy years to come the young graduate starting on an arduous career will be very thankful for his ability to lose himself completely in the physical and mental adventures of the better authors.

Tastes in reading differ widely, and this makes the task of suggesting readable material a difficult one, especially when no one person can be expected to have read even a part of the works of the best authors. But adventure is a subject in which most men are interested, and in this field are such books as Richard Halliburton's "New Worlds to Conquer," "Royal Road to Romance," and others, and the historical semi-fictional trilogy by Charles Nordoff and James Norman Hall — "Mutiny on the Bounty," "Men Against the Sea," and "Pitcairn's Island"—all guaranteed to make the reader forget himself and his surroundings for hours at a time.

In the general field of autobiography we have many excellent books, such as Michael Pupin's "From Immigrant to Inventor," and for heavier but no less interesting reading Shakespeare's works can be perused. Will Durant's "Transition" and "Mansions of Philosophy" will open many avenues of thought to a critical and interested reader.

The Convention

One of the most gratifying sights to both the faculty and the convention members of Engineering Society of Wisconsin —that of the many engineering students attending the convention speeches.

Indeed, our Wisconsin engineering students took full advantage of their opportunities. At any time during the speeches in the engineering auditorium, one could see a goodly number of our students present. Especially were the seniors well represented.

Conventions such as this last one bring out vividly the fundamental differences between engineering in the university and engineering in the field. In school, you are given a short problem with all the conditions stated or arranged for, the answer either given you or hinted to you by the professor, and help and assistance close by at all times. When the solution comes back to you corrected, you find the mistake affecting you very little, except to make you a bit wiser and more cautious in the future.

But in the field it is different. You get the problem—no more. All the preventions, conditions, and cautions—everything pertinent to the problem—you yourself must find and investigate. And no one answer will be "right." Nor will there be help close by. A mistake will jolt the welfare of many people—it will cost money, and money illumines things with the precious glow of all-importance.

It is good, then, that we are given the chance to see what is ahead of us. Such a glimpse indelibly impresses you with one of life's most important lessons— "you cannot be taught; you must learn!"

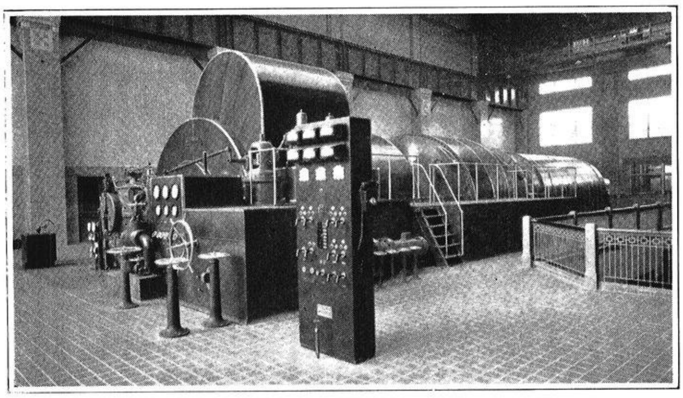
—*The Editor*

A FEW ENGINEERING PROBLEMS

By **MR. HANS DAHLSTRAND**
of The Milwaukee Electric Railway and Light Company

(Part of the paper presented by Mr. Dahlstrand at the Engineering Society of Wisconsin 1936 Convention in Madison, Feb. 20-21)

THE 80,000 K. W. steam turbine installed in the Port Washington Power Plant went into service in the latter part of 1935. The operating conditions adopted for this power plant are unusual, and the arrangement of equipment is quite different from other modern power plants. For that reason the engineering world has been following the construction and operation with unusual interest. The purpose of this paper is to discuss a few of the engineering problems covering the design of the steam turbine only.



Front View of 80,000 Kw. Turbo-Generator Unit

The steam turbine is of the reaction or Parsons type in two cylinders arranged in tandem and driving one generator. The steam is admitted to the turbine at 1230 lbs. pressure, and at a total temperature of 825°F. with a maximum temperature of 850°F. After partial expansion in part of the high pressure turbine element the steam is passed through a resuperheater located in the boiler, and there the temperature is again raised to 825°F. From this superheater the steam is admitted to the turbine behind a diaphragm located in the high pressure turbine element between the outlet to and inlet from the superheater. The steam from this point passes through the other part of the high pressure turbine element and then through the double flow low pressure turbine element and finally into the condenser.

The problem of securing suitable materials for the high temperatures adopted in this and other installations has engaged metallurgists and researchers for many years and it is to a large extent due to their efforts that materials have been developed, which in actual use have proved to be satisfactory for the high temperatures adopted at Port Washington. Good quality plain carbon steel is suitable for certain constructions up to a temperature of 750°F.

The strength up to this temperature does not increase to any appreciable extent and being less expensive than alloy steel it is used extensively in equipment for power plants. For higher temperatures than 750°F., steels of greater strength and stability are required and we find these characteristics to a varying degree in alloy steels. There has been developed a great variety of these steels, many of which have been used in service and others thoroughly investigated so that we can, with reasonable certainty, design power plant equipment suitable for 900°F., without experiencing any serious difficulties. The most common alloying elements used in steels are vanadium, nickel, manganese, chrome, molybdenum, and tungsten, the chemical composition varying with mass, type and kind of structure.

For some years it has been known that short time tests at high temperatures do not give sufficient information to determine the suitability of materials exposed to high temperatures for long periods of time for the reason that materials will gradually stretch when subjected to stress. This stretch is called "creep," and the rate at which this creep occurs now determines the suitability of the material for a specified condition. There are other characteristics that must be considered, such as non-corrosive qualities and expansion.

The rate at which creep occurs under a certain stress varies greatly with temperature. So, for example, at moderate temperatures the creep may not be measurable over a long period of time whereas when temperatures are increased the rate may increase manyfold. The permitted rate of creep may vary greatly and will depend upon the type of structure and also upon certain economical considerations.

For piping and pipe fittings, valve bodies, and similar equipment, a larger rate of creep is permitted than in the rotating parts of the steam turbine, the steam turbine cylinder and similar equipment where the maintenance of close clearances is important if efficiences are to be maintained. In such parts, the permissible creep may be limited to 0.1 of 1% in 100,000 hours. The creep varies widely in steels of different analysis; therefore, it is of great importance for the designer to have accurate knowledge of this creep when designing equipment for high temperature service. As mentioned, analysis of steel determines to a large extent the creep characteristics, but unfortunately it is not the whole story. Recent investigations have shown that with the same analysis of an alloy steel the creep characteristics may vary as much as 50%. This variation is the result of difference in pouring temperatures of the steel ingot or casting and the method of forging and forging temperatures.

Apparently grain structure formation varies greatly during these operations and this accounts for differences in creep rate. There is much more to learn about materials, not only of the characteristics obtained from the use of various alloying elements, but we must apparently also learn how to produce the materials correctly if we are to receive full benefit from the alloying elements. The economic steam temperatures have not been reached as equipment is now being built for a maximum temperature of 950° F., and 1000°F. is proposed.

Rotating parts operating at high speed must be balanced accurately so that there will be no excessive vibration. In addition the shafts must be designed so that the critical speed is either well below or well above the normal running speed.

This is important for the reason that shafts having their critical speed close to the running speed, even when well balanced, are quite unstable and will vibrate excessively with slight disturbances.

The balancing of large bodies is done in various ways, either statically or dynamically, or both. Bodies of any appreciable length must be balanced dynamically as it is necessary to have each section of the body in balance. For large turbine spindles the shafts are first balanced dynamically and the rings and the blading balanced statically before being assembled with the shaft. With this system there is no particular difficulty in securing a smooth running structure. Shafts, such as steam turbine spindles, exposed to temperatures must be made of materials that will not distort when uniformly heated. Any distortion will cause unbalance with increased vibration during operation and there is no way of eliminating this vibration. It is, therefore, important that spindle shafts and bodies are carefully heat treated, in order to secure a structure that will expand uniformly.

This characteristic of expansion with increased temperature that practically all substances have, is a real cause of annoyance. Various kinds of metals have different rates of expansion, and this makes it necessary in many cases to use only materials of same expansion characteristics. Besides when designing equipment for high temperature, the various parts of a structure must be left free to expand in all directions, in order to prevent distortion. An increase of 100°F. in temperature in a piece of steel held so that it cannot expand will cause a stress of almost 20,000 lbs. per square inch.

Taking care of this expansion in a large steam turbine involves quite a study in itself, and the design will in many cases appear more complicated than is necessary. However, it is of utmost importance to eliminate distortion; consequently, any complication in design in order to accomplish this purpose is well repaid. The throttle valve, steam chest, steam strainer and all inlet valves are combined into one solid structure and arranged so that at only one point is there a solid connection to the foundation. To carry the weight there are supports with springs at various points arranged with complete flexibility so that the structure is free to expand in all directions. Naturally, it is necessary to keep valve parts in line with relation to main turbine cylinder and this is accomplished by special guides arranged so that they will not interfere with the expansion. Connections from the main inlet valves to the high pressure cylinder consist of flexible bends with two bends from each valve, one bend leading to the top of cylinder and the other to the bottom of cylinder. With this arrangement steam is led into the cylinder at two points opposite each other, thereby assuring a more uniform expansion of turbine cylinder.

The expansion of the main steam turbine structure involves a number of problems, due to the large size and mass and to the necessary connections between the turbine and the steam chest, the steam reheater, feed water heaters and condenser. All piping connection from reheater and feed water heaters must be flexible to prevent any excessive strains being transmittd to the turbine structure. Besides, the turbine cylinder supports must be guided in a manner that will under all conditions maintain an accurate alignment of the rotating shafts. The clearances between the stationary and rotating parts are for economical reasons quite small and it is important that any expansion in any direction does not disturb these clearances. Therefore, the steam turbine must be held in perfect alignment during expansion and contraction.

This is accomplished by having the vertical centerline of the exhaust opening in the low pressure turbine element fixed so that expansion from this point will take place in all directions.

The high pressure turbine cylinder is bolted to the pedestal of the low pressure turbine cylinder at one end and connected to the thrust end by means of brackets, so arranged that any slight distortion in cylinder will not disturb the true alignment of the thrust end. The thrust end slides on the high pressure bedplate and is held with guides so that it will move in an axial direction only. In order to locate the high pressure spindle axially with relation to the cylinder, an adjustable thrust bearing is mounted in the thrust end. Likewise, the low pressure spindle is held in a fixed position with relation to the low pressure cylinder by a thrust bearing in the low pressure spindle bearing pedestal. When the whole structure expands the thrust end of the high pressure cylinder will slide on the bedplate, pulling the high pressure spindle along, but as the spindle is heated up at the same time as the cylinder it will also expand, thereby maintaining the axial clearances established between the two parts. The actual expansion measured at thrust end is in the order of 7/8 of one inch. With axial clearance measured in thousandths of an inch, the importance of uniform expansion may be readily realized.

The axial clearance between blading and dummies of the high pressure spindle and cylinder may be adjusted by moving the thrust bearing in an axial direction. The operating clearances are determined by checking these clearances while the structure is cold, when in operation and during shut down periods. When all expansion characteristics have been obtained, the actual operating clearances for the most economical operation can be determined.

The starting and shutting down of a large steam turbine unit is quite a problem and requires skill and care of the operators. There are a few special devices furnished with the turbine unit serving as an aid to the operators during these operations. These devices consist of a high pressure plunger oil pump arranged to force oil into the lower bearing shell between the shaft journals and bearings; a jacking gear consisting of an air operated cylinder piston with a pawl engaging a slotted ring mounted on the coupling, and a turning gear consisting of an electric motor with a chain of gears arranged so that the motor can rotate the turbine spindles at low speed. The turning gear is equipped with a device operated by air pressure, permitting of an easy engagement and disengagement from the turbine spindle.

Before letting steam enter the steam turbine, the turning gear is put into operation. If the unit is cold, a small amount of steam is admitted and passed through the turbine by opening the throttle valve. The slow rotation of the spindles will distribute this steam evenly around the circumference of shafts and cylinders, thereby insuring a uniform heating of the structure without distortion. The masses to be heated are large and therefore the heating must be done at a slow rate. When sufficient time has lapsed the throttle valve is opened and unit brought up to speed and loaded. The turning gear is automatically disengaged when turbine is speeded up.

The jacking gear is used for turning the rotating parts to certain positions and as an assistance in starting the turning gear. During the operation on the turning gear a motor driven gear oil pump furnishes oil for lubrication of all moving parts.

Before the unit is brought up to speed, a steam turbine driven auxiliary oil pump is put in operation to insure an ample supply of oil to all bearings. This pump is also used when shutting down the unit. In addition, the oil from this pump is used for the initial operation of the control and regulating valves.

When the steam turbine is up to normal speed, the auxiliary oil pump is automatically shut down and the oil for lubrication and for regulation is furnished by two gear oil pumps driven from the main turbine shaft through worm gears. One pump furnishes oil at low pressure to the bearings. This oil is cooled in an oil cooler to the proper temperature before passing to the bearings. The other pump furnishes oil at a higher pressure for the control and regulating systems.

The lubricating and oil control system with all the special equipment constitutes a very vital part of a turbine unit. This can be visualized by mentioning that on Port Washington unit there are bearing pressures as high as 150 lbs. per square inch with a surface speed of the journal of almost 10,000 ft. per minute and that about 750 gallons of oil per minute is required to lubricate and cool the bearings.

When shutting down the unit and as soon as the speed has dropped to that at which the turning gear operates the turbine spindles, the turning gear is coupled in and keeps the spindles rotating during the cooling of the turbine structure. If the unit is to be shut down for any extended period, the turning gear is kept in operation only until the unit is fairly cold. If, however, the unit is shut down for only a short time, the turning gear is kept in operation until the unit is again started. The turbine spindles and the cylinders are through the circulation of the vapors maintained in correct alignment and there will be no distortion of any kind, consequently the unit is ready to go into operation without any preliminary warming up period.

The regulation of the steam flow to the turbine under normal operation is done through the opening and closing successively of three inlet valves. The regulating system consists of a speed governor driven from the turbine shaft through worm gears, a relay valve operated by the speed governor, and a large hydraulic cylinder with piston operated by the speed governor through the relay valve. High pressure oil is the medium used for the operation of the hydraulic cylinder piston. From the piston, connections are made to the inlet valves. During normal operation one, two or three valves may be open, depending on the load carried. The turbine generator operates in parallel with the power system and the load is adjusted so that the maximum efficiency on the system is obtained. This load is set by the switchboard operator through the operation of a small electric motor attached to the governor lever system.

Through the operation of the electric motor, the governor lever fulcrum is moved up or down, which in turn will actuate the relay valve. The relay valve admits oil under pressure on one or the other side of the hydraulic piston, and as the opening and closing of the inlet valves is controlled by the movement of the piston, a greater or lesser amount of steam is admitted to the turbine with an increase or decrease in load. The relay valve is moved back into mean position by a connection from the hydraulic piston. When the unit operates alone on the system, the speed governor regulates the increasing or decreasing steam flow when load increases or decreases by a change in speed.

In addition to the regulating system described above, there are several other devices for the control and protection of the unit in case of an emergency. Conceiving and designing these devices involved a very interesting engineering problem. With all the equipment in the power plant tied together and operating as a unit there are many things that can happen which may disturb operation and cause serious difficulties unless proper protection is provided.

ALUMNI NOTES

Mechanicals

GESTELAND, A. E., '33, is now associated with the Creamery Package Company at Lake Mills, Wisconsin. **HIPPERMEYER, IRVING R.**, '02, is an engineer at the same company.

GILLETTE, EDMUND S., '13, who made football history at Wisconsin as the quarterback of the last championship team, came within 500 votes of being elected mayor in the elections at Santa Monica, California, last December. He has been in business there for many years.

HANSEN, CHRIS, '33, has recently begun work as a draftsman and designer in the steam turbine department of the Allis Chalmers Manufacturing Company.

HOLLAND, WILLIAM T., '34, corresponds that he has accepted a position with the American Radiator Company.

PURVIS, ADRIAN A., '24, is connected with the acoustical division of the Johns-Manville Company at Chicago, Illinois.

RIECK, JOHN J., '33, M.S.'34, has the position of power engineer with the National Aniline and Chemical Company of Buffalo.

SOMMERFIELD, SUMNER S., '33, has left the U. S. Soil Conservation Service to act as an assistant engineer in the design and estimating departments of the Standard Galvanizing Company of Chicago.

SUTER, GEORGE D., '33, is employed by the Cities Service Oil Company as assistant to the superintendent of the power proving department.

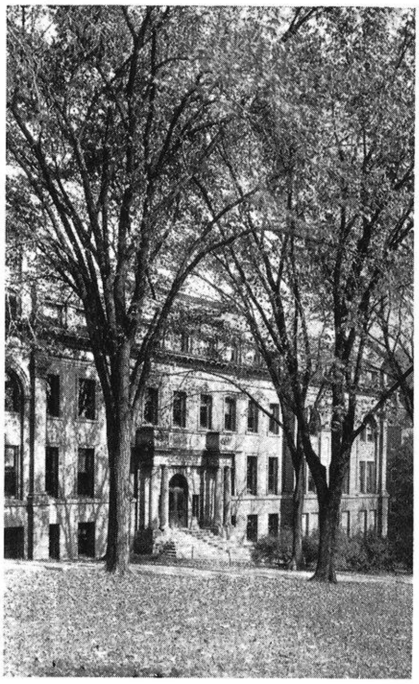
Civils

ACKERMANN, WILLIAM C., '35, who has been working for Kimberly-Clark, is now with TVA at Knoxville as junior engineering aide in the Engineering Data Division.

BAKER, GEORGE H., '14, is chief of the Bureau of County Roads and City Streets, Illinois Division of Highways, with headquarters at Springfield.

BECKER, ELMER W., '24, has been appointed senior engineer in charge of water supply for the Suburban Resettlement Administration. He will be stationed at Washington, D. C., until spring, when he will return to Milwaukee to work on the Milwaukee project near Hales Corners. He had been with the construction division of the Milwaukee Water Works for 11 years.

BRACKEN, EARL C., '09, (Brackenwagen) died at his home in Long Beach, California, on January 30. He is survived by his widow, Edna, and three children, La Verne, Earline, and Glenn. Bracken worked for the Wisconsin Railroad Commission for several years after graduation. During that time he studied accounting and qualified as a public accountant, in which field he continued to practice until his death.



DUNN, CLARK A., '23, has been teaching civil engineering subjects at Oklahoma Agricultural and Mechanical College at Stillwater since September, 1929. He is now an assistant professor.

KACHEL, WILLIAM F., '08, on January 1 resigned his position as assistant director of the department of public welfare to return to private practice in Milwaukee.

KOCH, FRED O., '34, was married on February 8 to Amalia Strand of Madison. They will live at Menomonie, Wisconsin, where Koch is stationed with the Soil Conservation Service.

MESSMAN, DAVID V., '34, on January 16 began work with the Southern Railway in the bridge department at Knoxville, Tennessee.

NIEDERER, EDWARD, Jr., '35, began work for the Philadelphia Electric Company on July 1, 1935, as head of maps and records for the eastern division for gas distribution. He is taking some night school work at Drexel Institute.

PRICE, REGINALD C., '35, started work as instrument man on December 18 for the Resettlement Administration on a project near Milwaukee.

SCHAD, JAMES A., '16, is secretary of the Concrete Reinforcing Steel Institute at 201 Wells St., Chicago.

TORKELSON, MARTIN W., '04, director of regional planning in Wisconsin, has been appointed head of Wisconsin's Works Progress Administration. He assumed his new duties on February 3.

Miners and Metallurgists

BEST, BYRON G., '12, was elected president of the newly organized Gogebic Range Engineers' Club which had its first meeting early in February. **KNOLL, WALDEMAR A.**, '14, M.S.'22, and **KNUDSON, BARNEY L.**, '15, were also elected to serve on the board of directors. The club, as now organized, consists of 50 civil, mining, mechanical and electrical engineers of the district. The object of the club is the advancement of engineering in its several branches and the promotion of social intercourse among its members.

ROSENTHAL, PHILIP C., '35, formerly a staff member of the **Wisconsin Engineer** and now employed at the Batelle Memorial Institute of Columbus, Ohio, was married on Saturday, February 22, to Kathleen Andresen of Milwaukee.

Electricals

BROWN, HAROLD H., '21, engineer with the Wisconsin-Michigan Power Company at Appleton, is chairman of the Overhead Systems Committee of the Wisconsin Utilities Association.

SKINNER, MERRILL E., '15, son of the late Prof. E. B. Skinner of the university's mathematics department, was the recipient of last year's McGraw award.

STANDISH, MILES E., has assumed the position of sales manager for the Marble-Cord Electric Company of Gladstone, Michigan. From the time of his graduation to the present he has at various times been connected with the Louis Allis Company, the Burke Electric Company and the Imperial Electric Company.

Chemicals

COOK, GEORGE H., '36, former editor of the **Wisconsin Engineer** who has just completed the requirements for a degree, has joined the engineering staff of the Standard Oil Company at Baton Rouge, Louisiana.

MANN, CHARLES A., '09, M.S.'11, Ph.D.'15, who is chief of the division of chemical engineering at the University of Minnesota, gave a talk at the recent meeting of the Wisconsin section of the American Chemical Society. The subject of his talk related to the new method of protecting metals against all inorganic acids except nitric acid. This new method was developed by him and his six assistants after five years of research.

A CIVIC AUDITORIUM FOR MADISON

REGINALD T. SAUE, m'36
EDWARD W. GROSS, m'36

This topic is based upon student work done in the Engineering Economics Course 102

THE city of Madison at present is handicapped by the lack of adequate convention facilities. To meet this need, an auditorium has been proposed which will accommodate conventions and meet diversified civic needs. Such an auditorium can be constructed for $766,000.

The city of Madison, with all its natural beauty and excellent setting for summer and winter sports and as capital of the state and home of the University of Wisconsin, is an ideal place for conventions of all sorts. It is centrally located in the Middle West and is advantageously near large cities as Chicago, Milwaukee, St. Paul, and Minneapolis. Yet, according to the Chamber of Commerce, many conventions of a profitable nature to merchants are turned away each year due to the lack of adequate seating and convention facilities. Some conventions require a structure capable of seating large numbers, while others desire room for display purposes. Those needs could be met with a civic auditorium.

Although Madison appears to have a number of buildings capable of housing a fairly large audience, on close investigation one finds that each has some undesirable characteristic which renders it inadequate for most of the functions for which an auditorium is needed. The University of Wisconsin Field House is the largest of these buildings, having a seating capacity of about 9,000. Although this building serves very well the purpose for which is was constructed, it is unusually bad as far as the acoustics are concerned, and it has very uncomfortable and poorly located seats. Its interior is rough and unattractive.

The University of Wisconsin Stock Pavilion has a seating capacity of about 3,500; its acoustics are good, and, for this reason, it is usually chosen for concerts and performances when good acoustics are necessary. The chief defects of this building are the ever-present animal odor, the railroad tracks immediately behind it, and the psychological effect upon the audience and performers. Whenever an organization like the Chicago Symphony Orchestra or the artists from the opera and concert stage come to Madison, the civic pride suffers immeasurably when necessity compels their appearance at the University Stock Pavilion. Year after year it has been necessary to prevail upon the hospitality of the University for the use of this building.

The Parkway Theater has a seating capacity of 1,600 and is the next largest building available for civic functions. It is obvious that this seating capacity is not large enough to encourage important functions and performances to be held in Madison. It also has the disadvantage of having to be rented for civic functions.

The public demand for an auditorium was made evident in a report by Alvin Gillett, Secretary of the Madison Association of Commerce in which he quotes prominent business men as saying, "Madison's greatest need is a municipal auditorium."

A convention hall is becoming as much a necessity as an airport or a railroad station. Cities are becoming aware of the value of convention business. It aids not only the hotels and restaurants, but also brings in considerable wealth to the city as a whole. The Convention Bureau of Milwaukee estimates that conventions in its city produce $5,000,000 per year revenue. San Francisco has an annual fund of $80,000, $20,000 of which comes from taxes, to bring conventions into that city. Figures show that 430,000 people attended conventions in San Francisco in one year and brought into the community $17,000,000 in cash. During their Milwaukee convention, members of the Master Builder's Association of Wisconsin report that they spent $21.39 per day. The lowest estimate that cities throughout the United States make as the average daily expenditure of convention guests is $10 per day. According to an estimate issued by the Madison Association of Commerce, convention delegates spent $1,648,725 in Madison during the year of 1935. Adequate convention facilities would greatly increase this annual income.

Because Madison is a highly intellectual center, its citizens readily support the better stage and musical performances. Past performances bear evidence to this fact. Fritz Kreisler, Don Cossack, "Carmen," "Il Trovatore," "Green Pastures," "Ah, Wilderness," and Katharine Cornell played to capacity houses. The prices charged for admission were necessarily high due to the small seating capacity of the places in which they were held. If a larger hall were available for these performances, the admission prices could be reduced, and the net proceeds would be as large, and perhaps larger, due to the increase in attendance. This would have a tendency to stimulate general enthusiasm in such performances.

According to investigations, the location of the auditorium should be at Gorham Street directly across from the City Water Works. Some filling will be necessary on the lake shore. The city might readily incorporate a beach improvement project with the filling. It is believed that the site could be purchased and the necessary filling and beach improvements done for about $95,000, since the city already owns the property now occupied by the Tracy Boat Company. This location will facilitate easy connection to the City Water Works' steam supply for heating and refrigeration purposes. The site is well located and will afford good parking and transportation facilities. Another advantage is the possibility of incorporating an improved beach and bath house with the auditorium. This is something that the city needs nearly as much as an auditorium.

The proposed auditorium is of the arena type. The outside dimensions of the building are 210 feet wide, 370 feet long, and 60 feet high. The outside walls are of local dolomite. The stone can be obtained from the city's own quarry at Sunset Point, the only cost being the cutting, which can be done at the present time by relief labor. The building will be completely fireproof, of stone and steel construction, with steel framed windows and composition concrete floors. The entire interior of the building will be so treated as to be excellent acoustically. The seats chosen will not only provide comfort to the audience, but also add to the acoustical properties of the building.

The proposed auditorium will have a skating rink 85 feet by 190 feet on the main floor. The cost of the floor, piping and refrigeration will be approximately $50,000. The seating capacity for ice functions will be about 4,200. Professional and amateur hockey have always attracted large crowds when good facilities for the game have been provided. Where a good ice surface can be maintained, skating is a popular indoor sport. It is considered that the ice rink would be used not more than six months of each year, since, without special equipment, it is difficult to control the humidity above the ice in warm weather.

It would be advisable to have an air washer in connection with the heating and ventilating system. This will give complete winter air conditioning, but the expense of installing refrigeration equipment to make complete summer air conditioning possible would not be justified. Except when the humidity is high, complete air conditioning can be had without refrigeration, but unfortunately the humidity is often high in Madison during warm weather. Therefore, when laying out the ventilating system and the air washer, provisions should be made so that refrigeration could be added at some future time if there is a popular demand for it.

In addition to the permanently fixed seats of 4,200 capacity, there will be floor space for about 2,700 movable seats. This will give ample capacity for very large gatherings. There will be 8,750 square feet of floor space on the first floor under the galleries, exclusive of halls and exits. It is expected that all but 5,000 square feet of this will be used for wash rooms and toilets. The remainder of this space should be used to provide bath house facilities.

By having movable seats, flexibility is obtained which will make possible the accommodation of any and all functions. For stage performances, the seating capacity will be 7,000. To insure the success of such presentations, a stage large enough to seat a 100-piece symphonic orchestra has been provided in the plans. The auditorium will provide floor space to the extent of 16,500 square feet for exhibits, etc., when such space is desired.

A preliminary estimate has been made of the probable cost of a building of the above described type, completely finished and decorated in such a manner that the people of Madison could well be proud of it. By making a study of similar projects, the following all-inclusive figures were obtained:

Construction Cost Estimates

Building and Equipment	$586,000.00
Land and Beach Improvements	95,000.00
Skating Rink	50,000.00
Contingencies	29,300.00
Engineering Service	5,860.00
Total	$766,160.00

If the auditorium is to be constructed, it must be self-supporting financially. It is for this reason that the arena type auditorium has been chosen. The result is a multi-purpose building, making the incorporation of a regulation size hockey rink an absolute necessity. Investigations have shown that the revenue to be received from exhibitions and ice events will more than pay for the additional investment necessary to construct an arena type auditorium as compared to the theater type which would not provide the flexibility necessary to serve the various interests of the entire community. The following is a summarized estimate of the probable annual expenditures and receipts of the development:

Estimated Annual Cost

ESTIMATED ANNUAL OPERATING EXPENSE:	
Administration and Clerical	$5,000.00
Labor	8,000.00
Maintenance	3,800.00
Heating	2,000.00
Light and Power	3,000.00
Water	1,300.00
Tickets, Stationery, etc.	730.00
Insurance	725.00
Miscellaneous	500.00
Total Operating Expense	$25,055.00
INTEREST AND BOND RETIREMENT:	
3%—50-Year Serial Bond Issue	30,000.00
Total Annual Cost	$55,055.00
SUMMARIZED ESTIMATED ANNUAL INCOME:	
General Rentals	$35,000.00
Hockey	15,000.00
Public and Exhibition Skating	5,000.00
Curling	2,000.00
Total Annual Income	$57,000.00

Considering the present favorable market for municipal bonds and the financial status of the city, a 50-year 3% serial bond issue could be floated. The serial bond issue is recommended because it would provide both short term long term investments to satisfy the various classes of investors.

Public opinion may be adverse to this undertaking, because of the fact that the benefits to be derived therefrom have not been presented in the right light. What group of public minded individuals would not favor the establishment of a major industrial organization in their city? The additional income for the city resulting from the expenditures of convention delegates is comparable to the payroll of a fair size industry. This additional income benefits the citizens as a whole. In stressing the material benefits of the project, there is a tendency to overlook the intangible values to be realized. The auditorium will not only be self supporting, but it will also increase the cultural and recreational facilities of Madison.

Municipal Diesel-Electric Plants in Wisconsin

by **MELVIN W. STEHR, e'34**

This article is based on the results shown in "Wisconsin Municipal Diesel-Electric Plants" by Jay Samuel Hartt, consulting engineer, Madison, Wisconsin

THE Diesel engine has been greatly improved during the past few years, and its use is rapidly entering new fields. One of the fields for oil engines is in municipally owned utilities for generation of electrical energy. The first installation for this purpose is claimed by Menasha, Wisconsin. Two 75-horsepower engines were installed in 1905 and connected to city water pumps. Later, a generator to supply municipal street lights was also connected to them. Since that time, 13 additional municipally owned Diesel-electric plants have been installed in the state of Wisconsin. Four of these installations supplemented existing hydro-electric equipment, two replaced steam-electric equipment, and eight were installed in municipalities which previously purchased energy at wholesale rates from other utilities. The total capacity of these plants is 10,260 horsepower, the largest installation being 3,600 horsepower.

The increased use of Diesel engines has aroused some interest in their performance and cost of operation. During the past few years, the most authoritative data on operating expenses have been contained in the annual reports of the Oil and Gas Power Division of the American Society of Mechanical Engineers. These reports, which are compiled from questionnaires sent to the plants, do not show the plant investment. Since the fixed charges on this investment represent the largest single item in the cost of operation, the total cannot be obtained from them.

All operating utilities in Wisconsin are required to submit, to the Public Service Commission of Wisconsin, annual reports which include an income statement, a balance sheet, a fixed capital account, and a brief summary of operating statistics. Much of the information for the survey was obtained from these reports but additional information was included which could only be obtained by personally visiting the plants and inspecting their records.

One of the first questions asked when contemplating a power plant is, "How much will it cost to construct this plant?" Very often this question is given more consideration than the question, "How much will it cost to operate it?" There are three important factors which affect the cost of installation of any power plant. They are the prevailing equipment prices, the adequacy of the equipment installed, and the adaptability of the equipment to the load on the plant. The first factor is obvious and requires no further discussion. An installation, to have sufficient capacity, must be able to supply the maximum demand on the plant even though the largest unit is down for repairs. In an electric utility generating plant, where the load is subject to change, it is considered advisable to provide additional capacity for future growth. A plant is well adapted to the system load when one or more units may be shut down during light load, so that those units operating will be carrying nearly rated load. The running plant capacity factor or the average load carried by the engines has a great effect on the fuel and lubricating oil economies.

The total investment, including station auxiliaries and switchboard, for the plants studied varied from approximately $80 per horsepower for a 3-unit, 1,050-horsepower installation to about $190 per horsepower for a 2-unit, 210-horsepower installation. The following is a breakdown of the total investment based on the average for all plants: land about 1%, structures about 12%, and generating equipment about 87%.

The answer to "How much does it cost to operate a Diesel-electric plant?" depends on the cost of superintendence and labor, fuel oil, lubricating oil, supplies and expenses, maintenance, insurance, and investment charges. The investment charges include taxes, depreciation, and interest.

The labor item in operating expenses is undoubtedly the most variable item of cost. In all of the municipal utilities, a portion of the superintendent's time is charged to the plant whether or not he actually operates it. This portion is sometimes based on time reports and, very often, on the judgment of the superintendent or the clerk keeping the records. The operators in most plants also operate the city water pumps, and the amount charged to the water department for this service was usually estimated. The salaries paid to the superintendents in the Wisconsin Diesel-electric plants in 1934 varied from $90 per month in the small plants to $300 in the larger plants. For these same plants the average salary paid to the operators varied from $60 to $167.63 per month. Where repair work is necessary, either the superintendent himself assists the operator, or additional help is employed. In the largest plant, a 4-unit installation, there are four operators and four workmen on the payroll. They also operate the water filtration plant. The annual cost of plant labor for continuous operation varied from about $1,500 per year for a small plant to about $8,300 per year for a plant with a capacity of 3,600 horsepower.

The fuel and lubricating oil economies, as previously stated, depend upon the running plant capacity factor. The number of kilowatt-hours generated per gallon of fuel oil for a plant with an average running plant capacity factor of approximately 60% was 11.5, and the generation per gallon at about 40% was only 8.9 kilowatt-hours. One plant, installed in 1921 and operating in conjunction with a hydro-electric unit, generated only 5.9 kilowatt-hours per gallon at a capacity factor of 30%. The lubricating oil economy is also affected by the age of the engines, and by the use of oil reclaimers. It varied from 241 to 1,076 kilowatt-hours per gallon in the plants studied.

Oil costs are subject to the fluctuating market price. The average prices paid per gallon in 1934 were 5.30 cents for fuel oil and 52.77 cents for lubricating oil. The 1926 prices were 7.1 cents and 61.6 cents per gallon, respectively, and it is very probable that they will soon be near this level. Based on 1934 prices the cost of fuel oil per kilowatt-hour of plant output varied from 3.57 mills to 6.79 mills and the cost of lubricating oil from 0.54 mills to 1.99 mills.

Information concerning maintenance costs was very limited. The smaller utilities report this item with supplies and expenses. Records covering maintenance for a period of years were available for two plants. One of them showed a 10-year average cost of $1.32 per year per horsepower installed or 0.90 mills per kilowatt-hour of plant output. The other showed a 3-year average cost of $2.60 per year per horsepower installed or 0.299 mills per kilowatt-hour of plant output. The total cost of supplies and expenses, including maintenance, for 1934 for all plants varied from 0.49 mills to 3.49 mills per kilowatt-hour of plant output.

Cooling water data for the plants was also very limited, because only one plant metered the cooling water requirements. This plant, during the past few years, used between 11 and 17 gallons of water per kilowatt-hour generated. Five of the 14 plants obtain all of the cooling water from city mains, and four obtain all of the cooling water from nearby lakes or streams. The remaining five plants use circulating systems. The make-up water for these plants is about one or two gallons per kilowatt-hour generated. The cost of water, where all of it is obtained from city mains, is between 0.23 and 0.55 mills per kilowatt-hour plant output. Where cooling water is pumped by station equipment, the station use of energy is increased from about 1% to more than 6% of the generation.

All municipalities in Wisconsin are required to carry workmen's compensation insurance for employees, and all plants but one carry fire insurance on equipment. The average rate for compensation insurance paid in 1934 and 1935 was approximately $6.75 per $100 of payroll. The cost per kilowatt-hour of plant send-out was about 0.1 mill for larger plants and 0.5 mill for the smaller plants.

The fixed charges on the investment, consisting of taxes, depreciation, and interest, represent the largest single item in the cost of operation. The amounts reported for taxes on the total electric department property by the utilities varied from 0 to 2.9% of the investment, the average being about 1.5%. The average rate charged for depreciation on electric utility property varied from 1.7% to 6.7% of the investment, the average being about 4.5%.

In the survey of these plants, the fixed charges shown in the final analysis of each were adjusted to the same basis. Taxes were computed to be 2% of the investment, because this is approximately equal to the state tax rate on taxable utility property. Depreciation, computed to be 5% of the investment, assumes a plant life of 20 years if considered on a straight-line basis, and of about 16 years if considered on a sinking-fund basis. Although some manufacturers claim an engine life of 25 years or more, all indications would lead one to believe that an estimated life of 15 years is a liberal allowance. Interest was computed at 6% of the investment, because this represents the return considered adequate by the Public Service Commission of Wisconsin.

Based on the above percentages for fixed charges, the costs per kilowatt-hour of plant send-out were as follows: taxes from 1.04 mills to 2.88 mills; depreciation from 2.60 mills to 7.20 mills; and interest from 3.12 mills to 8.64 mills. The lower costs shown are for the larger plants.

There is one point that must be considered in a discussion of fixed charges; namely, adequacy of equipment. As previously stated, a plant should have sufficient capacity to carry the peak load on the system even though the largest unit is down for repairs. Based on the peak loads reported for 1935, only four of the 14 plants have sufficient capacity. The largest excess is only 30 kilowatts or 3.5 per cent of the total capacity, leaving very little allowance for added load. The remaining 10 plants had deficits in carrying capacity ranging from 37 kilowatts in a 70-kilowatt plant to 169 kilowatts in a 2,400-kilowatt plant.

Three of the 14 plants are used for standby only, and the resulting costs are not indicative of Diesel-electric plant operation. The following tabulation shows the total installed capacity, the number of kilowatt-hours of plant output, and the total cost of operation, including investment charges, per kilowatt-hour of plant output in the remaining 11 plants for 1934.

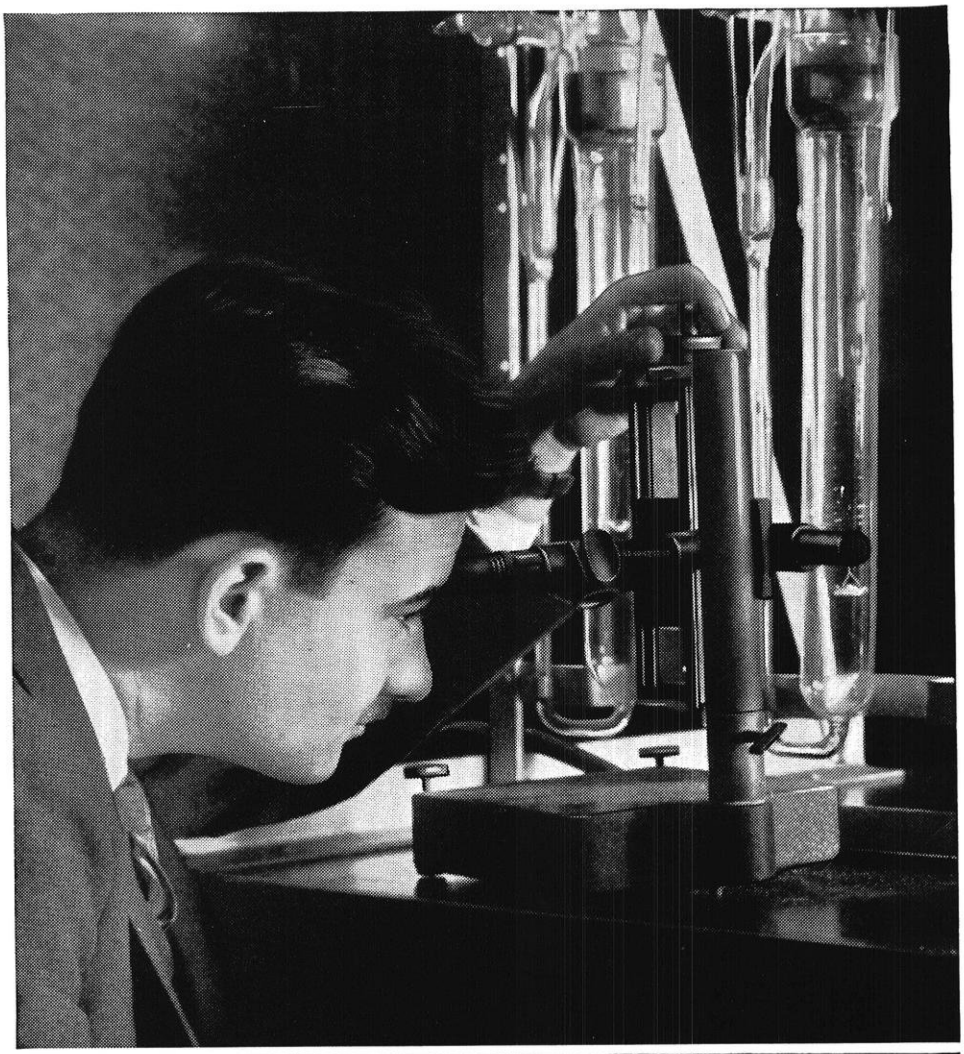
Plant Number	*Installed Capacity in horsepower*	*Plant Output in kw-hours*	*Total Operating Cost in cents per kw-hour*
1	3,600	5,775,860	1.493
2	1,050	1,590,506	1.626
3	1,200	1,124,898	3.053
4	800	966,038	2.171
5	600	865,139	2.289
6	1,080	842,972	2.538
7	600	500,162	3.180
8	360	479,700	3.004
9	300	479,571	2.866
10	210	288,194	3.224
11	150	131,330	4.603

The following breakdown of the total cost of operation is based on the weighted average of the 1934 results obtained in the 11 plants for which cost data were available.

Labor	14.4%
Fuel Oil	25.5
Lubricating Oil	4.3
Supplies and Expenses—Including Maintenance	4.8
Cooling Water	0.9
Subtotal	49.9%
Insurance on Plant	1.0
Compensation Insurance	1.0
Taxes (2% of Investment)	7.4
Depreciation (5% of Investment)	18.5
Interest (6% of Investment)	22.2
Total	100.0%

The results shown in this article are briefly summarized. They portray only a faint picture of this survey which covered Diesel-electric plant operation only. There are also many municipally owned utilities in Wisconsin which purchase their energy requirements from other utilities at wholesale rates. Information regarding the costs of purchased energy is available from the annual reports filed with the Public Service Commission of Wisconsin.

The Diesel engine is a relatively new development, and many changes which will improve its performance and increase its efficiency can be expected. Many engineers, however, believe that its use will begin to decline in the near future, because the increased demand for fuel oil will have a serious effect on oil prices. The introduction of the Diesel engine in new fields will be interesting to watch.



"Assets in the making"

THE work of Bell Telephone Laboratories might well be called "assets in the making." It deals with many problems whose solution will be of great future value to telephone users. ℂ The truth of this statement is indicated by improvements already developed and now in daily use. The convenient handset telephone, the dial system, new magnetic alloys, overseas and ship-to-shore radio telephony are just a few examples. ℂ Today more than 4000 men and women are carrying on this work to make tomorrow's telephone service still better.

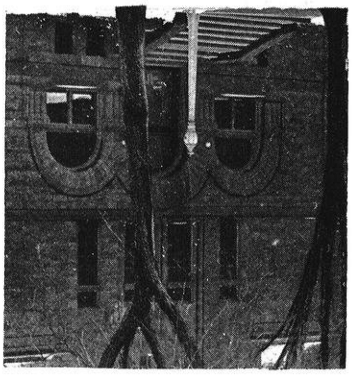
Why not telephone home at least once each week? For lowest rates to most points, call station-to-station after 7 P.M. daily, or any time Sunday

BELL TELEPHONE SYSTEM

"STATIC"

by **ENGIN EARS**

● We hear that the annual Slum Clearance Commission is considering the demolition of the Law Shop in its drive to eliminate the breeding places of crime and disease. Polygon is rumored to have turned in the low bid on the job. We've had experience in this line, after all. Here is a view of the aforementioned tenement just after last year's Spring housecleaning by the Plumbers.



» «

● You can't all have heard the one about the young aero-engineer who designed and built a new plane which the experts agreed was a honey. As he started his initial test hop, he seemed a little puzzled and preoccupied. At 300 feet, over high tension lines, a wing crumpled. The look of concentration on his kisser gave way to a scowl of annoyance. "D--n," muttered he, "So I DID put that decimal point in the wrong place."

» «

● That's not the same aero whose new propeller was the "torque" of the town.

» «

● It is rumored that it was a civil who first paved the road to Hell with good intentions. Must have done a good job of surfacing, too, considering all the traffic (90% shysters) that it carries.

» «

● For those who do not catch on quickly, the reason no mention of women is made in this magazine is because this has **Esquire** beat . . . this is really a magazine for men!

» «

● Have you heard about the boys in E.E. 51 lab. who got there early and worked themselves into a sweat building up a charge on the doorknob via the electrophorus, only to have the first two prospective victims walk calmly in . . . wearing gloves. Were this the ideal story, it would have been instructor Benedict who walked in.

HISTORY LESSON NO. 1 FOR FROSH

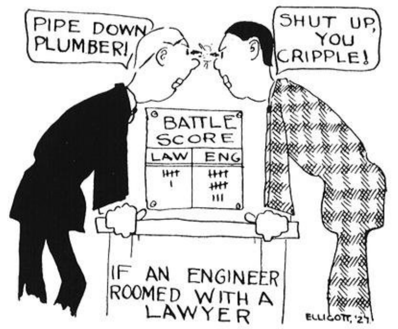
● Recent surveys have shown the existence of a deplorable state of affairs wherein many yearlings do not even know who Saint Pat was. (One even suggested that it was a brand of face powder.) In correction let us state, once and for all, that Saint Patrick was an Engineer. He was; he was; HE WAS. Patron Saint of engineers from Vancouver to Calcutta, he returns each year, like Santa Claus (remember?) to reward all virtuous Plumbers and, incidentally, to bat the ears off the few rash shysters who dare crawl out from behind the woodwork on that glorious day.

He was a great pioneer in his chosen field. His feat of driving the snakes out of Ireland was a fine bit of sanitary engineering. As a surveyor he had no peer. He did all the transit work on the road to Hell and was the first man to sight the Pearly Gates through a Dumpy level. He was so fast on the slide rule that his slider had to have a built-in water jacket and cooling system. For some years he had his shillelaghs custom built by Paul Bunyan. Perhaps the only blot on his record was his invention of calculus, but let's not talk about that. How could he know we'd be writing E.E. reports some day. At last writing he was installing a burglar alarm on St. Peter's Golden Gates (somebody let a couple of lawyers into Heaven by mistake) and after his Madison visit will be off to Purgatory where he has contracted to teach a gang of ex-shysters how to make out steam engine indicator cards.

» «

● Calling the roll is a practice which grew up when instructors first found that the number of seats assigned and the number of students in attendance did not bear to each other a simple one to one ratio.

—*Purdue Engineer*



» «

It's here, shysters!

● In response to many queries, we announce that "The Engineer's Sweetheart" was the real goods, authored by a dream who is known as "The Duchess."

» «

● In Freshman English:

Prof: Analyze this sentence—"Let the cow be taken into the barn." What mood?

Bright ChE: The cow.

Seven Engineers on Committees for Military Ball

Cadwell

Finn

Matthias

SEVEN committee chairmen of the 1936 Military Ball, directed by W. Jay Tompkins, B.A.'36, are engineers. They are: James Cadwell, m'36; Robert Finn, e'36; Carl Matthias, c'36; Merten Heimstead, c'36; Frank Stone, c'36; William M. Senske, c'36; and Eldon C. Wagner, c'36.

James Cadwell, a member of Tau Beta Pi, honorary engineering fraternity, Pi Tau Sigma, also honorary engineering, Phi Kappa Phi, senior honorary society, was a recipient of sophomore high honors, is first lieutenant of Scabbard and Blade, a member of A. S. M. E., member of the advanced course pistol and drill teams, and worked on the 1935 Military Ball.

Robert Finn, who will be the provost marshall of the ball, is a member of Scabbard and Blade, the advanced course drill team, is past president of Lambda Chi Alpha, social fraternity, and worked on the Military Ball of 1935.

Carl Matthias, who has been appointed chairman of the program committee, is a member of A. S. C. E., treasurer of Chi Epsilon, secretary of Polygon, recipient of sophomore honors, and a member of the ROTC drill team.

Heimstead

Stone

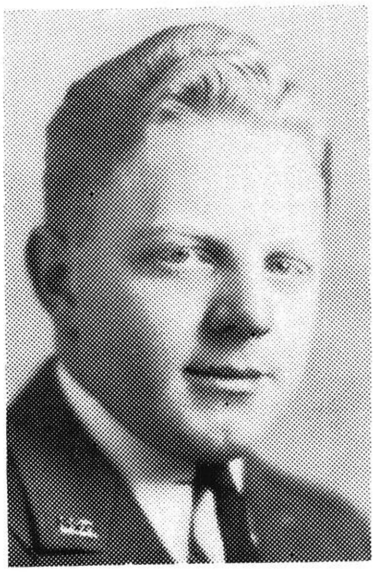
Senske

Merten Heimstead, co-chairman of decorations, is a member of the corps drill team and the A. I. Ch. E., and worked on the Military Ball of 1935.

Frank Stone, besides being president and social chairman of Phi Kappa Sigma, was active in freshman orientation week in 1934-35, was a member of the freshman rifle team, belongs to A. S. C. E., and is a member of the advanced course drill team as well as having worked on the 1935 Military Ball.

William M. Senske, dinner chairman, is a member of Phi Eta Sigma, freshman honorary society, A. I. Ch. E., is second lieutenant of Scabbard and Blade, was a recipient of sophomore honors, belongs to the corps drill team and the Presbyterian Student center council.

Wagner is a member of Phi Kappa Phi, senior honorary society, Tau Beta Pi, honorary engineering fraternity, president of Chi Epsilon, honorary civil engineering fraternity, a member of Scabbard and Blade, Phi Eta Sigma, freshman honorary fraternity, a member of the American Society of Civil Engineers, being the past president and past secretary of that organization, as well as being a member of the ROTC drill team, and a recipient of sophomore honors. He was active on the Military Ball of 1935.



Wagner

ON THE CAMPUS

ST. PAT'S PARADE

This year we hope to have the biggest parade in the history of the college. Polygon is sending out written invitations and information about the parade to all fraternities, sororities, and independent houses, as well as to all the engineering societies. Let's get together and help to make this a thing to be remembered.

So far, the plans for the parade are something like this. The various societies are to select their candidate for St. Pat. The five candidates will be presented at the Engineer's Dance, Friday evening, March 20. For the following two weeks, election of St. Pat will take place, and the floats for the parade made ready. The afternoon of Saturday, April 4, is the fatal time. There will be, at that time, on open season on lawyers.

So, everyone, get your "think-tanks" functioning, and see if you can walk off with a prize. Incidentally, be sure to check up on whether your float conforms to the rules or not . . . if it doesn't, the judges will disqualify you from the parade.

RESEARCH CONFERENCE

A good crowd attended the second research conference of the year which was held on March 10 at the Mechanical Engineering building. The topic, "Hydraulics of Vertical Pipes Flowing Partially Full," was presented by A. A. Kalinske, research fellow in the hydraulic engineering department, J. G. Van Vleet, research assistant in mechanics, spoke on "Photoelasticity," and R. A. Rose, instructor in steam and gas, described "A Combustion Indicator for Diesel Engines."

Another conference will be held during the first week in May.

FUELS CONFERENCE

A conference discussing "Solid Fuels and Domestic Stokers" will be held in the Mechanical Engineering building April 21-23. At this conference leaders in the fuel and stoker industries will combine with experts from the university in talking over common heating problems and how they relate to domestic stoker operation.

Any students who may be interested are invited to attend any of the lectures.

ROTC GETS NEW OFFICER

Lt. R. N. Naylor, Corps of Engineers, arrived about the middle of February to do the preliminary work for the engineer unit of the ROTC which is to be established here in September.

Later, in the summer, one other engineer officer and a non-commissioned engineer officer are expected.

LARSON HEADS HEATING GROUP

Prof. G. L. Larson, chairman of the department of Steam and Gas Engineering and superintendent of the university heating station, was recently elected president of the American Society of Heating and Ventilating Engineers at their annual convention in Chicago. Congratulations, Prof. Larson.

SENIORS SEE MILWAUKEE MARVELS

Meyer Bogost, in his report of the fall inspection trip which the senior civils took to Milwaukee, records that he observed "a special goat-milk-cooled saw" cutting steel beams at a bridge plant. Arnold Elsinger was "amazed at the huge size of the steam engines which tower 200 feet above the basement."

THE ALL-ENGINEERING SMOKER

About 200 engineers tucked their slide rules into some inconspicuous corners Wednesday night, February 15, and spent several enjoyable hours in the Union. First of all, Prof. George Bryan gave an illustrated talk, "On Safari in East Africa." Had there been time, he could have led the boys through West, North, and South Africa as well, so interesting was he.

Apparently, the engineers did not care much for the sisters who did some dancing, because the applause raised the Union roof only three inches. Pat Smith, "Engineer ala-something-or-other," musically informed the Engineering College he was still with them.

Then the crowd descended upon Tripp Commons, where beer, cigarettes, and friendly feeling confirmed the already universal suspicion that the engineers were having a great time at their smoker.

Let's give a vote of thanks to Polygon, and hope that there will be many more smokers for those who come after us.

LEAKAGE TESTING DEVICE

A device for testing leakage in high-voltage armatures developed in the high tension laboratory of the electrical engineering department has recently been installed in the Allis-Chalmers plant in Milwaukee. This apparatus was constructed in the university shops and is used to measure dielectric losses and capacitances in insulating materials around armature bars of high voltage motors. It is similar in principle to a wheatstone bridge and is built to operate at potentials up to 100,000 volts.

MINING REUNION

In the 25 years that it has been sending trained graduates out into the world, the department of mining and metallurgy has never had a class reunion. It is being planned to remedy this situation during spring vacation by having a real "gabfest" Friday and Saturday, April 24 and 25.

The program tentatively calls for a trip through the mining and metallurgical laboratories, a dinner and dance at the Memorial Union, a **few** talks, and a good long gossip fest. The idea is not to inflict speeches on the returning grads but to give them a chance to make up for the 25 years they have been away from their old pals.

Wives and children will be welcomed and arrangements made for rooming families together.

Any person interested who wants more information on this reunion can get it by corresponding with the mining department.

TAU BETA PI

At a meeting Tuesday night, March 10, the active members of Tau Beta Pi elected the eligible candidates to their honorary circle. President Earl Senkbeil, ch'36, announced that those elected would be notified by mail within a week or two.

MINING CLUB MEETS

Mr. Bean, the state geologist, was the guest speaker at a Mining Club supper meeting March 4. The entire Geology Club was present . . . and the supper was prepared under the direction of the new chief mucker, John Yantowski.

Recently, Gilbert Nieman, club president, spoke to the members on his trip to an A.I.M.E. meeting in Chicago.

PI TAU SIGMA SMOKER

Pi Tau Sigma, national honor fraternity for mechanical engineers, entertained eligible prospective members at a smoker in the Beefeater's room of the Memorial Union, Wednesday evening, February 26. John P. Thomas, president, subjected the guests to a written "Non-Engineering Exam." Later, Profs. P. H. Hyland and L. A. Wilson led a general discussion.

Sandwiches, refreshments, and smokes were served.

The Wisconsin Engineer Announces the Third Annual

MECHANICAL DRAWING CONTEST

Sponsored By

ALPHA TAU SIGMA

National Honorary Engineering Journalism Fraternity

..CONTEST RULES..

1. All students who are freshmen in the College of Engineering of the University of Wisconsin are eligible for competition.

2. A pencil mechanical drawing to be assigned by the instructional staff of the drawing department as a part of the regular work in Drawing 2 will serve as the entry in the contest.

3. Entries will be received by the drawing department up to and including April ~~29, 1936~~.

4. The three best drawings shall be awarded first, second, and third places, respectively, by the judges. The three winners will receive material prizes as announced in the April issue of the Wisconsin Engineer.

5. The entries will be judged under the general headings given below, which are listed in the order of their weighted values, the first receiving the greatest weight:
   1. Technique and Theory
   2. Accuracy
   3. Lettering
   4. Neatness

6. One or more of the winning entries will be reproduced in the pages of the May issue of the Wisconsin Engineer.

7. The judges are P. H. Hyland, professor of machine design; W. S. Cottingham, assistant professor of structural engineering; and R. W. Fowler, assistant professor of drawing, Extension Division. Their decisions will be final.

At The Convention

New officers for 1936 are: Robert M. Connelly, consulting engineer of Appleton, president; Robert C. Johnson, chief engineer of Immel Construction Co. of Fond du Lac, vice president; Clarence A. Willson, structural engineer in the state architect's office, trustee; and Herbert O. Lord, chief engineer of the Metropolitan Sewerage District of Madison, trustee.

President Connelly, who served in the World War as a pilot in the air service, may be expected to keep the society flying high during the coming year. His main effort will probably be to induce most of the 1,000 registered engineers of the state to become society members.

The convention hall was filled to capacity when Col. H. W. Miller gave his talk on Big Bertha, the famous German gun that shelled Paris from a distance of 75 miles. His talk was easily the high point in a program that was unusually well arranged. "From an engineering standpoint," Col. Miller stated, "Big Bertha was a success. She dropped 367 shells into Paris. But so far as breaking the French morale was concerned, she was a flop."

So far as known, this was the first convention of the society at which the president of the society was not present. Prof. H. F. Janda, who has been in bed since Christmas Day, was forced to delegate his duties to Vice President Connelly. Connelly himself had trouble in being present, having wrecked his car in a head-on collision with a truck on his way to the meeting.

Alonzo J. Hammond, past president of the American Society of Civil Engineers, presented the aims and accomplishments of the American Engineering Council on Friday morning.

Mr. C. E. Davies, secretary of the American Society of Mechanical Engineers, was present at the Friday sessions.

The 1936 highway program in the state, as outlined by E. L. Roettiger, state highway engineer, will include construction to the amount of $16,000,000 and will be equal to that of the years 1934 and 1935 combined. There will be 100 miles of new concrete, 68 miles of bituminous roads, and 597 miles of gravel. Twenty grade separations are planned at a cost of $4,000,000.

James L. Ferebee, president of the National Council of State Boards of Engineering Examiners, discussed the registration of engineers at the session on Friday morning.

Chi Epsilon, following established tradition, handled the registration table. The men on duty were Crandall, Eppler, Leopold, Liebmann, Luecker, Matthias, Rohlich, Shipman, Ter Maath, and Voss.

Students attended the meetings in considerable numbers as several of the regular classes were excused for that purpose.

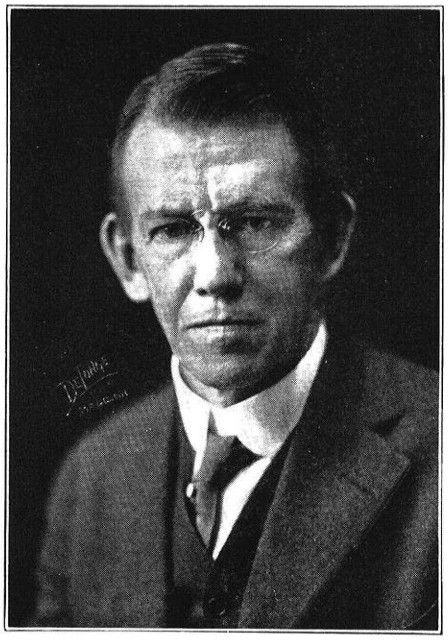
Secretary Owen reported a membership of 272 as compared with 343 last year. Only 113 are paid up, the others being from one to three years in arrears. A well directed membership campaign would seem to be the matter of first importance at this time.

A strong plea was made to have the society join the American Engineering Council, and the members present went on record as favoring the action. The directors were instructed to poll the membership by letter ballot, on the question.

In spite of roads blocked by snow drifts and weather that hugged the zero mark, the attendance was up to the usual numbers. The Soil Erosion Service was well represented with two men from each camp as delegates.

The symposium on the Port Washington power plant proved to be of great interest and covered so wide a variety of engineering features that it attracted a large audience.

Daniel W. Mead, president of the American Society of Civil Engineers, and Prof. Gustav L. Larson, president of the American Society of Heating and Ventilating Engineers, were given an ovation at the joint banquet with the Technical Club on Thursday evening.



DANIEL W. MEAD

Flowage Survey Field Work on the Upper Mississippi River

by **Messrs. L. M. BUHR and E. F. BROWNELL**

(Parts of paper presented at Engineering Society of Wisconsin 1936 Convention in Madison, Feb. 20-21)

IT IS the purpose of this paper to discuss in detail the methods used, and the resulting costs, of making topographical and real estate surveys in the United States Engineer District, St. Paul, Minnesota, preliminary to the Nine-Foot Channel development of the Upper Mississippi River. In speaking of this survey, the term "Flowage Survey" is used because of the combination of topographical and real estate work, and because the primary object of the survey was to determine the damages which would be incurred by the United States in canalizing the river.

During the period 1894 to 1895 the Mississippi River Commission made a very fine topographical survey of the Mississippi Valley, covering the area between the summits of the bluffs or hills on each side. It was at first believed that the maps prepared by the Commission, if supplemented by a small amount of field work, would serve the purpose for acquisition of land and determination of damages. It was soon discovered, however, that these maps would not suffice because of the many changes in topographical features which had occurred since the surveys were completed. Furthermore, no land lines had been retraced by the Commission survey and therefore the maps were of little value for real estate work. However, these maps were used extensively in making preliminary estimates, prior to our Flowage Surveys, and in making the paper location of the sites for the locks and dams.

Area Surveyed

The section of the Mississippi River surveyed by the St. Paul District is the reach from St. Paul, Minnesota, to Lynxville, Wisconsin, a distance of 191 miles. The area covered by our flowage survey is about 230,000 acres and lies within the boundaries of the states of Minnesota, Wisconsin, and Iowa. The valley is flat and wide, ranging in width from 1 mile to 4 miles, cut up by numerous sloughs, bayous and marshes. Most of the area is covered by a rather dense growth of brush and timber. Very little cultivated land lies within the area to be flooded. The river bed meanders from side to side of the valley. The flood plain is distinctly marked on both sides by abruptly rising hills or bluffs varying in height up to 600 feet above the river bed. Railroads and highways lie at the foot of the bluffs and bound both sides of the flood plain.

Organization

In the spring of 1930, when the survey work was authorized, the St. Paul District had among its engineering personnel several men with extensive survey experience who were qualified for the supervisory positions. There were no experienced topographical draftsmen, instrument men, or rodmen employed in the district at the time, which necessitated almost an entirely new organization of about 30 men. This number varied at times during the course of the survey up to a maximum of 110 men.

The field and office work was put under the direct supervision of an assistant engineer with an assistant engineer in charge of the computations and mapping. For a period of about 1½ years a field office was maintained at La Crosse, Wisconsin, in order to be in more direct touch with the field work. During this time all computations and mapping were carried on at this office.

A detailed make-up of the parties is given here, with their average salaries, to serve as a basis of comparison of the survey costs in this district with those of other federal or state departments or private interests.

TRANSIT PARTY	
Instrumentman (Chief of Party)	$175.00 per mo.
Recorder on topo. (Head chain, land lines)	150.00 per mo.
3 Rodmen	130.00 per mo.
1 Axeman	120.00 per mo.
LEVEL PARTY	
Instrumentman (Chief of Party)	175.00 per mo.
2 Rodmen	130.00 per mo.
PLANE TABLE PARTY	
Instrumentman (Chief of Party)	175.00 per mo.
Recorder	150.00 per mo.
2 Rodmen	130.00 per mo.

The office force averaged about 11 in number, made up of computers and draftsmen with salaries ranging from $1,680 to $2,000 per year.

A truck with special type body was available for each field party for transportation from the parties' permanent station to the field work. Survey equipment, with the exception of instruments, was painted and kept in repair by members of the survey parties at odd times.

Horizontal Control

The survey of the Mississippi River Commission, previously mentioned, established a well monumented triangulation system computed on geographical coordinates based on Cairo Datum. These triangulation stations varied from 5 to 10 miles apart and were located on prominent points on the bluffs along the river.

A secondary control system was also established by the Mississippi River Commission and known as "Stone Lines." Originally these monuments consisted of a stone post about 3 feet long, the upper portion dressed to 6x6 inches, the lower part of the stone left rough. The top of the stone was dressed and marked with the letters "U. S." A hole was drilled in the center of the top of each stone. Copper bolts, projecting slightly above the surface, were leaded into the holes. Later this monument was changed, and in this district they consist of a flat tile, 18x18x4 inches, buried about 3 feet below the surface of the ground, with a steel pipe 4 inches in diameter and 4 feet long resting on it. A copper bolt was leaded in the tile. A brass cap was bolted on the top end of the pipe and marked "Mississippi River Commission." It also was marked with the latitude and longitude. These lines consisted of a series of four monuments in a line, across the river bottoms, with the lines set three to four miles apart. These stone lines were tied to the main triangulation system.

In 1931 the U. S. Coast and Geodetic Survey ran a first order triangulation system spanning the Mississippi River. This line covered a much wider area than the Mississippi River Commission triangulation system, its stations being set farther back on the bluffs and the distance between them varying from 15 to 20 miles. Several ties were made to the Mississippi River Commission surveys so that both systems are tied together. The U. S. Coast and Geodetic Survey system is computed on North American Datum.

A field check, in 1930, showed that most of the Mississippi River Commission monuments were still in place and therefore available for use. It was then decided to use this control system and tie all surveys to it.

The first problem then was to transfer the control points from geographic coordinates to plain coordinates. This was done by the method as outlined in "Special Publication No. 71—Relation Between Plane Rectangular Coordinates and Geographic Coordinates" as published by the U. S. Coast and Geodetic Survey. To establish a system of coordinates for each project, it was necessary to choose first the position of the coordinate axis. This origin was placed near the center of the area to be surveyed, in order to avoid large errors. In all cases one of the triangulation stations was used. It was given a large numerical value so that all coordinates were positive for the area to be surveyed. A distance of 40 miles gives an accuracy of one part in 20,000; 55.9 miles, an accuracy of one part in 10,000. After examining the area to be surveyed, it was decided to use three origins which seemed most convenient for the work and resulted in an accuracy for the triangulation system of one part in 20,000. The three origins covered the following projects: Projects 3 and 4 on one origin; projects 5, 5A and 6 on the second origin; and projects 7, 8 and 9 on the third origin. Each project was carried entirely on one origin to avoid splitting the work. Where data from one origin were needed to match with that of another origin, they were recomputed on that system of coordinates. Overlapping of two coordinate systems will not match, due to the convergence of the meridians through the origins.

Existing Vertical Control

No First Order and very little Second Order leveling was necessary on our Flowage Surveys because of the great amount of leveling performed along the Mississippi Valley in previous years by the Mississippi River Commission, the U. S. Geological Survey, the U. S. Coast and Geodetic Survey, and by the War Department. The "Stone Lines" set by the Mississippi River Commission were also permanent bench marks of Second Order. Permanent bench marks, established by the above departments, existed at 3 to 5 mile intervals on each side of the flood plain and along the bank of the river. These bench marks were established on various datum planes but have all been reduced to Mean Sea Level Datum, 4th General Adjustment, 1912, and are published in the U. S. Geological Survey Bulletins on Spirit Leveling for various states. The Bulletins for Minnesota, Wisconsin and Iowa are numbers 560, 570 and 569 respectively. All elevations on surveys and structures in the St. Paul District are now based on Mean Sea Level Datum, 4th General Adjustment, 1912. As a check against the existing permanent bench marks, a line of Second Order levels was run between Minneapolis, Minnesota, and Prairie du Chien, Wisconsin, a distance of 225 miles. As many permanent bench marks as possible were tied into this line. A few errors were found and adjusted. All bench marks, both permanent and temporary in the St. Paul District, along the Mississippi River between Minneapolis and the Mouth of the Wisconsin River, have been compiled into one bulletin for use on all work in the district.

Third Order levels were run to establish temporary bench marks for use at specific points for gages, soundings and topography. For use on topography surveys, temporary bench marks were established at approximately 1 mile intervals around the entire area surveyed and near the proposed pool elevation contour. In addition, they were set at approximately every section corner on the flood plain and where land lines crossed the banks of the river and main sloughs. These lines of levels were run from previously established First, Second or Third Order bench mars and tied in on closed loops. Length of sights was held at 300 feet or less and balanced as nearly as possible. The limiting error of closure on bench marks of equal or higher order was placed at 0.05 length of circuit in miles.

Land Lines

Since the completed flowage survey maps were to be used as a basis for acquisition of land, the retracing of section lines was a very important part of the survey. This meant retracing all land lines within and up the nearest section corner above the proposed pool elevation, or, in other words, within and just above the contemplated project boundary. This was done by running a chained traverse around all necessary sections.

Before the field work of retracing the section lines was started, copies of the field notes of the original government land line surveys were obtained at the various state capitols. These records show all distances between corners, give all bearing ties, describe the corners set and give chainage pluses to shore lines of streams, hilltops, toes of bluffs, etc. Copies of these original field notes were taken into the field by the land line parties and aided greatly in finding corners.

On retracing land lines the transit party, as shown in a previous paragraph under "Organization," was made up of the instrumentman, head chainman (recorder on topography), rear chainman (rodman on topography), head and rear rodmen and axemen. Both chainmen and rodmen were required to carry axes and assist in cutting out the lines. Before running the section line traverse, the party was split up into two groups headed by the chief of party and the head chainman, and section corners were "scouted"; that is, all information relative to required corners was obtained from farmers, county surveyors and long-time residents in a section. This greatly expedited the running of the traverse later. These same parties searched for all permanent horizontal control points and triangulation stations and established flags on them to facilitate making azimuth closures.

With the scouting completed and flags set on all control stations, the party proceeded to run the traverse. These chained traverses were run on true azimuth with the south point as zero. The traverse was started off of a permanent horizontal control point with 0+00 stationing and true azimuth obtained by sighting another control point. The traverse was then run to the nearest corner. Stationing was then started at 0+00 at each section corner and carried continuously for 1 mile to the next section corner, and so on to the tie at the next control point. This procedure was continued until the outermost section lines had been run around the entire project. All other section lines within the limits of the project were then run and tied into permanent control points or looped on themselves.

All corner monuments, mounds of rock, fence corners and bearing trees along the line of traverse were tied in either by occupation or by azimuth and distance from the nearest hub. Chainage pluses were taken on line to all crossroads, fences, pole lines, shore lines of water courses and, in fact, any pertinent data that might have a bearing on a land subdivision or land ownership. On steep bluffs and hills where accurate chainage was difficult triangulation was used. Chainmen carried hand levels to assist in level chainage when breaking chain frequently. All chained distances were checked by stadia. Approximately 1,300 miles of section lines were retraced. Each party averaged about 1 mile per day through this rough country as compared to 2 to 5 miles per day in open cultivated areas.

After the land line traverses had been computed, closed and plotted in the office, and the correct location of missing corners decided upon, data sheets were prepared by the office force and furnished to the field party for the establishment of the corners. These data sheets gave the azimuth and distance from the nearest traverse station to the corner location. Before the corner was established, another thorough search was made for the missing corner, and all possible information obtained from adjacent land owners. After the corner was established, it was well referenced to bearing ties, either trees or permanent objects. The monument set was a 3 inch iron pipe 4 feet long with a bronze cap. The cap was marked "U. S. Engineer Office, St. Paul, Minn." with the section, township and range number stamped on. No corners were established in the area to be flooded but only the missing quarter corners and section corners immediately above the proposed project boundary location.

Topography

The taking of topography is by far the largest part of the field work on Flowage Surveys. Both plane table and transit stadia methods were employed on this work. The transit party make-up was the same as on land lines except that the head chainman acted as recorder. The plane table party consisted of topographer, recorder and two rodmen. The land line traverses were used as horizontal control in additional to the permanent triangulation stations and "Stone Line" monuments. Horizontal control depended on the permanent and temporary bench marks previously established. In carrying elevations on topography traverse a system of balancing height of instrument was used which eliminated any chance for large errors in observation. For example: the transmit or plane table is stationed at hub "A" whose elevation has previously been established. The H.I. is measured and a rod reading taken on hub "B" and its elevation determined. The transit is moved to hub "B" and the elevation of the H.I. measured. A back sight rod reading is taken on hub "A." If both forward and back sights are correct the elevation of hub "B" plus the H.I. will be equal to the elevation of hub "A" plus the back rod reading. If they are not equal an error has been made and is discovered immediately. If there is a difference of only a few hundredths in the two sums the mean of the two is taken and used as the H.I. at hub "B" and the line moves forward. With this method of balancing the H.I.'s elevations may be carried several miles by transit and stadia without any appreciable error.

A chained transit topography traverse was run around the project within 3 to 5 feet vertically of the proposed pool elevation or, in other words, near the probable location of the project boundary. This was done to obtain a greater degree of accuracy in establishing the project boundary.

The upper limit of topography on each project was set at 10 feet above the proposed normal pool elevation. The upper limit was exceeded in the case of steep banks or in order to tie in roads and railroads which were just above the upper limit of elevation but very near horizontally. Where the pool elevation contour lay in a bluff or caving bank, sufficient topography was taken to include all probable areas of caving banks. Tributaries of the Mississippi were run out to a point where the water surface elevation was equal to the upper limit of topography on that project.

Loose leaf note books were used with a form of notes devised especially for the work in this district. On the transit stadia topography field sketches were plotted by protractor and scale with topographic features plotted to aid and increase the accuracy of office mapping. The Beaman Arc was used on all side shots that could not be shot with level telescope. Traverse stations were numbered with a numerical and alphabetical system, the first symbol being the first letter of the transitman's name. The amount of area covered per day and the number of side shots per square mile naturally depended entirely on the type of topography. About 600 acres and 1,200 side shots were considered a good week's work. Each party was required to turn in a weekly work report in addition to daily labor reports, monthly equipment reports, car reports and safety reports. All linear closures on stadia topography traverse were required to be 1:500 or better and on chained topography traverse 1:1500 or better. The entire acreage covered by topography amounted to 230,000 acres.

Costs

The surveys have not been entirely completed so that final unit costs for the entire survey are not available. Total and unit costs for four completed projects covering approximately 100,000 acres have been compiled and the average cost of the survey per acre found to be $1.14. This includes all Division and District overhead in addition to all costs of field and office work to put out the completed maps and tracings. The unit cost per acre of the different features of the work making up the $1.14 are as follows: land lines $0.39, levels $0.02, topography $0.66 and project boundary $0.07. Under the item "land lines" attention is invited to the fact that section lines only were retraced.

The work was carried on continuously throughout the year. Because of the dense growth of timber and brush on the bottomlands and because of the numerous sloughs and marshes, it was found that topography work could be performed much cheaper during the winter months. For this reason, work was arranged as far as possible so that most of the land line, level and monumenting of the project boundary work was performed during the summer, and the topography taken during fall, winter and spring. Spring floods and high water interfered with the work to some extent. The cost of land lines is high compared to that to be expected in more open country. The other unit costs and the average cost per acre for the completed surveys are believed to be below the average for a survey of this type.

G-E *Campus* News

LET SCIENCE ARBITRATE

In heated arguments of this kind, the color analyzer is the court of last resort. Recording photoelectric spectrophotometer is the official name of this device, which was recently exhibited at a scientific meeting at St. Louis. It recognizes an infinite variety of hues and shades; it distinguishes differences in color too slight for human eyes to detect; it automatically records the exact color prescription.

The spectrophotometer is proving especially useful for standardizing the color specifications of inks, dyes, paints, paper, and textiles. It makes obsolete such vague descriptive names as blue-black, blue-white, and yellow-green, and substitutes carefully drawn graphs extending over the whole visible spectrum. The operation of the device, which is automatic, depends upon an ingenious combination of a phototube and thyratron tubes with a precise optical system.

The previous method of making exact color measurements required hundreds of tiresome readings and consumed most of a day. The recording spectrophotometer produces a curve of comparable accuracy in three minutes.

DIG HERE

In the old days, a mysterious individual, called a dowser, with a forked devining rod of witch hazel, used to be called in to locate lost articles buried in the earth. A new magnetic detector, recently developed in the General Engineering Laboratory of the General Electric Company, is now substituting science for magic and hocus-pocus. With uncanny accuracy, it is tracking down lost pipe lines.

Water and gas pipes are often lost because old surveys are inaccurate or because records have been destroyed. Digging up a whole street, in order to find a missing pipe line, is expensive business. The new detector has solved this problem by successfully locating pipes laid 40 years ago—pipes buried as much as seven feet below the surface. In one case, pipes were found fully 100 feet from their supposed location, and the detector spotted them within one diameter of the pipe.

NEW LIGHT ON THE MIDDLE AGES

Medieval ecclesiastics would cry "Witchcraft!" could they see the cathedral at Burgos, Spain, tonight. Carefully wrought details of architecture and ornamental carving, never before clearly seen in all their seven hundred years, now stand forth in bold relief. The thirteenth-century Gothic structure glows, for two hours each night, in the light of a battery of modern General Electric floodlights.

Burgos was, for centuries, the capital of Old Castile, the kingdom of that Queen Isabella who offered to pawn her jewels to finance Columbus' momentous voyage to America. Now, after 444 years, American lighting equipment returns to add luster to what was one of the most important of Isabella's possessions.

96-237DH

GENERAL ELECTRIC