The Wisconsin engineer. Volume 18, No. 4 January 1914

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

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

The Wisconsin Engineer

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JANUARY, 1914

Vol. 18 No. 4

Volume 18 **Founded 1896** **Number 4**

The Wisconsin Engineer

$1.00 a Year **20c a Copy**

Entered as second-class matter Sept. 26, 1910, at the postoffice at Madison Wis., under the Act of March 3, 1879.

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JANUARY 1914

Published monthly from October to May, inclusive, by the WISCONSIN ENGINEERING JOURNAL ASSOCIATION, Engineering Bldg., Madison, Wis.

Address all communications to The Wisconsin Engineer.

Subscription price $1.00 a year if paid before February 1; $1.25 a year after that date. Canadian subscriptions, $1.25 a year. Foreign subscriptions, $1.50 a year.

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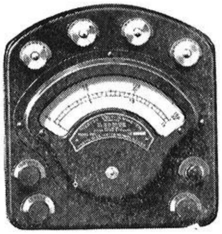

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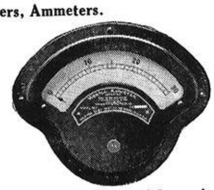

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The Wisconsin Engineer

VOL. XVIII JANUARY 1914, NO. 4

THE SIGNIFICANCE OF HIGHWAY MAINTENANCE.

PROF. L. S. SMITH.

We, in America, fail to understand that the main reason why our roads are so inferior to those of Europe is the general lack of an adequate system of maintenance. A century of experience has taught the European engineers and taxpayers that the time to begin the repair of a road is the day after its construction is finished.[1] In America, however, we put off the repair of our roads until the day after they are worn out. As a result, while the European road surfaces are well maintained and long lived, the American roads are too often rough and short lived. This criticism, while generally true of country highways, is also, to a lamentable extent true of the city pavements. We know how to construct as good roads and pavements but we have yet to learn the need of their maintenance. This misconception of the significance of road maintenance is well illustrated in a current engineering magazine in which a road commissioner, after describing how well he has constructed an asphalt concrete road "subject to the heaviest travel", says: "We feel that we will not be required to do anything in the way of repairs for eight or ten years."

Alas if such confidence were only justified!

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[1] The European engineers when constructing a macadam road provide an extra supply of the same material regularly deposited at the side of the road at intervals of 50 or 100 meters.

It is the writer's experience that such a pavement is certain to show some weak spots after the first winter, if not, indeed, the same season. These defects, though insignificant and easily and cheaply corrected at first, are soon enlarged by a heavy traffic to such an extent as to greatly impair the life of the pavement.

In no other construction does the old adage, "A stitch in time saves nine", apply more aptly than in road repair. This principle has been proved so many times in the history of road construction that the Europeans consider us very stupid indeed not to accept and act on it. This failure on our part to appreciate the function of maintenance as an important element in the economics of highway construction is unfortunately not confined to our humble country path masters but is shown by officials high in authority. It is well understood abroad that both the construction and maintenance of roads have a single object and that both are necessary to attain that object. It may well be that a better service will be afforded by a poorly constructed road, well maintained than by a well constructed road without maintenance. At the present time taxpayers are showing much enthusiasm for the construction of hard surfaced highways, and it is important that this enthusiasm and interest in road building shall be fostered and encouraged. Can anyone doubt if the first pavements prove a disappointment because of their short life, that the effect of such failure will tend to discourage further road building?

Where states or communities build roads or pavements out of the proceeds of the sale of bonds, there exists an additional reason for systematic and thorough maintenance of such roads. For even with good maintenance, there will usually be some difficulty in preserving the road for a term equal to the life of the bonds, and, lacking such maintenance, most highway construction will have worn out long before the bonds are paid. This has actually happened in some of our American states and municipalities.

There are many miles of expensive macadam roads in New York state, the life of which will be less than twenty years, all built out of the proceeds of bonds running for 50 years. Such a system of financing good roads cannot be characterized as anything short of dishonest, for the reason that we thereby transfer to the backs of our children the burdens which we of today should bear.[2] It does not require a prophet to see that tho' the present road problems are serious, those of the future are quite certain to be much more so. Again the failure to maintain the New York roads during the first few years succeeding their construction has resulted in an excessive cost of maintenance during the past three years of over $1,000 per mile per year. But New York state has learned from experience the lesson of continuous maintenance, and other states may well profit by her example. During the year of 1912 the maintenance department on New York state highways employed 735 patrolmen, who cared for approximately 3151 miles of completed highway. Each patrolman furnished a horse and cart, together with the necessary small tools. The work of maintenance under this patrol system consisted in keeping the surface of the paved roadway in as nearly perfect condition as possible, keeping the dirt shoulders smooth and safe for travel; culverts and drainage system free from obstruction; weeds, grass and brush cut within the limits of the highway and in making small repairs to structures and guard rail. In addition to these duties, the patrolmen filled the ruts and repaired small defects which appeared in the road as a result of heavy travel.[3] The total amount of money spent by New York state in 1912 on this maintenance and repair work amounted to nearly $3,000,000. Contrary to the common belief, macadam roads there are not *permanent* structures.

One reason for the general indifference in the United States toward this question of maintenance is found in the failure to visualize the future traffic. For example, the officials of one state highway commission took a traffic census several years ago on country highways and found only a light traffic, they therefore conclude that a construction suitable for such traffic is all that should be provided. As a matter of fact the building of a hard surfaced road at once disturbs the old equilibrium of traffic by attracting to the new road new traffic, which formerly sought other routes. This can best be illustrated by giving some statistics [4] from a paper by Col. Sohier, Chairman of the Massa-

[2] It should be a matter of much pride to citizens of Wisconsin, that our state is building all roads out of current taxes alone.

[3] Appendix A, Report of State Commission of Highways, 1912.

[4] Good Roads, Jan. 4, 1913.

chusetts State Highway Commission, and presented by him at the Convention of the American Road Builders Association at Cincinnati. Briefly stated, he found the average daily traffic on one road, which in 1909 was 185 vehicles, had increased in 1912 to a daily average of 586 vehicles, an increase of 217 per cent in three years. The increase of motor-driven vehicles was 200 per cent and of heavy teams 288 per cent. On another road the average daily traffic increased from eighty-one vehicles in 1909 to 333 in 1912, or 300 per cent. In this case motor-driven vehicles comprised 42 per cent of the traffic in 1909 and 75 in 1912. These examples are probably indicative, in general, of traffic changes in other states, though of course not always with the same percentages. The point which here needs emphasis is, that if a dirt road requires little or no maintenance before being macadamized, after such improvement the increase in traffic which it is certain to attract will render some maintenance imperative. This has been repeatedly shown to be true in every eastern state, and it is high time that the western states profited by such experiences. The situation would only seem to require that the full facts relating to this experience should become widely known to our citizens.

To a student of highway economics, the alarming rate at which maintenance expenses increase, when any considerable amount of the state highways have been improved, is certain to cause apprehension, and should be of vital interest to the taxpayer.

Turning again to New York State, we take the following figures from the published report of the State Highway Department.

Cost of Maintenance.

	Mileage	Maintenance Cost	Cost per Mile
1909	1787	$1,500,000	$840
1910	2137	1,800,000	840
1911	2622	2,122,763	1,001
1912	3151	2,919,959	926
1913 [5]	3813	5,000,000	1.311
		Average......	$983

[5] Approximate estimated by the State Sup't of Highways.

Heavy traction engines, fast moving automobiles, and heavily laden narrow steel-tired wagons are responsible for a very large part of this excessive cost of road maintenance. In all justice to the taxpayer this class of vehicles should be made to contribute to the maintenance fund their just share of such damage. This principle has long been recognized and acted on in Europe, and, to a lesser extent, also in some of our states. Most states exact an automobile license fee, but often not more than five dollars per year, an insignificant sum if intended to compensate for the wear of the roads. Instead of a flat sum it seems more fitting that the license fee should be made proportional to the weight and horsepower of the vehicle. In England a 45 H. P. touring car would be required to pay a license fee of about $100 per year. Such a tax has been justified, not only as a partial return for damage done to the road thro the use of the motor car, but also as coming from a class to whom such a tax would be far from a burden.

Another method of securing the funds for maintenance, and one largely used in Europe, is the taxing of all gasoline used in motor cars. It has been estimated that a tax of six cents per gallon (the tax in England) would have produced a fund of $1,600,000 in New York state in 1912. Such a tax would have the advantage, also, of being proportional to the use of the roads. This method of taxation will be recommended to the next New York legislature by the state superintendent of highways, and would seem to deserve a wide adoption.

But better still than paying for excessive wear to our roads is a system of state legislation designed to prevent such wear. Several eastern states have already enacted such regulations. Some of the provisions of the New York law include the following: (a) Traction engines are prohibited from traveling over improved highways for threshing purposes after January 1, 1914, and, in the meantime, such engines must pay for any damages. (b) The tires of each wheel of any steam roller, automobile truck motor, or other vehicle shall be smooth, and the weight of such vehicle, including load, shall not exceed 800 lbs. upon any inch in width of the tire wheel or roller. (c) No motor or other power vehicle shall have a greater width than 90 inches except traction engines 100 inches. (d) No traction engine, steam roller, automobile truck or motor carrying a weight in excess of 4 tons, including the vehicle, shall be operated at a speed greater than fifteen miles per hour, and no vehicle carrying a weight in excess of six tons, including the vehicle, shall be operated upon any state highway at a speed greater than six miles per hour, when equipped with iron or steel tires nor greater than twelve miles if equipped with tires of hard rubber.

With a force of over 700 patrolmen evenly distributed over the state highways, and assisted by the other regularly constituted peace officers of the state, it would seem entirely feasible to enforce the above laws and regulations. There can be no doubt that such enforcement will go very far toward preventing the present excessive wear on improved roads. Neither European nor American roads have been built to withstand the present traffic demands, especially the fast moving auto and heavy motor truck. Even the expenditure of $45,000,000 per year on the widely heralded French highways has not prevented these water bound roads from wearing rough where subjected to excessive motor traffic. The general substitution of the motor vehicle for the horse drawn vehicle, while greatly reducing the maintenance cost of city pavements built of wood, stone, brick or asphalt has had exactly the opposite effect upon country highways built generally of some form of broken stone or gravel.

In the judgment of our most experienced engineers the road of the future, designed for heavy fast moving traffic will make use of our immensely valuable broken stone and gravel resources in a permanent concrete foundation, provided with some comparatively thin and easily replaced wearing surface. If such wearing surface be made of some kind of bituminous material which could be remelted and laid again, the maintenance costs involved would seem to be a minimum. In a large part of the Mississippi valley the use of vitrified brick on a concrete base is becoming deservedly popular because of its long life and resulting uniformly low cost of maintenance. At the present time numerous American road officials are experimenting with various mixtures of concrete for both foundation and wearing surface. The reports on these experimental pavements are very conflicting except on one point viz. that concrete roads have not been able to withstand the abrasive action of heavy steel tired vehicles, though well suited for motor traffic.

The writer disclaims any partiality toward foreign practice of roadmaking. In fact, except for their superior systems of *road maintenance,* his investigations fail to show any superior knowledge on road construction over that possessed by American engineers. Indeed so far as the theory and practice of asphaltic materials for road purposes is concerned, European engineers frankly confess that they look to America for the correct solution of present problems. Again, in making any comparison of highway conditions in America and abroad, due allowance should be made for the fact that European road systems have taken a century for their construction; in fact, many of their main roads were first built by the Romans over 1500 years ago. Moreover, this great work was first initiated, and in very large part supported by an ever present military necessity.

In America, the good road movement is scarcely fifteen years old. In this brief experience we have learned how to make our standard roads as well suited to our comparatively thinly settled country and the attendant traffic conditions as the French roads are suited for French conditions. One might go farther and say that no county in England has a system of roads so permanently constructed as the 1700 miles of brick pavement in Cuyahoga county, Ohio. It is not in the construction, but in the *maintenance* of our roads that we need to copy from Europe. When will we learn that pavements are not permanent structures, but instead require constant repair and maintenance? We will be very stupid indeed if we do not accept and take advantage of the experience of Europe and our own eastern states. The highest efficiency and continuity of management will be promoted by placing the maintenance of all state or main trunk roads in the hands of the State Highway departments, out of the influence of petty county politicians.

Most significant to highway engineers and most encouraging to the taxpayer is the present well founded confidence in and reliance on scientific methods, both in the selection of road materials and in their incorporation into the completed road. But only after our people are equally well converted to scientific maintenance can we realize our ambition for good roads.

"BREADTH" IN THE TRAINING OF ENGINEERS.

PROF. WM. A. SCOTT,
Director of the Course in Commerce.

Both breadth and specialization are essential to efficiency in education. In some respects they may be compared to the foundation and superstructure of a building. The former without the latter is useless and no good superstructure can be built without a strong and well laid foundation. This is an easily understood and generally accepted principle. Regarding the manner in which this foundation should be laid and the elements of which it should be composed, however, the case is not quite so clear and there is room for differences of opinion.

Some of the elements upon which an engineer's training must be built are easy to determine. These are the fundamental sciences of physics, mathematics and chemistry. He must also be able to read and comprehend the literature of his specialty and clearly and effectively to express his ideas, plans and specifications orally and by written statements, diagrams, drawings, etc. He must, therefore, know his native language thoroughly and be able to write it in a clear and forcible manner; he must at least be able readily to read the foreign languages in which the literature of his specialty is being written, and he must be able to draw, make blue prints, etc., etc.

In comparatively recent times, another group of studies has been presenting its claims for consideration as elements in the training of the thoroughly equipped engineer, namely the social sciences, notably political economy, accounting, business administration and commercial law. What are these claims and are they well founded?

As a group, these subjects describe the structure and workings of the commercial and industrial organism of which the engineer is a part, and to the running of which he makes a necessary contribution. To ask whether he should be familiar with this structure and its workings seems like asking whether a man ought to know the nature and operations of the machine for which he is making a cog, or a wheel or a spring. Obviously if some one tells him precisely what he is to make, he can make it without such knowledge. It cannot, therefore, be said that he must understand the machine in order to be a fairly good cog or wheel or spring maker, but it is equally obvious that if he is to be anything more than a mere cog or wheel or spring maker, he must know the machine in the making of which he is co-operating with other people.

An equally profound and detailed knowledge of every part of the economic and social mechanism and of every phase of its working is, of course, not necessary or possible. This mechanism is so complicated that a life time of study would not put one in possession of complete knowledge concerning it. Political economists and sociologists who make a business of its study must specialize within the field in order to become proficient and to make themselves useful. For an engineer to become a political economist or a sociologist is, of course, unnecessary. He needs only to appropriate certain of the results of the work of these specialists.

Specifically he needs to know the functions of natural agents, labor, capital, money, credit, banks, transportation agencies, corporations, etc., in the economy of modern nations, the manner in which these agencies are organized and the laws of their operation. A brief course in the elements of political economy will give him this knowledge. He does not need to concern himself with the controverted questions which trouble political economists nor to make extended excursions into the realms of theory. He should also acquire such familiarity with the terminology of the science as will enable him intelligently to read current literature, especially the financial papers and the more popular economic periodicals.

Commercial law concerns itself with the legal structure of the economic organism. A knowledge of the elements of this subject should be known to every business man and to all the groups of specialists who give him advice and assistance. From the standpoint of the engineer it belongs in the same category with political economy. Both of these subjects treat of the larger, broader aspects of the matters with which he deals, with the environment, the conditioning medium of his work.

Accounting and business administration belong in a different category. These subjects the engineer should know more thoroughly than it is necessary for him to know political economy and commercial law, because they alone can supply him with the specific information concerning the plants of the concerns with which he is connected needed for his intelligent action. Accounting treats of business records. It teaches how records should be kept in order to reveal actual conditions and results and how to interpret such records. The engineer needs the knowledge which the study of this subject brings him in order intelligently to conduct the affairs of himself or of his firm, as well as an aid in understanding the problems which he is expected to help in solving.

Business administration deals with the structure of plants and the functioning of their various parts. It is the science of organization in all its aspects. Like accounting the engineer should study it in the interests of his own private business as well as in that of the concerns who employ him as an expert.

The interrelations of business, science and politics are becoming closer each year. Every worker in any of these fields is obliged to cooperate with all the others, and such co-operation, if it is to be efficient, involves some knowledge of the work of each of the others and an intelligent appreciation of the completed work to which each one is contributing a part. The engineer belongs high up in the hierarchy of skilled workers and his outlook should be correspondingly broad. The prizes in the profession will certainly go to those who have this breadth.

PROFIT-SHARING.

HARRY HERSH, '15.

Dr. Eliot recently said in one of his lectures to the students of Harvard University that, "The industrial situation in this country, and, indeed, in the world at large, has not improved during the last twenty-five years." He ascribes this lack of improvement to the "incessant conflict" between the "employed and employer." As a result of this antagonism, systems of profit-sharing have been introduced to promote the zeal and efficiency of the worker and to substitute more amicable relations for this "incessant conflict."

These conditions are fully realized when one is actually in contact with the employees as a disinterested party. Nothing has given me so much pleasure or has been so interesting to me as to get in touch, so to speak, with the workmen of the shop in which I worked last summer. The very fact that I was working with them and trying to learn something from them gained me their confidence and friendship, and through this intimacy I became aware more than ever before that the workman is not a mere human tool, but that he is a real flesh and blood individual who has just as many ideals and just as great a yearning for the comforts of life as the man who hired him. On the other hand, I did not meet many employees who took as much interest in the work he was doing or who tried to make as many savings during his working time as the man who hired him. A feeling prevailed among them that a man was not violating his part of the agreement if he could "kill time" without being caught by the "old man." The men, as a rule, never looked far enough ahead to enable them to order at one time all of the supplies needed for a certain job they were on, but they were only too glad to wast an hour or so until the errand boy brought them each little order. They liked the outward appearance of being industrious, but my fellow-worker intimated that shirking was the rule when he said, "Take it easy, you don't have to kill yourself." These incidents in this one case alone serve to illustrate the great need of forming some kind of alliance between the employer and the employee, and the economic necessity of making the employee bear part of the responsibility of the plant in which he is employed.

For the past thirty or forty years the manufacturers and engineers have been too much occupied with the development and improvement of the industries to pay much attention to the employees. In fact this would be true about any company starting in business at the present time, for all matters must be gradually adjusted.

In recent years, however, the so called efficiency improvements have been introduced into many manufacturing plants, and in these improvements the status of the laborer has been one of the chief factors under consideration. Consequently, the sanitary and lighting conditions of the shops have been improved, the employees have been provided with schools and allowed hours for instruction, and, as Mr. Gilbreth pointed out in his lecture to Wisconsin students last October, the number of movements in a great many operations have been reduced. Many premium, bonus, time-rate and piece-rate systems were also devised with a purpose of paying the laborer according to his merit. But in spite of all these advances the good-will and interest of the employee has not been fully obtained, for he was prone to regard such improvements with suspicion and was slow to adopt them. For this reason many concerns have adopted various profit-sharing plans, the purpose of which, as stated before, is to gain the co-operation of the employee by making him a partner to the profits of the business.

The distinguishing feature of a profit-sharing plan is that the per cent of profit which is to be distributed among the employees is determined before that profit has been made. Furthermore, a profit-sharing plan is not to be put in a class with social panaceas, for it is a straight-forward business proposition the effectiveness of which depends solely upon the laborer. Mr. G. W. Perkins of the United States Steel Corporation states that the purpose of their plan is not to make philanthropists out of the officials, but to earn more for the corporation and consequently for the men.

Profit-sharing first originated in France and England about 1840. It was introduced into the United States twenty or thirty years later, but it has not been in very great use until the last twenty-five years. The present systems adopted by many firms vary in the following respects:—some give the employees their share of the profits in the company's stock; others give pensions which depend on the length of service; and still others pay the profits in cash.

The latter system is the plan adopted by Bernhard Stern & Sons of Milwaukee, Wisconsin, on September 1, 1913, and is based practically on the one that has been in effect at the Simplex Wire & Cable Company of Boston, Massachusetts for over thirteen years. The bulletin sent out to the employees of the former company states that "At the conclusion of a twelve months period after the above date a certain and definite percentage of the net profits of the business is placed to the credit of a fund which is known as 'The Employees' Profit-Sharing Fund.' All employees who at the time of the distribution of the profits shall have been in the employ of the company for a period of at least one year prior to September 1, 1914, shall participate in the distribution of such fund in proportion as each employee's wages or salary for that year shall bear to the entire amount paid for wages and salaries by the firm during that period to those employees."

All the employees, except those in the selling department, are eligible to participate in the profit-sharing fund unless they leave the service of the firm prior to November 1, 1914, when the distribution of the profits will take place; or shall be dismissed in the interest of the firm.

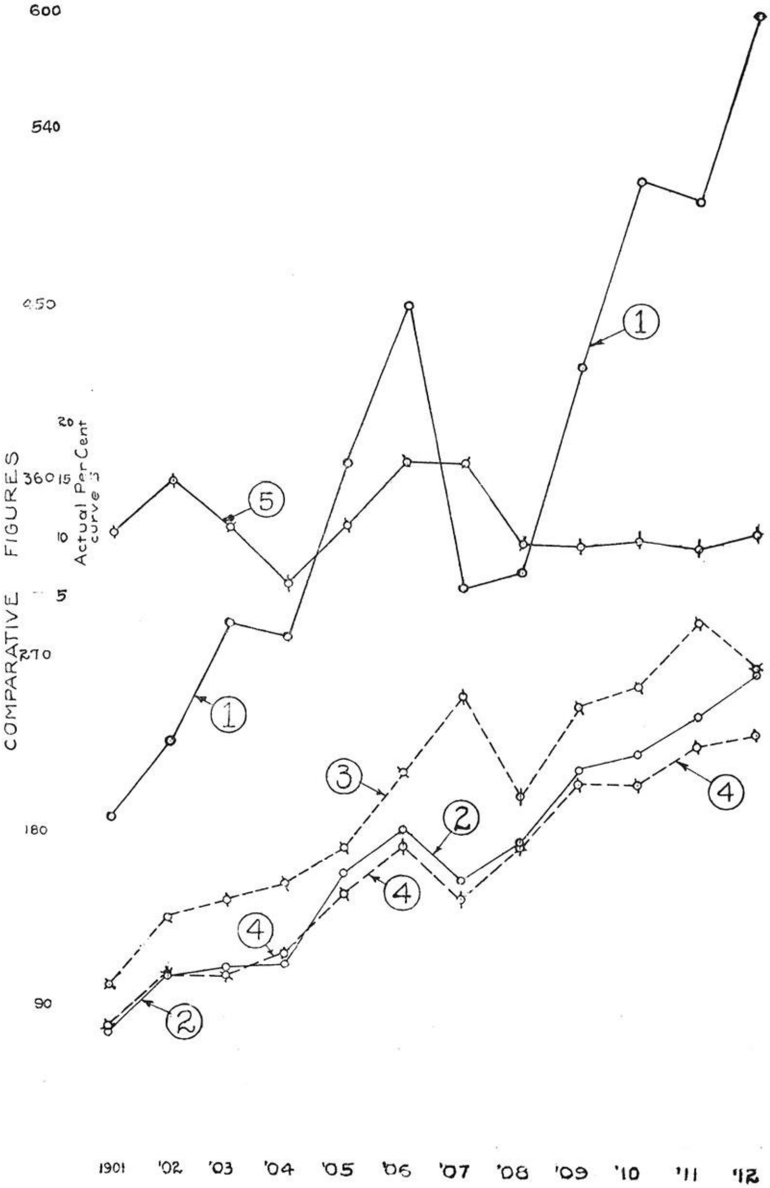
This plan is readily understood by the employee and is also more practical for all classes of employees than are many of the other plans in use. For instance, a pension system is considered by many to be too unreliable when undertaken by a private company; and stock certificates, as a share of the profits, may not be the investment the employee might desire. However, it is well to note that employees have acquired ownership of a large plant in Guise, France through the latter system.

A member of the firm of Bernhard Stern & Sons stated that, "This plan is not entirely altruistic, but we expect to inspire our employees to greater loyalty, co-operation, economy and efficiency by offering an incentive of a personal interest in the net results of the business. We believe this move on our part is in line with the modern tendency on the part of the employer to show a greater spirit of fairness and equity to his employees and thereby bring about a closer relationship between employer and employee.''

The causes for the adoption of the plan are fully justifiable. To insure its successful administration and to make it fair to both sides, a certain fixed percentage of the net profits which is to be credited to the employee's profit-sharing fund is decided upon at the beginning of each fiscal year. No firm makes this percentage public, for it is not considered necessary nor wise, from a business stand-point, to give any publicity to the amount of their actual net gains. The employees receive their share of the profits two months after the end of the fiscal year. This is advantageous to the company because they can be sure of their employees remaining through the busy season and also have sufficient time to make up their books. The faithful and efficient workers are rewarded by being retained at all times and given the benefit of the profit earned by those who are discharged before profit-sharing time because they were deemed undesirable and unworthy in that they did not work for the interests of the firm. The laborers will consequently strive to do their best and create sentiment against those who do not work as earnestly as they do, for in both cases it means added profits for them.

Now what does such a plan mean to the employee? To the thrifty conscientious one it means a lump sum available at a certain time every year for such investments as he may desire to make. To the unthrifty one it means the same thing, for that sum is uncertain and therefore he can not very well anticipate it by spending more than his ordinary weekly or monthly salary. As a result he will either buy some additional things that are needed in his house or start a savings account. Finally the employee will feel that he is working for his own interests as well as those of his employer's because whatever he earns for him he also earns a proportionate share for himself. When a man takes an interest and a responsibility in the work he is doing, he will no longer find it drudgery, and that will lead to greater friendship and satisfaction between both sides.

To the reader this may seem a Utopian plan which will not survive when incorporated into our keen competitive business life. But the plan has stood the tests and the results obtained, as shown by data furnished by the Simplex Wire & Cable Company, warrant its adoption by all enterprising companies. Re-



ferring to the graphs, curve (1) shows the comparative figures of the total amounts paid out each year in salaries by that firm. Curve (2) gives the comparative figures of the amounts of the salaries of those who shared in the profits. Curve (3) gives comparative figures of the number of names on the pay rolls entitled to share in the profits at the beginning of the year, while curve (4) gives the comparative figures of the number of names on the profit-sharing pay rolls which actually shared in the profits. The general trend of all four curves is upward, showing that there was, on a whole, an increase in the number of people employed and in the salaries paid out. Curve (2) is below curve (1) by an amount which indicates that about forty or fifty per-cent of the actual payroll was on the profit-sharing payroll. The ordinates of curve (4) are about three-fourths the height of the ordinates of curve (3), thus indicating that practically seventy per cent of the number of people employed shared in the profits given to the employees. Curve (5) shows the actual per cent of the employee's salary paid as a dividend. This curve neither rises nor decreases much from year to year. Conclusions are, therefore, that the firm is receiving the best co-operation and most careful services from the employees because, in spite of the fact that the number of employees and the total amount of salaries have increased for the past thirteen years, the percentage that the employees have received in dividends has remained practically constant. It would be impossible to keep this percentage constant when the other two elements were increasing unless the increasing number of employees did their just share to earn a profit for the business. They show further that nearly three-fourths of the employees remain at the same place from year to year. They become a permanent part of the community and are prompted to work for the good of the community. This leads to civic betterment.

The employer does not regard the profit-sharing plan as a means of being charitable to his employees. He does not desire any appreciation or thanks whatever. He has inaugurated this plan because he considers it a tendency in the direction of greater fairness to the employees, and by treating his employees fairly he hopes to do away with the discontent, antagonism, disloyalty and wastefulness so prevalent in the average manufacturing plant without a profit-sharing plan.

A NEW IDEA IN PROFIT-SHARING

It Is Neither to Stimulate Labor Nor to Promote Efficiency, But to Reward Past Services as They May Deserve

Nowadays it is not uncommon for a company to recognize the equity of its employes in its prosperity by affording them an opportunity to share in its profits by acquiring stock on an easy payment plan. This is usually done, however, with a view to stimulating the interest of the worker and thereby increasing productive efficiency. A rather unusual feature, therefore, is found in the recent opportunity given to those employes of the Youngstown Sheet and Tube Company who hold managerial positions. The company bases its offer not so much on the points outlined above as upon the proposition that these employes are entitled to some reward for their loyal services in the past. A statement in reference to the matter has been issued, explaining the plan:

"At the last annual meeting of the stockholders of the company 5,000 shares of the common stock, having a par value of $500,000, was set aside to be sold to employes of the company in such amounts and on such terms as the Board of Directors might approve. The board has decided upon a plan for disposing of this stock. Owing to the limited amount available, it is impossible to sell it to all employes who might wish to purchase it.

"The stock will be sold to employes of the company holding the more important positions of responsibility. In general, this includes, in the executive, sales, and accounting departments, the heads of departments and their chief assistants, and in the operating department the superintendents of departments and their chief assistants, making a total of about 125 employes. Each of these, under the plan of the Directors, will be entitled to subscribe to an amount of stock which, at par, is approximately equivalent to his yearly salary."

It is purposed to grade the price of the stock according to the length of service of the employe, but all will be able to purchase it for less than actual value:

"In deciding upon the price at which the stock should be sold, the Directors were desirous of recognizing the loyalty and efficiency on the part of the company's employes which had been instrumental in earning the present accumulated surplus, a large factor in determining the present market value of the stock, which —were any considerable amount of stock involved—would be about $175 per share. It therefore seemed necessary to make such recognition commensurate with the length of service of the employe, since the longer a man had been in the service of the company the greater part he would have had in the earning of the surplus. Following this reasoning, it was decided to charge the man who entered the company's employ in 1905, or prior to that year, par or $100 per share for his stock, and to add $5 per share to the price for each successive year, making the price to men who entered the company's employ in 1913 $140 a share, or the maximum price charged. This procedure seemed as equitable as any which could be devised, in that the man paying the highest price still secured a very substantial profit, namely, about $35 per share, and the men entering the company's employ in any one year were all treated alike, there being no favoritism."

The company has prepared a form of contract for the sale of this stock, which will, in every possible way, safeguard the interests of the employes. The principal features of this contract are as follows:

1. The stock is to be paid for out of the dividends earned by it, and is held by the company for the employe until such time as it is fully paid for and a certificate can be issued. Interest is charged the employe at the rate of 5 per cent. on the unpaid balance, and all dividends in excess of this interest charge are credited to the stock, together with such cash payments as the employe may elect to make. No certificate, however, will be issued to an employe in less than two years from the date of his subscription.

2. If the employe resigns or is discharged from the service of the company within two years from the date of his subscription, it is provided that he will receive in cash all of his net credits on his subscription, together with an extra dividend equal to 10 per cent. of the par value of the stock subscribed for.

3. If the employe should die at any time before the subscription is fully paid up, his legal representatives have the right to pay up the remainder of the subscription and receive certificates for the full number of shares, or they may cancel the subscription and take certificates for the number of shares already paid up.

4. In case the employe should, at any time, be permanently disabled by injury or sickness, to the extent that he is unable to discharge the duties of his position, he may either pay up the full amount of his subscription and receive certificates for the full number of shares, or he may cancel his subscription and receive certificates for that portion of his subscription which is paid up.

A resume of this contract shows that there is no obligation put upon the employe; on the other hand, he is protected in case he is discharged or he resigns, and in case of sickness, injury, or death.

In addition to this stock distribution, the company have had in effect for the past several years a profit-sharing plan in which all of their employees participate. In general, this plan consists of paying at the end of the fiscal year to each of their employees entitled to participate, a sum of money equal to a certain percentage of the wages or salary received by him during the year ended. The percentage is based upon the net earnings of the company for the year, and while it is not figured by any arbitrary formula, they have decided that whenever their earnings justify any distribution of profits, a minimum of 5% will be paid, whereas the maximum will probably not exceed 10%. The first two years the plan was in operation 5% was paid, and the last year 6%.

The rules of eligibility are covered in the following notice recently posted in their works:—

PROFIT SHARING NOTICE

At a meeting of the Board of Directors of the company held October 6, 1913, it was decided that the system of profit distribution among the regular employees of the Company be continued throughout the present fiscal year, dating from July 1, 1913, upon substantially the following basis:

FIRST. All of the employes of the Company to partcipate therein, in proportion to their earnings during the year, with the exception of elective officers and legal and medical advisers.

SECOND. Only those employes shall be entitled to participate who shall be in the service of the Company on June 30, 1914, and who shall have been in its service for at least six months prior to and including that date, except as interrupted by accident or sickness. No employes who, during the year, shall have left the employ of the Company, shall participate.

THIRD. The amount of profit sharing distribution will depend solely upon the net earnings of the Company for the year, and the distribution—if any—will be made after the earnings are ascertained and approval given by the Board of Directors.

(Signed)

THE YOUNGSTOWN SHEET & TUBE CO.,
J. A. CAMPBELL, President.

Editor's Note.

We do not believe that any comment on this article is necessary. Our readers can see the advantages to both the employer and employe, that will arise from such an organization, and feel confident that the article will prove an inspiration to some of the men that are working hard to develop this spirit of loyalty and co-operation which a successful business needs. We are indebted to The New York Times Annalist, as well as the Youngstown Sheet & Tube Co., for the material for this article.

As we go to press Mr. Henry Ford announces that from now on every man over 22 years of age in his employ will receive not less than $5 a day. We are unable to imagine what the effect of this is going to be. There are hundreds of firms where the margin of profit has been cut until a small per cent increase in wages would ruin them, yet what are they going to do in the face of such an announcement!

INVESTIGATIONS OF THE FLOW OF WATER THROUGH PUMP VALVES.

C. B. LITTLE.

The purpose of this paper is to present the results of a series of tests on the flow of water through pump valves, investigating for variations of coefficients under different heads at a constant depth of submergence.

The tests were made at the Hydraulic Laboratory of the University of Wisconsin during the summer session of 1913, under the direction of Professor C. I. Corp and with the assistance of Messrs, G. Youngberg, Woods and Lendall.

DESCRIPTION OF APPARATUS.

The apparatus shown in Fig. I consists of two sections of fourteen-inch-flange pipe with suitable reductions on two ends

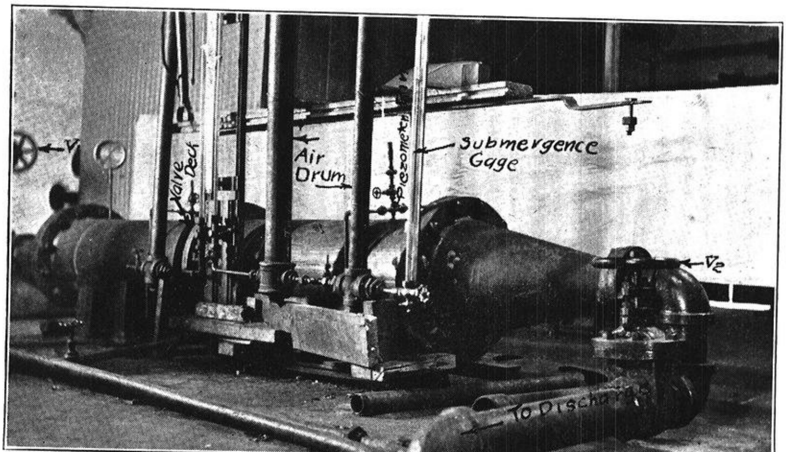


FIG. 1.

to four-inch pipe. Connections for piezometer rings were made just above the joint in the center of the apparatus and meter rings used consists of lengths of one-fourth-inch pipe, connected at quarter points around the fourteen-inch pipe. On the up-stream side, the piezometer ring was connected to one side of the differential gage, while the down-stream side was connected to the other side of the gage and to an open tube to indicate submergence.

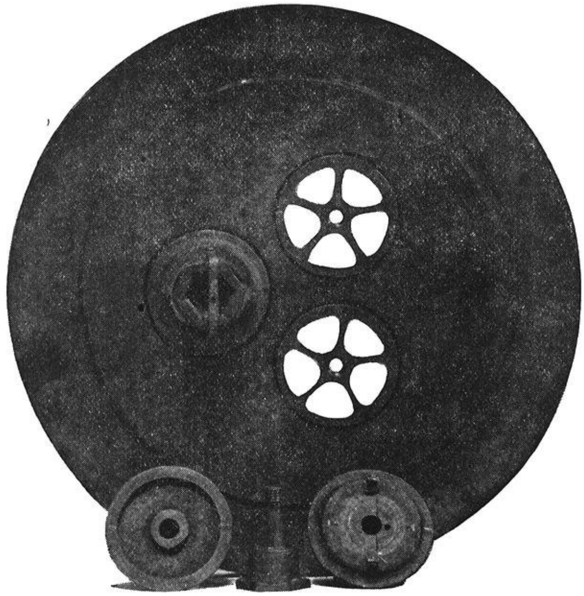


Fig. 2.

The valves used were taken from the Fairbanks-Morse pump in the laboratory. The three seats were obtained from the manufactory and were placed in a valve deck in a position similar to that of the pump (see Fig. 2), the valves being so arranged that their centers formed an equilateral triangle with four one-half-inch sides. The deck itself was seventeen inches in diameter and and one-fourth inches thick. It was placed between two sections of fourteen-inch pipe so that the centers of the two valves were in the same vertical line and the horizontal line of the drum bisected the other valve.

The valves were placed upon the seats as shown in Fig. 3, and were held open by rubber washers placed between the top of valve (A) and stud (B). To insure constant opening at all times, a block of wood was wedged between the top of the stud and the yoke (Y)

The water was supplied from the large tank on the main floor of the laboratory through a four-inch pipe to the drum. A valve (V_1) regulated the supply of water. To obtain the required sub-

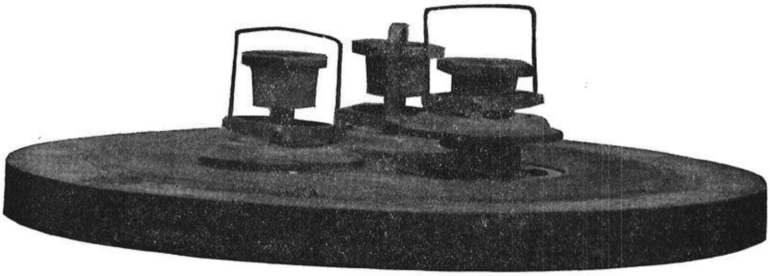


FIG. 3.

mergence and also difference in head, another four-inch valve (V_2) was located in the discharge pipe directly below the drum. The discharge pipe was run through the floor to a measuring tank where the quantity of water passing through the three valves at any period of time was measured.

It was found necessary to install three air drums to dampen the fluctuations in the gage glasses.

These air drums, as shown by Fig. 1, consist of lengths of pipe of various diameters, capped on one end and connected by Tees to the one-fourth-inch pipe between the gages and the piezometer rings. A long threaded nipple was extended to the center of the Tee, and an elbow was attached with its open end, directed up the pipe to deflect the water upward and prevent waves traveling directly across the air drum to the opening leading to the differential gage. This side of the drum was connected to the pipe leading to the piezometer ring, while the other side was connected to the differential gage by straight pipe only. The length of these drums was governed by the pulsations in the gages.

Air vents were provided on top of the apparatus to exhaust the air and to fill completely the 14-inch sections before the beginning of each run, thus eliminating errors due to air in the apparatus. An air pump was attached to the differential gage to force the columns of water to such positions of the gage that they could be read.

METHODS OF PROCEDURE IN TESTING.

The general method employed throughout the tests was to adjust the valves at any desired opening and replace valve deck. The supply valve was then opened wide and the exhaust valve partially closed until the submergence head was approximately 3.2 ft. Thus the smallest difference in head used in these tests was one-tenth of a ft. With these two points fixed, the range was divided into five parts and readings at these different points were taken. At each head, two runs were taken in which as many readings of difference in head submergence were taken as the time to fill the water tank allowed. The tank had a capacity of approximately 1300 lbs. of water. The initial and final weights, together with the time, were recorded for each discharge.

The first run was made with the seats alone and without the air drums. Great difficulty in reading the gages was experienced on account of the fluctuations in all three gages. At times the fluctuation on the submergence gage was more than one ft. A test for average readings was tried on all three gages with the valves nearly closed, but in each case this average did not correspond to the true average with the valves open.

To overcome the difficulty, air drums were made, as before mentioned (shown by Fig. 1). Since the greatest fluctuation was noted on the down-stream side of the differential gage, a drum was made of three and one-half-inch pipe, about five and one-half feet long, while two drums of two-inch pipe were used on the other two gages. These drums reduced the fluctuations in almost every instance to one-tenth of a foot.

Under these new conditions, the runs were started with openings varying by eighths of an inch: from one-eighth of an inch to seven-eighths of an inch. In the first run the wedges between the yoke and the stud were not used, but in the following run the wedges were used and the opening calipered at quarter points and an average opening calculated to the nearest one-sixty-fourth of an inch. ....

The second series of runs, similar in every respect to the first set, were made with a single valve, the other two seats blocked on the upstream side with wood. The valve in this series of runs was placed on the horizontal diameter of the valve deck. No reading of the valve seat alone was taken.

Valve Opening 7/8 inches — *Circumferential Area 0.0572 sq. ft.*

Run Number	Actual Discharge	Difference in Head	Depth of Submergence	Co-efficient of Discharge
45a	.393	3.62	3.11	.448
45b	.390	3.61	3.10	.447
46a	.353	3.02	3.09	.445
46b	.349	2.94	3.28	.442
47a	.318	2.26	3.07	.463
47b	.301	2.21	3.17	.442
48a	.219	1.10	3.20	.453
48b	.220	1.11	3.19	.458
49a	.0746	0.14	3.13	.434
49a	.0755	0.14	3.12	.438

Valve Opening 3/4 inches — *Circumferential Area 0.049 sq. ft.*

50a	.380	3.80	3.20	.476
50b	.376	3.81	3.20	.465
51a	.266	1.92	3.20	.482
51b	.267	.192	3.20	.485
52a	.341	2.99	3.26	.497
52b	.344	2.98	3.28	.501
53a	.194	1.05	3.20	.472
53b	.194	1.02	3.22	.472
54	.071	0.15	3.27	.455

METHODS OF CALCULATION.

From the data* taken in these runs, the coefficient of discharge was computed in the following manner: the theoretical discharge in cubic ft. per second was calculated from the formula, $Q=A(2gh)^{1/2}$ where

Q=discharge in cubic ft. per second

A=circumferential area in sq. ft.

h=difference in head.

The circumferential area in sq. ft. was the product of the circumference of the inner diameter of contact between valve and seat and the valve opening.

The actual discharge was computed by dividing the discharge in lbs. by 62.5, and the time in seconds. The ratio of the actual discharge to the theoretical discharge gives the coefficient.

DISCUSSION OF CURVES.

From the data and computations of each valve opening, points were plotted for each relation, as shown by a single run, between head and corresponding coefficient. In nearly every run, two points at a given head were thus obtained. Through the average of these two points a dotted curve was drawn to represent results of data alone, the ordinates being head in ft. and abscissae the coefficient.

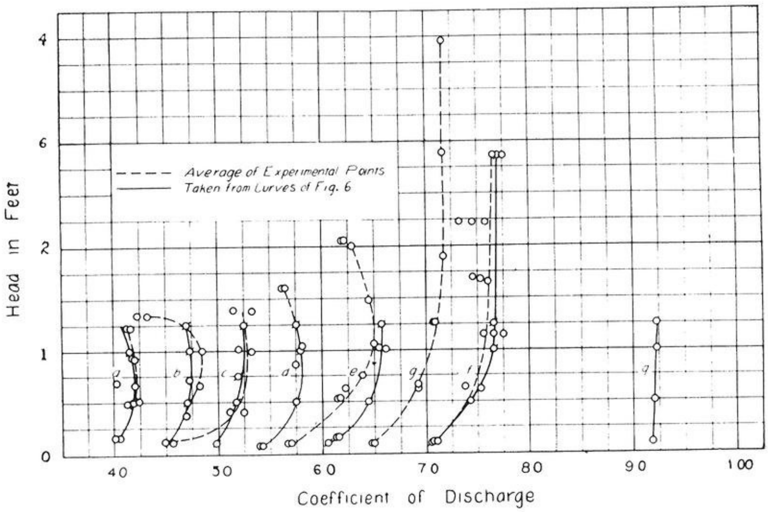


FIG. 4.

From these average points, correction curves were drawn in the following manner: at several given heads the values of the coefficient were determined from figs. 4 and 5 for each opening, and points were plotted with openings of valve as ordinates and coefficient as abscissae. (See Fig. 6.)

Points were then determined at these several heads for each opening plotted on the original sheet of curves and a solid curve drawn through them.

In the runs with the three valves, the curve from the data for the one-eighth-inch opening was found not to correspond with the apparent law of the curves. It appeared that the coefficient increased with increasing head, and decreased with increasing opening. This fact caused the curves to be placed proportionately. Since the one-eighth-inch curve fell between the one-fourth-inch and three-eight-inch curves, and no position was determined for it by the correction curve, this fact can be attributed to faulty measurement of the circumferential opening, and the absence of blocks to keep the opening constant.

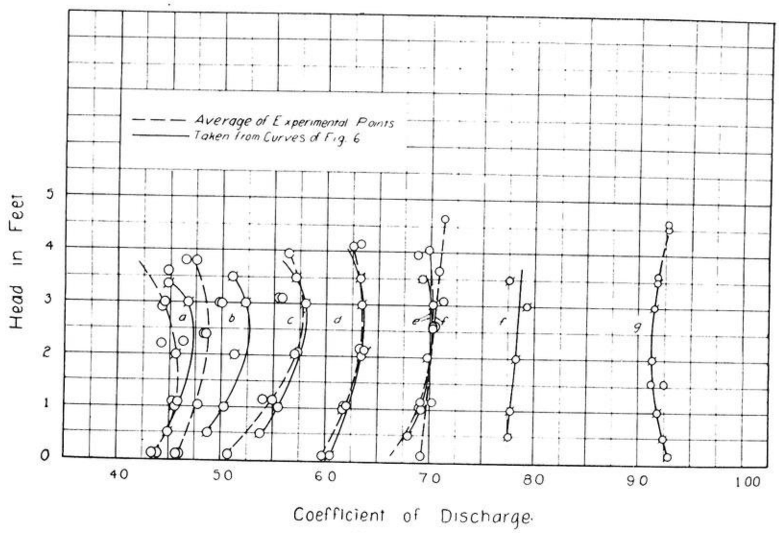


FIG. 5.

With the single valve it was noticed that the results of two openings appeared to be incorrect. These were the three-fourth and one-fourth-inch. From the correction curve, the approximate relation was established. One peculiarity not noticed in the three valves was apparent with the single valve. The one-fourth-inch opening was practically a straight line, while the one-eight-inch opening had a curvature reversed from the other runs. In this curve the variation in coefficient was less than 1%, indicating that the coefficient at this opening was entirely independent of the head.

A comparison between the single valve and three valve coefficients, shows that the single valve is slightly higher in every case than that of the three valves. This fact may or not be typical and can only be proved by an average coefficient of the results of the three valves tested separately.

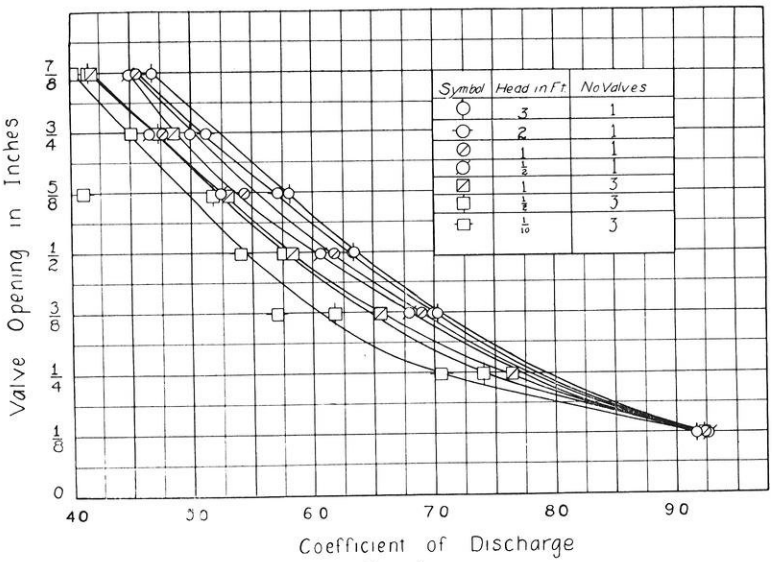


FIG. 6.

CONCLUSIONS.

In brief it may be concluded that the coefficient is dependent upon the opening of the valve and upon the difference in pressure above and below. The coefficient increases with decrease in opening and for a given opening with increase of head.

For the larger openings, the variation of the coefficient with change of head is much greater than for the smaller.

The coefficient is influenced more by the variation in opening than by the variation in head for the range of the experiment. The greatest variation of coefficient with varying head at a single opening is approximately 3% for single valve, and 7½% for three valves, while the range of variation with varying openings is from .43 to .93 with single valve and from .403 to .93 with three valves.

Up to the present time no data has been obtainable concerning the losses in commercial pump valves. The results of these experiments show what factors affect these losses, and how large we may expect them to be for this type of valve.

MANUFACTURE OF HIGH TENSION INSULATORS

Revised by F. A. KARTAK.

Probably the thing which more than anything else in recent years influenced the enormous development of central stations was the possibility of transmitting power over great distances, by high tension transmission lines. The distance over which power could formerly be transmitted by low voltage systems had been very limited, since the line losses were too great. With the development of the high tension systems, the type of line insulator had to be improved on, since the old, low voltage type could not safely withstand the excessive strain imposed on it by the high tension voltage.

A line insulator must in general possess two principal inherent characteristics. In the first place, it must be made of such material as to embody a high dielectric strength. Without this characteristic, it would break down under the high voltage. In the second place, the mechanical strength of the insulator must also be very high, in order to withstand the excessive strain to which it is exposed, because of the weight of wire, ice, wind load, etc.

The best kind of insulators are those made of porcelain. Porcelain is commonly divided into two distinct classes: namely, hard or natural porcelain and artificial porcelain. Artificial porcelain is of an inferior grade, being only used on low voltage systems, and does therefore not properly come into this discussion.

True, or natural porcelain, consists essentially of four materials—kaolin (hydrated aluminum silicate), clay (alumina), quartz, and a fusible silicate, such as feldspar. The chemical name of true porcelain is potassium aluminum silicate. It is expressed by the formula ($K_2\,O\,A\,1_2\,O_3\,Si\,O_2$). Kaolin forms an infusible body, which is made plastic by the addition of clay. The purpose of adding quartz is to prevent excessive shrinking. The feldspar is an infusible material that holds the quartz and kaolin together.

The four materials just named are mixed together, and then raised to a temperature high enough to melt the feldspar and permit it to unite the particles of quartz and kaolin. By this process a homegeneous body of uniform mechanical and electrical strength is formed, which is suitable for line insulators on high tension systems.

In writing this article, I will deal with the manufacture of high tension insulators in a general way, so as to give the reader information on the subject in a broad sense.

Having briefly considered some of the fundamental characteristics that a high tension insulator must possess, I will next take up the first process in the manufacture of insulators, namely, that of preparing the material. But before going into the discussion of the actual process of preparing the material, it would probably be better, for the sake of clearness, to consider the state in which the raw materials are found, and a brief discussion of their formation.

Kaolin, more commonly referred to in the porcelain industry as china clay, is formed by the weathering action of water on feld-spathic rock. The water containing slight traces of carbonic acid, converts the potassium silicate in the rock to potassium carbonate; the latter on being washed to lower levels is deposited in beds, as alumina silicate or kaolin. These kaolin beds naturally contain considerable proportions of impurities, which have to be removed. Several methods are employed for this purpurpose.

One method consists in digging the kaolin out of the beds, and breaking it up into fine particles, as much as possible. The kaolin clay is then washed in a stream near the mine. After the washing, the particles are allowed to settle, after which the water is drained off by some arrangement.

Sometimes another method is used, one which is perhaps more economical and at the same time equally as effective as the first method. In this method large areas of the clay banks are exposed to the action of frost and thaw, for it has been found that the successive action of these elements will satisfactorily disintegrate the clay bank. The disintegrated particles are then washed as before, in the other process.

Plastic clay, or the second material entering into the composition of porcelain, is also found in the natural state in clay banks, as alumina. Like kaolin, it is formed by the weathering of rocks by water. The chief characteristic of this kind of clay is that it is more plastic than kaolin; this fact making it a very desirable element in the composition of porcelain, inasmuch as it unites the other materials together. The clay is dug from the banks, where it has been deposited, and it is then washed by a process similar to that described for kaolin. After the washing, this clay is also ready for the final mixing process. In connection with this subject, it might be well to mention the fact that some manufacturers endeavored to omit plastic clay in the porcelain manufacture. The result was just what might be expected. Electrically this kind of porcelain was equal to that of the other kind containing plastic clay, but mechanically it was found to be very brittle.

Quartz, known chemically as silicon dioxide is found in the raw state, in rock quarries. The rock is quarried, and ground to a fine powder in mills and heavy stamps. The function of quartz is entirely different from that of the two elements mentioned previously. It acts in the same capacity as the bones of a human body; that is, it gives the insulator rigidity. In this way quartz prevents excessive breaking and shrinking of insulators.

Feldspar also occurs in nature as a silicate rock, and like quartz is quarried and ground directly at the spot where it is found. The function of feldspar in porcelain is to provide a fusible element, which when heated to a vitrifying temperature, will unite the other ingredients.

Up to this point, I have confined myself to a discussion of the preparation of the individual materials that compose porcelain. The next step will be the preparation of the material in the main factory.

The separate materials arrive at the porcelain factory in the form of fine powders. These powders are now mixed with water, and the mixture is stirred by a machine called a "blunger." This machine consists essentially of a large tank, which is mounted on rockers, so that a translatory motion can be imparted to it by means of a power driven eccentric. After the mixture has been thoroughly stirred, it is passed over a rocking screen. This screen is composed of 37 gauge brass wire, and has a number 50 mesh. The purpose of the screen is to remove such impurities as can be removed by screening, but it will not remove small particles of iron, which are always present in the mixture. Since the presence of iron in the porcelain will greatly decrease the dielectric strength of the insulator, the removal of this form of impurity is especially important. For this purpose, a very ingenious device consisting of a row of magnets at the bottom of the screen has been invented. The magnets draw the iron impurities from the rest of the mixture, thereby leaving the mixture free from this undesirable form of impurity. Both permanent and electromagnets are used, but from an economical standpoint, the permanent magnet is the more desirable, because it does not require a separate exciting current.

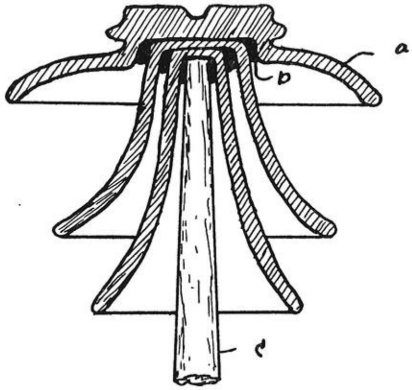
With the impurities removed, the mixture is put into a large cistern, where it is constantly agitated by means of a mechanically driven stirrer, so as to keep the clay from settling.

The next step in the process of manufacture is to draw off the water by means of a filter press. The press consists of a rack containing rows of cast-iron plates, with canvas bags stretched across the intervening space between consecutive rows of plates. Each plate contains a hole in the center, through which the wet mixture is forced by means of a pump. As the mixture comes through these holes it enters a large box, of about twenty-five cubic feet capacity. This box soon fills up with the mixture, and as the latter is compressed, the water in it is forced through the canvas bags, leaving the rest of the material in a fairly dry state. An interesting thing in connection with this part of the process is the fact that the plungers of the pumps are made out of porcelain, so that the material worn off by friction will not affect the conductive properties of the finished insulator.

The final step in the preparation of the material is to remove bubbles of air that are entrailed in the mixture. This is accomplished by means of a "pug mill," which consists essentially of a die through which the material is forced. The mixture is now ready for the next step in the manufacture, namely, that of forming the material.

Before taking up this phase of the subject, it would probably be well, in order to make the process clearer, to discuss briefly the conditions that determine the shape of an insulator. Porcelain insulator manufacturers have found that the thickness of a porcelain insulator shell cannot very well exceed five-eighths of an inch; the reason for this is that, for thicknesses beyond this limit, flaws and cracks will develop during the process of drying. In order, therefore, to gain the necessary thickness for the high dielectric strength necessary, the insulator must be made up of several shells which are cemented together.

Wet weather conditions also determine what the shape of an insulator should be, because the conductive properties of a surface are greatly increased if the surface is covered with a film of water. The insulator must therefore be designed with the aim of eliminating as much of this wetted surface as possible. The accompanying diagram shows a typical kind of insulator, known as the petticoat type of pin insulator. The cross hatched parts show the porcelain shells which are cemented together, and are of uniform thickness. The curved surfaces of the shells, and the manner in which they fit together prevents excessive wetting of the inner shells during a rainstorm.



Petticoat Type of Pin Insulator.

Having now considered the conditions that determine the shape and size of an insulator, I will next proceed with the process of forming the shells. There are in general two processes employed: namely, the dry process, and the wet process.

The dry process consists in forcing the material into a mold corresponding to the shape of the insulator. This process requires the materials to be worked in a fairly dry state, and consequently the character of the porcelain is not so good. The dry process is only used in the manufacture of low voltage insulators, and a further discussion is therefore not necessary in this article.

The wet process produces a high grade of porcelain and is therefore used exclusively for high tension ware. The first step in this process consists in making a rough model of an insulator shell, by means of a machine called the ''potters wheel.'' This machine consists mainly of three essential parts: a revolving table turning horizontally, a mold corresponding to the outside surface of the shell, and a stationary tool which corresponds to the inside surface of the shell. The table rotates at from 60 to 150 r. p. m., the speed being controlled by means of two friction cones underneath the table. The mold is fastened on the revolving table, so that the motion of the inside surface of the mold is concentric with that of the table. The shape of the stationary tool conforms with that of the inside of the shell. This stationary tool can be adjusted so that when it is in its final position, the area between it and the inside of the mold is equal to the area of the cross section of a shell. The process of forming a shell, consists in partly filling the mold with the plastic mixture, and then bringing the speed of the table to the correct value by means of the friction cones. The stationary tool is next adjusted to its final position, so that after a few revolutions of the table, the rough model of the shell is completed. The model at this stage of the manufacture is still saturated with water, and in order to remove it, the model together with the mold is taken to a drying room. This room is kept at about 130° Fahrenheit, and the time required for drying is about an hour. At the end of this period, the shell (by which name I will call the model now) has shrunk sufficiently to allow it to be removed from the mold. At this point it might be well to mention the fact that during the entire drying and finding processes, the original shell will shrink about 15 per cent. This undesirable feature is however offset by making the mold this per cent larger.

The shell is however very rough yet, and the net process consists in smoothing the outside surface in a lathe. The shell is clamped in a chuck, and the rough surface is taken off by means of a tool of special design. The shell is now ready for the second drying process.

Since the quality of the porcelain depends greatly on whether or not all the moisture in it is removed before firing, the process of drying, although not necessarily involved, is still a very important one. The importance of drying will become evident, when we realize that the slightest trace of moisture will cause cracks to appear in the porcelain: this would make the insulator worth less.

The drying room contains long rows of shelves, upon which the shells are placed, and is heated by steam in coils of piping. Besides the steam pipes, some artificial circulation of air must be provided in the room, so that the moisture will not condense on the cool surfaces of the shells. The time required for thoroughly drying the shells is about three weeks, although the time varies considerably with the size of the shell. At the end of this period the shells are carefully examined for cracks and flaws, and if any are found the shells containing them are condemned, while the others are ready for glazing.

The purpose of glazing is twofold: In the first place, the surface of the shell would be extremely rough after the firing process, and would gather dirt very easily. The glaze puts a smooth exterior on the shell and thereby keeps it free from dust.

The other purpose of glazing is to color the shell. This last purpose probably does not appear as very important, since it might seem that the natural white color of the unglazed insulator would make a very good appearance. The idea however is not to make a good appearance, but, on the contrary, to make the insulator as unnoticeable as possible, so as to reduce the number of insulators that are broken mischieviously. The importance of this statement will become evident, when I mention the fact that on two lines, one with white and the other with brown insulators, the percentage breakage in the former was considerably higher.

Glazes are usually of three classes: namely, the soft fire glaze, the hard fire glaze, and a combination of the two known as the white ware glaze. I will first take up the different kind of glazes and discuss their relative merits, and in what respect they are, and are not, adapted for high tension insulator work.

Soft fire glaze consists of a mixture of lead oxide and silica. There are two serious objections to this kind of a glaze. In the first place, the glaze does not have the same coefficient of expansion that porcelain has; consequently cracks will appear after heating. In the second place, this glaze is attacked by the weather. The soft fire glaze is therefore not suitable for high tension insulators.

The white fire glaze is similar to the soft fire glaze; it contains only a smaller proportion of lead. It has the same characteristics that soft fire glaze has, and is therefore not suitable for this work.

The hard fire glaze consists of silica and kaolin together with a suitable flux. This kind of glaze has the same coefficient of expansion that porcelain has. Besides this feature, it is not attacked by the weather, which makes it a very desirable glaze for outdoor work.

The process of glazing consists in dipping the insulator in a solution of the glazing material, and then drying it again. The drying is done in rooms heated by steam pipes, similar to those used in the other drying processes. The insulator shells are now ready for firing.

The firing of the shells is done in circular kilns, which are lined with firebrick. The fires are usually built in fire boxes located in the sides of the kiln. Before discussing the firing process, it might be profitable to discuss briefly the fuels that are available and adapted for this part of the manufacture.

Coal is probably used more frequently than any other fuel. The reasons for using coal are because of its high heating value and its comparatively low cost. A long flaming coal is usually preferred.

Wood is a fuel that is rarely used at present. The chief objection to using wood is its high cost.

A mixture of coke and coal is sometimes used, but it is not very satisfactory fuel, as the mixture burns with a low flame.

Besides the fuels just mentioned, there are two new fuels that are being experimented with at present, namely, producer gas and oils. Since these fuels are still in the experimental stage it would be difficult to pass any criticism on their merits.

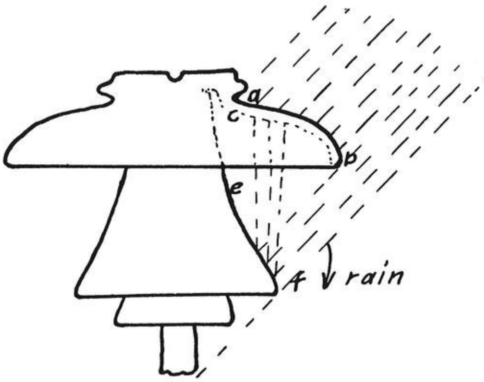
Having considered the fuels, I will now proceed with the firing process. The insulators are placed inside of large clay pots, called "saggers". These "saggers" are piled inside of the kiln, and the entrances are bricked up. The fires are then lit, and the temperature is raised gradually, so as to drive off anp moisture that still remains in the shells. It is very important that the temperature should be raised gradually, as sometimes as much as ten percent of water is present in the shells. After the moisture has all been driven off, the temperature is raised to about 2400°F. At this temperature the feldspar fuses and unites with the quartz and kaolin, thereby forming a homogeneous mass. This maximum temperature is maintained for a few hours, during which time the condition of the ware is examined from time to time by drawing small samples from the kiln. When enough heat has been given to the porcelain, the fires are extinguished, and the kiln allowed to cool slowly. It is very important that the ware should cool slowly, because a rapid cooling will cause cracks and flaws in the porcelain. After the porcelain has become cool, it is ready for testing.

The first test that is made on the shells consists of a mechanical test. The purpose of such a test is to determine whether the insulator possesses sufficient mechanical strength to withstand the loads to which it will be subjected from the weight of wire, wind, ice, etc. The mechanical test is usually not a very elaborate one, as it consists only in a test of samples in a testing machine. The necessary compressive strength of the porcelain is 15,000 pounds per square inch, while the tensile strength must be 2,000 pounds per square inch.

In taking up the other test, or the electrical test, I will first discuss the way an insulator breaks down, both under normal and abnormal conditions, and the final effect of the design on these conditions.

Suppose we consider a particular insulator upon which the voltage is gradually increased. As the pressure increases, a point is reached in the pressure, although considerably less than the final breakdown voltage, at which a small current begins to flow between the wire and the support of the insulator. This current is a charging current, which flows into the insulator as a condenser. This charging current is not serious as it represents a very small energy loss. Suppose now that the potential increased to a higher value. Either one or the other of two things will happen. If the dielectric strength of the porcelain shell is too low, the voltage will break down the shell. On the other hand, if the dielectric strength is high enough, a brush discharge will take place over the surface of the insulator. This brush discharge consists of a rupturing of the film of air adjacent to the surface of the shells, by the high electrostatic strain imposed upon the air at this point. A brush discharge is very serious, because it tends to increase after it once gets started.

Having considered the breakdown of an insulator under normal conditions, I will next take up the breakdown under abnormal, or wet weather conditions. Probably the worst conditions to which a line insulator can be subjected, are a driving rain or



Insulator in Rain.

a heavy drizzle. The strain upon the insulator during wet weather is further increased by the fact that rain seldom comes down vertically, but usually comes at an angle. In the following diagram is given a petticoat type of insulator. Assuming the rain to come at the angle indicated, the surface (a b) will become wet first, which brings the potential of the line to this point. A certain amount of water will get past the first shell, and strike the second on the surface (e d). Some of the water striking on (e d) will spatter upward and wet the surface (c b), which brings the line potential to the point (c). Beyond this point, the path for the potential is broken since there are no other surfaces from which the water can spatter. From this brief discussion it can be easily seen that the strain on the middle shell is very high during a severe rain storm, a fact which must be considered in designing a line insulator.

With this discussion in mind, I will next explain the electrical tests as performed in the factories. In order to understand the test better, I have included the following diagram of connections, as are used in practice.

A=Alternator
V=Voltmeter
N=Needle Gap
In=Instrument Transformer
T=Auto-Transformer
I=Insulator
P=Needle Gap

The testing table consists of a long bench, which is insulated from the floor by means of porcelain legs. On the top of the table are a series of shallow pans partially filled with water.

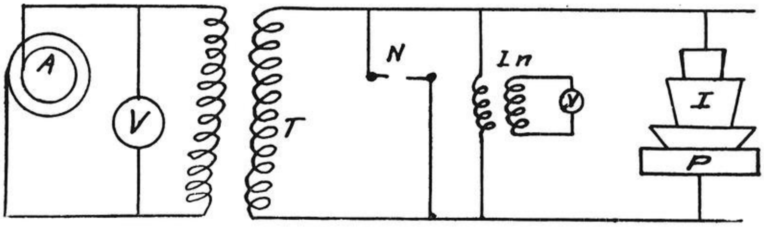


Diagram of Test Connections.

Each pan is connected electrically with a high tension wire which is embedded in the top of the table. The other high tension wire is suspended horizontally about a foot above the top of the table. Before going further with the test, I want to mention the fact that the different shells composing a complete insulator are cemented together while on the testing table and just previous to the time the voltage is impressed. The reason for doing the cementing at this time is that in case one of the shells is found defective, it can be removed from the rest of the insulator before the cement has set. The insulator after cementing is placed with the top end in the basin of water, the water serving as one terminal. The inside shell is next filled with water and connected by means of a wire to the other high tension wire I referred to before. The water in the inner shell serves as the second terminal of the high tension system. The voltage is next increased by means of an auto-transformer to such a value as the test conditions require. The insulators that stand the test are now ready for service, while the defective ones are discarded.

The Wisconsin Engineer.

EDITORIALS

We do not believe in blowing our own horn, so whatever sounds you hear are just those that get past our best efforts at inhibition. Occasionally, however, our Engineering College does make such a noise that every body has to take notice, and that's what it has done again. Most of the stir that was created at the last national convention of the A. S. M. E. was caused by experiments conducted by men connected with our college. "A Test on Bearing Losses" by Maurer, Thomas, and Kelso perhaps created the biggest stir of all. The "Pitot Tube Experiments" by Rowse (formerly of our steam and gas department) also created a big stir. Prof. Christie was down and helped shoot off the fire-works. The paper on the "Thomas Gas Meter" by our own Prof. Thomas made a fitting climax for this thoroughly Wisconsin convention. No other group of men seemed to share anything like the interest which the results of the Wisconsin experiments aroused. These are some of the things that make it worth while to be an undergraduate or alumnus in this University, and for the work that has been done by these and other departments, we feel that we have reason to be proud.

* * *

At the first meeting of the Student Conference last fall a resolution was passed requiring all Freshmen to wear a green button and prohibiting them from entering a saloon. Much opposition has been brought against the enforcement of this ruling. The chief cause for opposition seems to be that the freshmen dislike to be labeled. The Wisconsin Engineer considers the button a good thing. We believe it convenient and fitting that we have a means of recognizing members of this class during the period when they are not required to wear their green caps. The idea of a class button is a good one. We wouldn't mind wearing a little button indicating our class, or better yet we advocate a button for all engineers. Not a big badge, but a neat modest button that could be worn in the lapel and which could be kept standard for years. The opposition against the button will be strenuous for a short time only, but we hope that the Conference will see that their rulings either are lived up to or repealed.

* * *

We beg to say that the article in our December issue, "A Fuel Saving Device For Oil Engines" should have been credited to M. E. Chandler, '13 and E. K. Morgan, '13, and not as given in the introduction to that article.

DOING THINGS EXACTLY RIGHT.

We made the statement last year that you could count, on the fingers of one hand, the number of students in the Engineering School that could be depended upon to always do just exactly what they were supposed to do. No one has ever questioned or refuted that statement,—at least not to our knowledge. We mentioned some of our experiences to one of our Professors the other day and said that we were going to write another editorial on the matter. He said, "Yes, and have it set up in big, black capitals."

It is no wonder that so many business firms refuse to have college graduates in their employ. After sixteen years, or more, in school, and working at an average of seventy per cent efficiency the man has developed habits that must be almost unchangeable. Work only partially done, or never done, work put off and late, and a tendency to do as little as possible instead of as much as possible for a given reward or credit is too often the result.

We start a new semester soon. Look the matter in the face and see if you can't get your problems, notes and reports in on time,—and get them right. We excuse ignorance or mis-understanding but carelessness will not be pardoned. We hope some of our instructors will see this editorial and help us along by being more strict about such things and not so lenient. We have from no less an authority than the general manager of the largest privately owned Elevated Railway in the United States, that dependability in a man is worth 99 per cent and ability 1 per cent. You may not agree with him, but you must admit that there is something in it or he wouldn't be where he is to day.

* * *

We would rather not mention financial matters in the editorial columns, but we still have quite a few unpaid subscriptions. We send the fourth bill with this issue, and we believe that should be enough. After Feb. 1st the subscription will be $1.25.

DEPARTMENTAL NOTES.

Without appearing to be personal—what are you going to do when you get through, Mr. Senior? To those who graduate this year, such a question seems strangely familiar. It sort of falls right in along the line of thought that they have been percolating for the last few months. And, believe me, it is a serious proposition. Along with which heavy thought comes the idea that the geek who knows what he is going to do is the original wise guy who can specialize for that particular trade during the one remaining semester of college career. Hamlet's famous soliloquy on existence has hardly got our own little riddle cheated. It is a big thing—this going out and choosing a profession much as one would take a wife—for better or for worse—and the long-headed boy gets next to the smoothest proposition usually. Not being a self-made man, we are in no position to advise the callow youth of 1914, but we do sit back and put our feet on our mahogany desk as we quote the words of one who was self-made: "Nothing in this idea of working for experience and a low salary—go after the kale and you'll get the experience along with it."

* * *

And while we think of it, our faith in humanity was shaken the other day when Admiral Dewey described ten to the minus eighth power as "ten to the 'funny sign eight.' "

* * *

This George Ade stuff must be banished from our class rooms.

* * *

And then again Willie Miller makes the line when he whispers "next," as Prof. Goddard calls the roll in Shop 12, and mentions Barber's name.

* * *

We quote from Webster's, "ENGINEER, one skilled in engineering."

* * *

And again, "ENGINEERING, the art of managing engines."

* * *

You get the idea, of course, that anyone who can manage an engine is an engineer. From the definition given one can draw no other conclusions. But once we knew a fellow who managed an engine and he was skilled in the art of managing that engine, too. But he wasn't an engineer. The engine, in this case, was a threshing engine. So filter to the fact that Engineering is an indefinable term, and even more indefinable are the sciences which it embraces. So, get the spirit, you rough-necks, and don't feel down-hearted when you begin to realize how little you know about things, which from the view-point of the outsider, you are supposed to understand.

* * *

Just before going to press we notice on the bulletin board a notice of the plant test. Wherewith we held up the edition a couple of days that we might publish here in livid letters an unvarnished account of the proceedings. 'Twas without avail, however, for the comedy gang was located in the Tunnel and we were taking Indicator Cards on the engine; not only taking them but also planimetering them as well as reading R. P. M.'s Steam-line Pressures, Calorimeters, etc. All in all, we had a swell chance to collect any real dope or to write up any funny situations. In fact the only funny thing we noticed was the way in which the Gang-boss worked. He blew a silver whistle every fifteen minutes and then went out and washed his hands. It's a hard life, eh, Spike?

But to arrive at the point of the argument—it was a good test and if it wasn't for getting up in the middle of the night, we would certainly like to have more of them.

* * *

Before closing, let us announce officially the great coming event—Prof. Beebe's Ampere Hunt. All Seniors are invited to be present. Pat has been catching them in the water-rheostat for the last few weeks and will turn them loose on the Engineering building steps at 6:00 Sunday morning. Automatic shotguns barred.

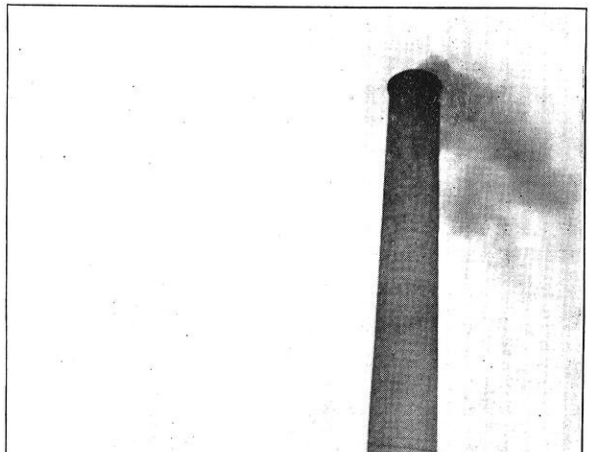
This is a new activity and we want lots of hunters to get out. Entrance fee of $1.00, payable in advance to Spider Young, manager of the Wisconsin Engineer.

* * *

By the way, now is the time to boost the Minstrels. It's your show and people expect a lot. Let's show up the Agrics.

It will be a matter of much interest to both our undergraduates and our alumni to learn that the College of Engineering has recently greatly extended the courses in Highway Engineering, so that hereafter the work in this department will be more in keeping with the importance of highway work to the state.

The new work will include not only advanced courses in the



theory of highway construction, but also laboratory courses for the testing of materials. One course has been arranged especially for agricultural students. For this work the University has equipped a new Highway Engineering Laboratory with all the necessary apparatus required for the testing of both stone and bituminous materials. All of the physical tests will be made in the new highway laboratory in the Engineering Building, while the chemical tests will be made in the Chemical Engineering Department. The department will be, as hitherto, in charge of Professor L. S. Smith. These courses, while intended primarily for Civil Engineers, may also be elected by students in any other university course. A complete statement of these courses is the subject of a new University bulletin, which will be distributed the present month.

The developments of the past few years seem to make certain that Highway Engineering is destined to be one of the most important lines of future engineering work. The failure of thousands of miles of so-called good roads in certain eastern states, due to lack of proper expert supervision, has shown clearly to the country the great importance of the Engineer, both in designing and in superintending country highways and city pavements.

* * *

The faculty gave the engineering students a splendid mixer at the engineering building the middle of last December. Many new and interesting stunts were given, but the most enjoyable of all were the "take-offs" on the various "Profs." The crowd gathered in the Auditorium where slides were thrown on the screen illustrating the "take-off" which was being sung by a double quartet. Perhaps the most pleasing of these are "Bill Kinne Rocks the Cradle," and "Thorky runs the Heating Plant."

Here is the whole jingle.

1. Listen while we sing a rag,
For it's all about the U,
And the smoke goes up the chimney just the same:
If our verses make you glad,
That's just what we want to do,
And the smoke goes up the chimney just the same.

2. Studes that come to study law,
How our hearts go out to those,
And the smoke goes up the chimney just the same.

For they learn to wag their jaw,
What's behind it no one knows,
And the smoke goes up the chimney just the same.

3. Agrics have an easy life,
For they're up at four a. m.
Making smoke go up the chimney if they kin;
That would never do for us,
For we always hate Big Ben,
With his ting a ling a ling a ling a ling.

4. Those that get their's through the mail,
For their emblem have the stamp,
And Dean Reber is their patron saint you see:
After every foot ball game:
They all have the writer's cramp
From the rooting that they've done for Varsity.

5. Home Economy's the course,
Where they study Irish stew,
And they learn to boil the water for the tea?
O we like the pretty cooks and
And we like the cookies too.
Lady fingers are our greatest specialty.

6. Best of all the engineers,
We are loyal men and true,
And the smoke goes up the chimney just the same.
Work with hand and heart and head,
And we work each other too,
Work's the only thing we've had here since we came.

7. Dean Turneaure's a kindly man,
And our profs are kindly men,
And the smoke goes up the chimney just the same:
Just the same we notice that
When the finals come again,
Poor old frosh goes rolling homeward sad and slow.

8. Regents built a heating plant,
For to warm us through and through,
When the frost is thick upon the window pane,
Torky runs the heating plant,
And its run efficient too,
BUT the smoke rolls out the chimney just the same.

9. Bachelor's lives are gay and free,
For they have no yoke to bear,
But the married man is busy all the day:
Now there's Christie and Bob Disque,
Who have no domestic care,
BUT Bill Kinne rocks the cradle night and day.

10. When the seniors go away,
For to take their yearly trip,
Visiting engineering plants,
There is little that they miss in every sight?
But the things they see all day.
Are not in it with the things they see at night.

Professional Cards