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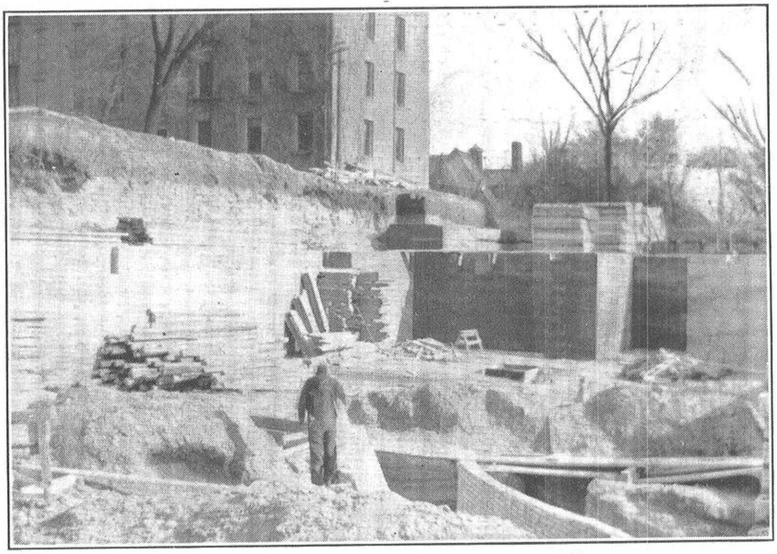
The Wisconsin Engineer



FOUNDATION OF NEW BIOLOGY BUILDING.

DECEMBER, 1910

Volume 15 Number 3

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WISCONSIN ENGINEERING
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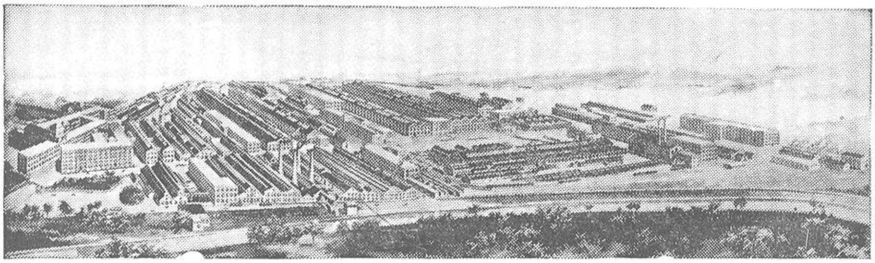

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The Wisconsin Engineer

VOL. XV DECEMBER, 1910 No. 3

THE CASE HARDENING AND HEAT TREATMENT OF LOW CARBON STEELS.

A THESIS BY A. C. SLADKY, '10, AND A. F. SCHULTZ, '10.

ABSTRACTED BY A. C. SLADKY.

For our work we ordered the following machinery steels, 0.10,–0.20% C., 0.20–0.30% C., 0.30–0.40% C., 0.40–0.50% C., low in phosphorous and sulphur, and 0.10% C. with higher phosphorous and sulphur, in open hearth and bessemer stock, and received the following from the mills:

No.	*Heat No.*	*C.*	*Mn.*	*P.*	*S.*
1	D.2366	.10%	.59%	.020%	.039%
2	I.9994	.26	.48	.026	.040
3	D.20028	.40	.58	.034	.037
4	D.2283	.45	.53	.032	.033
5	H.1778	.12	.63	.030	.029

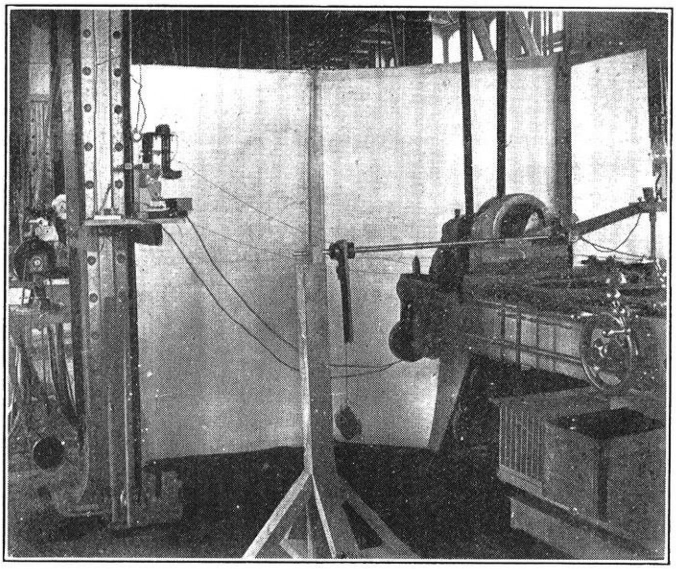
Through some error the bessemer bars were not received. This assortment of steels gave an opportunity to determine what percentage of carbon will give the best results with case-hardening and heat-treatment.

The steels were tested under static and live loads. For the static-loading a 100,000 lb. Riehle testing machine was used, and data recorded for yield point, ultimate, elongation and reduction in area. For the live loads a fatigue machine was designed and built by ourselves which by means of a crank motion, subjected the specimens to reversals of stress about the neutral axis.

EDITOR'S NOTE.—Mr. Sladky's article was begun in the November number.

Regarding the conditions of stressing the specimens in the fatigue machine, there were two courses open. The specimens could be broken with the machine set at a standard deflection, or the deflection varied under a standard load. We chose the latter as representing more nearly actual working conditions in machine members subjected to vibration.

Machines are designed to do a certain amount of work. Conditions of load, speed, etc., are predetermined or they may be



Machine Used in Tests.

fixed. A certain load on a certain machine member made of one steel will cause a certain deflection; if the member be made of a different steel or a steel specially treated, the deflection may vary. One kind of steel would perhaps stand up indefinitely with a certain deflection, while another steel would fail quickly with that same deflection. Taking these facts into consideration we felt justified in using the standard load and allowing the deflection to vary.

The accompanying cut shows the fatigue machine mounted on a Pratt and Whitney lathe in the University shop. It consists of a crankhead through the center of which a T-slot is cut. An adjustable crank pin is fitted in this slot and is fastened in position after the bar is deflected by means of a washer and nut. A heavy steel bar is clamped to the lathe ways, and the lower end of the specimen clamped in an upright position by means of a V-clamp. Motion is imparted from the crank head to the upper end of the specimen by means of a connecting rod. The head block of the connecting rod is fitted with an adjustable wedge to allow for the angularity of the motion and difference in size of the specimens, so as to obtain an equal deflection on either side

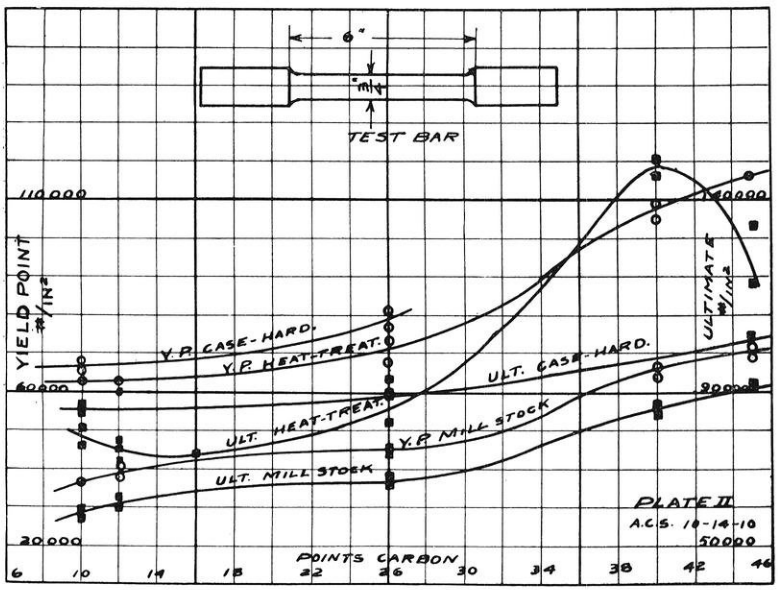


Plate 2.—Showing Yield Points.

of the axis of the test bar. The screw, fitted with a ratchet and weight arm, which is seen in the foreground is used to deflect the bar. The bar is loaded with the screw by means of the weight until the weight arm remains in a horizontal position. The conditions of friction in the ratchet and screw remain practically constant, and will not affect the equality of loading. Assuming the efficiency of the screw to be 20%, the load on the bar is approximately 350 lbs. It is not necessary to take this load into account so long as the bars are being loaded equally.

The mechanism fastened to the post on the left of the cut is an electrically operated revolution counter release which cuts out the counter when the bar breaks. The hook and rod seen on the head block of the connecting rod is merely a weight used to lift the broken bar from the bed block to insure a break in the electric circuit of which the bar is a part, and to prevent damage to the apparatus. While this weight subjects the bar to about 150 lbs. to the square inch tension, it is constant, and inasmuch as the results are comparative only, its effect may be neglected.

The case-hardened bars were carbonized in a Brown and Sharpe carbonizing furnace equipped with a nickel-nichrome thermocouple to indicate the temperatures. The specimens were packed in charcoal, and were given two heat treatments as described in the body of the thesis.

The results of experiments follows:

Stock No.	1	2	3	4	5
		Yield point lb. 1 sq. in.			
Mill stock	38000	45350	64400	70100	39650
	37750	45150	64750	69700	40150
Case hardened	68100	81700	.....	.....	64000
	66000	77100	.....	.....	66900
Heat treated	66600	68200	104300	116400	63000
	63150	73150	109400	93000	63000
		Ultimate strength lb. 1 sq. in.			
Mill stock	58250	67350	86500	98100	61650
	58700	66350	84800	90700	61900
Case hardened	86500	88600	98500	103000	77600
	85800	93300	.....	.....	90300
Heat treated	81000	92700	146800	133600	72600
	75800	99650	149800	117800	76200
		Per cent. Elongation in 5 in.			
Mill stock	36.4	28.4	26.4	22.0	30.0
	34.0	30.0	26.0	22.8	29.8
Case hardened	30.0	5.0	.....	.....	1.0
	30.	4.8	.....	.....	7.0
Heat treated	12.0	16.4	8.0	.....	25.0
	12.6	15.0	4.0	12.0	18.0
		Per cent. reduction in area.			
Mill stock	64.0	53.6	48.2	48.2	70.0
	70.0	59.1	48.2	48.2	70.1
Case hardened	71.6	.....	.....	.....	.....
	70.8	9.6	.....	.....	40.2

Heat treated	71.6	62.4	53.8	.....	70.0
	70.8	65.6	36.0	53.8	71.6
	Fatigue tests—Complete vibrations.				
Mill stock	2204	13037	15661	19871	12281
	2593	10987	11507	18047	7877
Case hardened	6267	26655	101603	148834	.....
	9505	63989	.....	.....	.....
Heat treated	12298	142833	135669	115840	12748
	18225	120101	89276	.....	17567

CONCLUSIONS.

The results of our experiments warrant the conclusion that heat-treatment and case-hardening greatly benefit the strength of steel both under static and live loads. For purposes where a hard surface and high strength are desirable, the steel should be case-hardened, but the steel used should be low in carbon, not exceeding 0.20%. Steel with carbon exceeding this amount becomes too brittle when quenched, as is shown by the small reduction in area and elongation. In some cases our results show considerable difference between the yield point and the ultimate, with practically no reduction in area and with little elongation. This is due to the fact that the hard steel ruptures first and is followed by the yielding of the softer core. Invariably the case-hardened bars showed surface cracks over the entire length of the bar when broken under static loading. Heat-treatment, on the other hand, increases the strength of the bar, without hardening it to any extent, and at the same time not materially lessening the reduction in area or elongation. It is moreover a less costly operation, and when the hard surface may be dispensed with, may well be used instead of case-hardening.

The surprising increase in strength and resistance to fatigue shown by the heat treated bars, shows clearly that the possibilities of carbon steels have by no means been exhausted, and seems to indicate that if the same time, care, and expense that are spent on the treatment of special steels were similarly spent on carbon steels, there would not be much difference in the results.

In these experiments a bar such as is shown on Plate 2 was used for all the tests. The rough bars were turned from 1⅛ to 1 inch. The minimum diameter was ¾ inch, the distance between shoulders 6 inches. In any future work this form of bar should positively not be used for the fatigue tests for the following reasons. However carefully the bars are turned at the shoulder, there will be more or less difference in the radius of the fillet, and consequently a difference in the length of the moment arm. Another objection is the fact that it is difficult to turn a perfect fillet, and there are chances that lines of rupture will be present that will affect the results. Also, this form of bar is

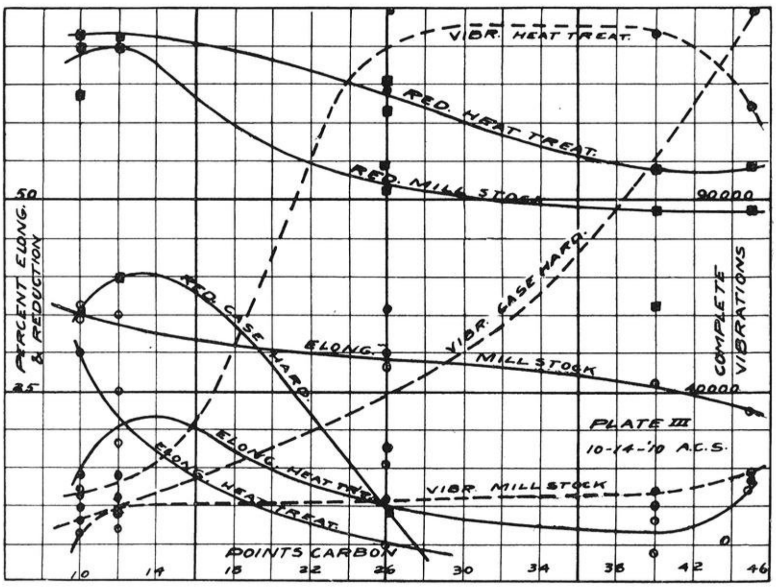


Plate 3.—Showing Per Cent of Elongation.

too expensive, both as regards cost of material and cost of making. Straight, turned bars should be used, preferably not less than ½″ in finished diameter.

Writer's note:—The writer acknowledges indebtedness to Mr. Aston of the Chemical Engineering department, Mr. W. G. Lottes of the University Machine Shops, and Mr. Chas. Wesely, Milwaukee, Wis., for many valuable suggestions and much help during the time the experiments were being made.

THE HISTORY AND ECONOMICS OF CENTRAL STATION RATE MAKING.

M. D. Cooper, '08.

In the commercial world of today, electricity plays a very important part. Nobody knows just what electricity is, but scientists and engineers know what it can be made to do. When properly controlled, it can be made to do any number of marvelous feats and perform all manner of work.

The multitude of uses to which electricity has been put has led to the installation of an enormous number of plants for generating current. Some plants are owned by street railway companies and generate current for these railways only, others are installed for delivering light and power in large buildings or factories, and are called "isolated plants," and a large number are operated as commercial enterprises, selling current to individuals or corporations at retail or wholesale. This latter class are called central stations, and while they may not be as large a class in numbers as some of the others, yet it is safe to say that central stations generate more than half of the electric power used in the country.

As engineers, we are interested in the central station industry mainly from the operating or technical side. The best talent of the age has been devoted to the perfection of generating machinery and methods of using it, and remarkable results have been attained in increasing the economy of the consumption of fuel, the transformation of heat into electrical energy, and in the transformation and transmission of electricity.

Technical men are perhaps too much inclined to think that the main feature in securing economy of operation of an electric station as a whole is to secure the maximum possible amount of electrical engery from a given amount of coal, or the maximum number of kilowatt hours per pound of coal burned. Boiler, engine, and generator efficiency are most assuredly prime elements in the economy of operation, but they can be over-estimated. Even in the plant itself, other costs are involved besides the cost of fuel, such as fixed charges on plant investment, depreciation on machinery, etc. In tracing costs from the coal pile to the customer, the plant expenses end at the switchboard, and up to this point but a small part of the total cost of rendering electrical service has been incurred. Beyond the switchboard are encountered the costs of transmission and distribution—largely fixed costs depending upon the investment in distributing system—and the costs of utilization, such as repairs to customers' apparatus, renewal of lamps, meter reading, billing, etc. Add to all these the expenses of the general office, the salaries of the management, and the expense incurred in securing new business—advertising, soliciting, etc.—and it can be readily seen that the fuel expense and fuel economy are not as important items in the operation of a central station as they are sometimes thought to be.

The successful operation of a generating plant depends upon the skill of its operators, but the successful operation of a central station enterprise as a whole depends upon the commercial policies of its management, the mental attitude of its customers and the confidence placed in it by them, hence reverts directly to the system of charging for electrical service.

The history of the development of modern rate systems is very interesting. At the time when electric lighting first became commercially successful, integrating meters were not available, hence electric companies could not charge on a kilowatt hour basis, and had to resort to charging accordingly to the number of lamps installed. At this time, if ever, rates were made "as high as the traffic would stand," or in other words, were based on the size of a customer's pocket book. This original flat rate scheme led to a multitude of abuses—on the part of the customer, in waste of current, and on the part of the company, in changing their rates to obtain new business or hold old business.

The numerous disadvantages of the flat rate scheme led to the invention and perfection of the electolytic ampere-hour meter, which measured the consumption of current by the weight of metal deposited on one of its plates. This type of meter did not find universal use, for it was tedious, inaccurate and costly work to read it.

When alternating current distribution was first introduced, companies had to go back to the flat rates, for no meter was at hand which would operate on this kind of current. In due time, however, the induction type of ampere-hour meter was developed and found considerable application. One main trouble with this type of meter was that it failed to start on less than ten or fifteen per cent. of full load and hence permitted the continuous use of a small current with no charge. Another trouble with the meters was their habit of running slower and slower as time progressed. The accuracy of the induction ampere-hour meter was not much better than 10% and trouble with the jewels and with loss of revenue due to slow meters prevented the adoption of these meters by small companies and forced many large companies to keep desirable customers on a flat rate basis.

The next succeeding campaign in the rate war witnessed the introduction of the integrating watt-hour meter, which was more accurate than any former type of meter and which would register on light loads. The great demand for these meters made possible their manufacture at low cost, and even small companies could afford to use them, so that it was but a few years till flat rates were almost entirely abandoned.

Central station men looked to the meter system of rates as the salvation of the industry, and it was with disappointment that they found that under this system their income was not increasing in proportion to the growth of business. Attempts to solve the mystery directed attention to the fundamental theory of rate making and to the difference between the central station industry and other types of commercial enterprise.

In dealing with most commodities a charge for the quantity delivered is a fair one. A charge of so much a ton for coal, or so much for a pair of shoes is perfectly logical, for the total cost of production depends almost directly on the quantity produced. In the electrical supply industry, however, conditions are encountered with are different from those of any other enterprise.

Unlike a gas plant, which can generate gas at any time and store it in tanks till wanted, an electric plant must stand ready to instantly generate current at the turning on of a switch, or in effect, each customer has reserved a certain part of the plant for his own particular use, and the company must maintain this portion of the plant and keep it ready for his use. This entails a certain fixed expense to the company which does not depend at all upon the output of energy, but rather upon how great a part of the plant the customer has reserved for his own use, or in other words upon his maximum demand for current.

As early as 1883 it was recognized* by Dr. John Hopkinson that a straight meter rate could not satisfactorily cover both the fixed and variable costs of operation, and a system of rates was developed which consisted of a fixed charge depending upon a customer's demand and a low rate for energy.

When Wright developed his maximum demand meter, the two charge system of rates was given a secure place among methods of charging, for the principal argument against Hopkinson's system lay in the disputes that arose over the question of determining a customer's demand.

Wright also developed a modification of Hopkinson's system that made it more popular. Under the Hopkinson system, a customer was assessed his demand charge whether he used any current or not; while under the Wright system, a customer paid his full demand charge only when he had used his demand for a given number of hours per month, (usually 30). For use of total demand for less than the specified time, the assessment was in proportion to the time of use. Under this rate system "short hour" business could be secured that was impossible under the Hopkinson system. Whether this business was desirable or not is another question, for the short-hour user would not always pay the station all that was incurred in the demand expense of serving him, and the loss would have to be made up on the more desirable long-hour customers.

Right here is encountered the bone of contention of the central station industry—whether it is politic to serve some customers at a loss and make up the difference on others. That the contention is not a new one can be seen from the following quotation from Dr. Hopkinson's original address:—"The charge for a service rendered should bear some relation of the cost of rendering it. If it is a matter of open competition the matter will soon settle itself, for no one will for long be able to supply some customers at a loss and recoup himself by exorbitant profits from others. It is clearly to the advantage of a station to secure all those cus-

*"The Cost of Electrical Supply," presidential address of Dr. John Hopkinson before Junior Engineering Society, reported in the Electrical World, Dec. 3, 10 and 24, 1892.

tomers whom it pays best to supply, and as far as may be, to compel those who are unremunerative to adopt other methods" (of illumination).

As a public service corporation, a central station is not as free to choose its customers as a private enterprise, so most station managers feel it their duty to act in direct opposition to economic laws by making rates which are not based directly on cost, and by serving many small customers at a loss. Where central stations are operating under short time franchises, and must depend upon the good will of the people for the continuance of the franchises, such a procedure may be warranted, for most of the voters are short time users, but under other conditions it would seem more logical to charge in accordance with cost, or else decrease the cost of serving the small customers to some amount less than the rates charged them.

From the time of the introduction of the Wright and Hopkinson systems up to the present day, a number of modifications of the two rate systems are found. Hopkinson covered the demand cost by a straight demand charge. Wright approximated the same results by charging a high rate for current used during the hours of the station peak and a low rate for all other current used.

In some cases, a set of two meters has been employed to accomplish this same purpose, one meter registering the energy used during peak hours and the connections being shifted to the other during the non-peak hours. The two meters can be combined in one case by so arranging the parts that either a resistance is cut into the shunt circuit, a part of the series coil is cut out or a lower ratio gear train is mechanically shifted in during the non-peak hours. In all of these "double rate meters" a clock work mechanism must be used to regulate the time of shifting. This system is somewhat unreliable, costly, and hard to explain to the satisfaction of a customer.

Assuming a fixed charge per kilowatt of demand and a given rate per kilowatt-hour for energy, it is possible to combine the two items into a single charge per kilowatt-hour, this combined charge varying with the equivalent hours use per month of the maximum demand. A schedule of rates could then be made up in which the charge per kw-hr. is determined by the hours use of the demand, or in other words, by the load factor. Such a schedule is called a "Sliding Scale Rate." For a customer with a very low load factor, the rate per kw-hr. would be quite high, so under this system a maximum rate is generally established for load factors less than a given percentage. The objection to this system is that customers of the very low load factors do not pay the cost of serving them.

Another kind of sliding scale rate is made up by establishing constant rates over given ranges of load factor or by allowing the rate to decrease by steps instead of uniformly, as the load factor increases. The abrupt changes in this rate system constitute an added disadvantage, for a customer is liable to be very much dissatisfied if he finds that his neighbor, who used his lamps but a few minutes more each day than he himself did, is able to secure not only a lower rate, but a lower total bill as well.

The so-called "multiple rate" is the same as the older Wright system, except that a customer's demand is usually computed from his connected load or else agreed upon in his contract.

In 1900 Henry L. Doherty* outlined a method of cost analysis that went one step farther than Dr. Hopkinson's, and separated the fixed costs into two parts, one proportional to the demand on the station, and one proportional to the number of customers served. The thread of his argument as since amplified and extended by Mr. S. E. Doane** runs as follows:

A station furnishes its customers two things—*electric pressure* and *electric current*. To supply *pressure* there must be an electrical connection between the plant and the customer's premises. If pressure only were to be supplied, a line consisting of very small wire could be used, and a set of dry batteries, or one small generator could be used to generate the pressure. The actual cost of keeping up the pressure is relatively so small as to be negligible. The expenses connected with the pole line and the small line wire, including interest, taxes, maintenance, etc., will vary directly with the number of customers served, hence are

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*"Equitable, Uniform and Competitive Rates," paper read before the twenty-third convention of the National Elec. Light Ass'n, May, 1900.

**"High Efficiency Lamps, their Effect on the Cost of Light to the Central Station," paper real before the thirty-third convention of the National Electric Light Ass'n, May, 1910.

classed as "Customer Expense." Other items varying directly with the number of customers are the cost of meters, the expense of reading them and of making out bills.

The cost of suplying a customer with *current* depends, first on his "maximum demand" and second, upon the duration of his use of current. The size of the plant is dependent on the demand made upon it, so the fixed charges on the plant investment are "Demand Expense," as are also the fixed charges against substations, line transformers, and a greater part of the line copper. The duration of the customer's use of current, together with the amount of current used, determine how much coal must be burned in the station, how long the engineers, firemen and other attendants must work, etc. These are items which vary with the output of kw-hrs., and which constitute the "Output Expense."

By a careful method of analysis, every item of the costs entailed in operating a central station can be classified under these three heads, Customer, Demand and Output Expense. Knowing the total number of customers, the total demand, and the total output, it is a simple matter to compute three charges, which if assessed, the first against every customer regardless of his demand or consumption, the second against every kilowatt of demand regardless of consumption, and the third against every kilowatt-hour of output, would secure to the station an income exactly proportional to the cost of rendering the service.

Such is the theory of the Doherty rate system. At the time of its promulgation (1900) the lighting load of central stations consisted mainly of carbon lamps, and at that time a straight meter rate was a sufficiently close approximation to actual costs to make it commercially feasible.

At the present time, however, when high efficiency lamps are coming into general use—the central station industry finds itself in a predicament. By installing high efficiency lamps customers cut down their energy consumption, and with it their bills, by the ratio of the new lamp efficiency to the old. The fixed expense of serving lighting customers has changed but little, and as the fixed expenses usually amount to about 70%* of the total station cost, the industry finds its income from lighting cut down by two-

*See second reference at bottom of page 112.

thirds, while only about 30% of its costs are decreased in proportion.

The fear that the effect of the introduction of the high efficiency lamps would be to cut down income and profits has led to considerable agitation in favor of the logical rate system as outlined by Messrs. Doherty and Doane.

The principal difficulty in establishing a logical rate system of this kind lies in the method of application of the Demand Charge. Consumers having large installations could readily be supplied with maximum demand meters in addition to their watt hour meters. A system then could be evolved whereby these customers would pay a Demand Charge for the whole year according to their highest demand at any time during that year. This is a point of difference from the older Wright Maximum Demand System, in which the largest *monthly* demand is made the basis of a fixed charge. The logical basis for this fixed charge would be the maximum annual demand, for if a customer makes a demand of say 10 kw. at any one time, he has in fact reserved 10 kw. of the plant capacity for his own particular use, and should therefore pay the charges upon this amount for the whole year. The expense of serving lighting customers, and particularly the small ones, is already great enough; hence it would not be practicable to supply them with demand meters, and it would be necessary to have other means for fixing the demand charge. Estimating the demand as a given percentage of the connected load might appear to be a satisfactory scheme, but here we encounter the difficulty that the maximum demand is not the same percentage of the connected load in a large installation that it is in a small installation, and in addition the fixing of the Demand Charge in this manner would impose limitations upon the installation of electrical appliances. A method which seems to meet with considerable favor in the minds of those who have given the situation considerable thought, is to base the Demand Charge on the floor area to be lighted. The power required to give a satisfactory value of illumination over a given area is quite accurately known; hence the demand could be readily determined. Mr. S. B. Hood, in a paper* read before the last convention of the Ca-

*"The R. C. M. Electrical Service Rate System," 20th convention Canadian Electrical Association, July, 1910.

nadian Electrical Association, proposed a rate system of this sort. His scheme of computing area to be charged for is to consider only the living rooms in a house, leaving out alcoves, pantries, halls, and all such seldom used places. The second floor rooms, such as chambers and sleeping rooms, which are used by individual members of a family rather than by the whole family, are discounted one-half in figuring up total area, the reason for this being that it is assumed these rooms will not be used as much during the peak hours as are the main living rooms. This method of applying the Demand Charge places no restrictions on the connected load, and customers are able to improve their load factors by the use of such utensils as flat-irons, cooking devices, fans, etc.

As a central station system expands, it could be expected that the demands of the individual customers would decrease, due to the increasing use of high efficiency lamps. Under these conditions the Customer Charge becomes a greater and greater proportion of a customer's total monthly bill; hence the revenue from the Customer Charge becomes a greater and greater proportion of the total income of the station. The need is apparent, therefore, of keeping the Customer Cost as low as possible, in order that electrical service may be put within the reach of a maximum number of customers. One effective way of keeping the Customer Cost low is to keep the density of service high—that is, to secure a maximum number of customers per thousand feet of line. The line expenses constitute a large proportion of the total customer cost; hence keeping the existing lines well loaded will keep each customer's share of the total expenses within reasonable limits.

Even a high density of service and consequent low Customer Charge will not bring electrical service within the reach of some classes of customers, these being principally the laboring classes who could not afford to pay more than $1.00 or $1.50 per month for light. If these customers used electric lamps at all, they most certainly would use high efficiency lamps in order to keep their demand low. Under these conditions the Customer Cost would be a very great proportion of the cost of carrying the customer. The Demand Cost would rank next, and the Output Cost would be insignificant. Hence it is seen that to reach this class of load at all, it will be necessary to keep the Customer Cost as low as possible.

The substitution of a cheap current limiting device to take the place of the integrating meter will greatly decrease the meter expense, and with it the Customer Cost. These limiting devices, or "demand limiters" are so arranged as to rapidly break and make the circuit when the current rises above a given value. The resultant flickering of lamps serves to notify the customer that he is exceeding his allowable demand. By turning off a lamp, the demand can be reduced, and the light again becomes steady. With the integrating meter done away with, flat rates would be the only feasible method of charging for this class of small lighting customers. In places where this rate system is now used, the evil of waste of current under a flat rate charge is met by requiring customers to buy their own renewals, and impressing them with the fact that needless burning would entail needless renewal expense.

In conclusion, the writer wishes to state that this article is not intended to be a complete treatise on either the history or the economics of rate making, but if it serves to bring to the realization of engineers the importance of a knowledge of rates to anyone connected with central station operation, its purpose will have been fulfilled.

Below is given a resumé of references to books and papers which were used in compiling this article, and to which the reader is referred for more detailed information on the subjects treated.

The Cost of Electrical Supply, Dr. John Hopkinson, Electrical World, Dec. 3, 10 and 24, 1892.

Equitable, Uniform and Competitive Rates, Henry L. Doherty, Proceedings National Electric Light Association, 1900.

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The R. C. M. Electric Service Rate Systems, S. B. Hood, Proc. Canadian Elec. Association, 1910.

Diversity Factor, H. B. Gear, Proc. A. I. E. E., Aug. 1910.

The Tungsten Lamp and the Central Station, Electrical World, Sept. 1, 1910.

AN ELECTROLYTIC CELL FOR HOUSEHOLD USE.

CHAS. F. BURGESS.
Professor of Chemical Engineering.

A simple little device, the recent invention of two University of Wisconsin engineers, has established a record of saving two hours of labor a week, or one hundred hours per year. Three thousand or more are already in use, thus representing a saving of 300,000 hours of labor each year.

This device is taken as a text for a dissertation the purpose of which is to show the manner in which scientific knowledge can be turned to practical account, and also to illustrate one of the numerous uncultivated fields toward which the engineer may profitably direct his attention.

The term "house cleaning" designates a semi-annual event which to many of us calls up memories of upsetting of household routine, strenous effort in wielding the birch rod on rugs and carpets, and similar disagreeable impressions. Such memories the future generations may not be called upon to share, since the engineer has given this problem his attention and has developed machinery for doing this work. Vacuum cleaners are replacing large numbers of laborers and without any indication of strikes or dissension on the part of those whose employment is thus taken from them. Corporations have been organized to install this machinery into homes, and to keep on the road traveling equipments which go from house to house, and extract the accumulated dirt and dust at a moderate cost, with surprising rapidity, and with greatly reduced labor as compared with the antiquated methods.

If all of the dish washing, or window cleaning, or furnace tending of this country could be undertaken by a corporation, it would be called upon to handle labor which as now done involves work equivalent to the continual employment of many thousands of laborers. The natural course for such a corporation to pursue would be the employment of high grade engineering and scientific skill upon the simplification and cost of doing the work;

and marked improvement in methods would be the certain result.

There is a large field for work of the engineer in the study of household economics, a field which hitherto has been largely neglected. Heat is being applied to cooking operations in a shamefully wasteful way, though some improvement has been effected in the development of the modern fireless cooker, a truly engineering device.

The destruction of enameled ware, the rapid rusting of tin ware, and the low and inefficient heat conductivity of iron vessels have furnished an incentive for the study of methods of working aluminum, and the consequent introduction of this metal into the kitchen.

One of the regularly recurring duties of the housekeeper or her employees is the cleaning of silverware; the removal of that discoloration or tarnish which grows on silver from contact with food materials and even by simple exposure to the atmosphere.

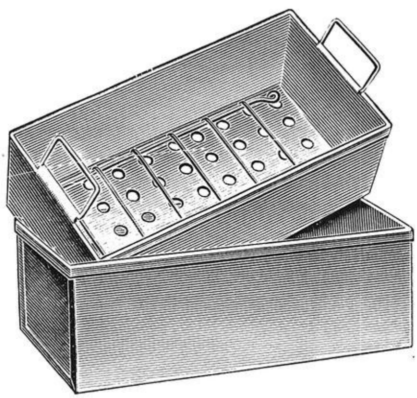
An estimate of the labor involved in this one simple operation alone gives the following results; assuming that the 90,000,000 population of this country represents 10,000,000 families, and that one family out of ten possesses a stock of silverware and enough pride in it to keep it clean; we have 1,000,000 houses in each of which at least two hours per week is expended on this work or 2,000,000 hours of labor per week. On the basis of a working day of 10 hours, or 60 hours per week, this labor represents the equivalent of employment of over 30,000 hands.

Assuming this work to be directed by skilled engineers seeking improved methods, there would be a rapid elimination of the numerous laborious and inefficient methods now employed and the working force would be greatly reduced, as indeed is shown possible by this device which is to be described.

It is designated as a silver cleaning pan, and is the joint invention of Professor J. D. Phillips of the Engineering Faculty of the University of Wisconsin and Mr. Carl Hambuechen, Chemical Engineer, U. W. '01, now with the Northern Chemical Engineering Laboratories, of Madison. They produced after lengthy experimentation and testing an apparatus which the United States Patent Office has deemed of sufficient novelty to warrant the granting of patents. Its practical working has been demonstrated in many boarding houses, restaurants, and homes in Madison and elsewhere, and a company has been organized to make a countrywide distribution.

To the uninitiated, the terms "electrochemical potential," "electrolytic polarization," and "cathodic overvoltage" may imply certain vague phenomena of theoretical interest or of minor practical usefulness; it is these phenomena which are involved in the electrochemical cell here under consideration.

It consists essentially of a pan or vessel as illustrated in the accompanying cut.



Silver Cleaning Apparatus.

The tarnishing of silver is due to the formation of a film of sulphide or other compound which attaches itself firmly to the surface. The common method of removing this tarnish is by the use of powders or abrasives which destroy the film by rubbing or mechanical action, and which thereby involve manual labor. The removal by abrasion also involves removal of some of the metallic silverware, causing a rapid depreciation, especially of plated ware.

For a long time there has been sought a chemical solution into which tarnished silverware might be dipped and which may remove the tarnish by chemical action without also attacking the silver. There are few chemicals which will meet this requirement, and none which is suitable for household use. A potassium cyanide solution will dissolve the tarnish and leave the silver bright, and is extensively employed in hotels and restaurants.

On account of the extremely poisonous nature of this chemical, however, its use is not advisable; in fact, it should be absolutely prohibited, as many accidental fatalities have been caused by it.

The new form of electrolytic cell, called a silver cleaning pan, makes use of a solution; and employing an electrochemical principle, it dissipates the tarnish with no expenditure of labor; it produces no damage to the silverware; it works with rapidity; and the solution involves no poisonous chemicals. It removes the tarnish without taking any of the underlying silver, and, therefore, preserves as well as brightens the ware.

The purpose of this cell is to clean, neither by physical force, nor by chemical solution, but by changing the silver sulphide back to metallic silver through electrolytic action. It has been known for a long time that the electric current flowing toward a tarnished silver surface immersed in an electrolyte causes a liberation of hydrogen, and thereby the extraction of the sulphur from the silver sulphide. This result can be accomplished by galvanic action, in which the current is set up by the use of zinc or aluminum as an electropositive metal.

A simple method of using such galvanic action consists in placing the silver in contact with a piece of zinc or of aluminum and covering with a solution of soda and salt or other suitable electrolyte. These two metals, silver and zinc, or silver and aluminum, constitute a galvanic couple, the electro-positive metal, zinc or aluminum, going into solution and liberating hydrogen upon the electro-negative silver. In this manner an aluminum dish may be employed for cleaning silver, as is in fact frequently done; but this method is open to an objection which lies in the fact that aluminum or zinc become coated with a film of non-conducting material, so that metallic contact with the silver cannot be made without first scouring the electro-positive metal. In other words, while the silver is cleaned without scrubbing, the other metal must be scoured to make it continually serviceable, and thus the labor saving advantage is largely reduced.

It is the simple method of overcoming this disadvantage that constitutes one of the points of merit of this new form of apparatus. One form of the apparatus, a pan made of sheet zinc, has a wire grating of another metal, preferably of tin attached to the bottom by solder. When the solution is poured into the pan this tin becomes a cathode and hydogen is liberated upon it by electrolytic action. Tin has the peculiar property possessed by but few of the other metals, of having a high overvoltage, by reason of which hydrogen when deposited upon it sets up a high counter electromotive force or polarization pressure which quickly stops the flow of current and prevents the needless waste of the zinc. Through the presence of hydrogen the tin is always kept chemically clean and bright, the insulating film does not form upon it, and there is therefore nothing to prevent silverware which rests upon it from making electrical contact.

When silver is so placed it becomes a cathode, and the reducing action upon the tarnish takes place. Various solutions may be employed for this purpose, such as caustic soda, sodium sulphate, sodium chloride, and the like. The designers of this apparatus and process sought a solution which would employ materials easily and cheaply obtained. The solution adopted by them is made up by dissolving in hot water ordinary baking soda and table salt. These materials being food articles are non-poisonous, and can have no detrimental action on the silver itself.

This apparatus constitutes a device of interest to the electrochemical student, in that it illustrates the practical application of electrochemical phenomena; and it might well be the subject of further study to determine the limitations of other fields of usefulness. The reducing action which is set up in this pan has been shown to be of sufficient strength to reduce most of the compounds of silver and of gold. Some of the compounds which form on brass and copper surface may likewise be reduced, but with theses metals the action is uncertain and the electrolytic cleaning cell in its present form does not appear to be of practical use for brass and copper. The question naturally arises as to whether this same electrolytic reducing action might not be utilized in removing rust from iron and steel. It is probable that such action may take place, although at a very slow rate, but just what this rate may be is a matter which would be of interest to determine.

THE WORK OF THE UNIVERSITY EXTENSION DIVISION IN ENGINEERING.

EARL B. NORRIS,
Assistant Professor of Mechanical Engineering.

The state universities and colleges have for many years recognized that residence instruction is but one of the functions of an educational institution which has been founded and maintained by and for the people of the state. This greater responsibility to the people has been realized by all the state universities, resulting in short courses, summer sessions, lectures and the other well known agencies, and culminating in the organization of university extension divisions to search out and supply those educational needs of the state which can best be filled by the universities or under their direction and guidance. Although the work of university extension is further advanced at Wisconsin than at any other state university, yet, even here, the work which has been done seems but a beginning when we consider the possibilities of university extension in all its forms. The Extension Division, in entering the educational work of the state, does not usurp the prerogative of any established part of the educational system but is planned to fill the gaps and supplement the work of the other parts of the state system of education. To search out and fill the educational needs of the people, the Extension Division has divided its work into four general departments, of Debating and Public Discussion, of General Information and Welfare, of Instruction by Lectures, and of Correspondence Study. In all these departments there are opportunities for furnishing to communities, clubs, or individuals, technical information of which they may be in need, and which is not available through any other public educational agency. The engineering force of the University Extension Division, numbering at present 12 men, is therefore allied more or less, with each of these departments of the Division as the opportunity arises.

The Department of Debating and Public Discussion finds civic clubs and other organizations which desire technical information to assist them in discussing such matters as water supplies, sewage disposal, municipal ownership of public utilities, and other problems of municipal engineering.

The Department of General Information and Welfare, as its name indicates, is planned to make available in popular form, information on subjects of general interest. To this end this department assists in effecting a more general distribution of the bulletins issued by the national, state, and university research departments besides the compilation of popular bulletins on subjects of general interest. There is a great amount of information to be had in such publications as those of the U. S. Geological Survey and of the engineering experiment stations, which fails to reach the people as it should. This department plans to aid in the dissemination of knowledge of investigations and discoveries of popular interest. Bulletins are also issued by the department when the available publications are not written in suitable form for popular distribution.

As an example of the possibilities for work in this department in engineering, we might mention the desirability of an investigation of the coal supply of Wisconsin, including a study of the available coals, their desirability for different uses, the most economical methods of handling, with an analysis of the rail and water freight rates from the different coal fields.

This department also serves as an information bureau upon matters of public interest. If the information desired is such as to bring personal profit to the inquirer, he is merely advised of the proper steps to be taken, great care being exercised in either case not to encroach upon the field of the consulting engineer or other expert but rather to encourage the engaging of an expert at the proper time. For example, through this department, city councils have been furnished technical information upon which they may base ordinances for the prevention of smoke.

The Department of Instruction by Lectures contributes to cause of education by arranging for lectures by the members of the university faculty and others. Lectures have thus been arranged for engineers' clubs, trade unions, and other organizations interested in technical subjects. The various organizations of stationary engineers throughout the state have been given lectures on such subjects as "Steam Turbines," "Smokeless Combustion,'' and ''Gas Engines.'' The employes of certain railroad shops were supplied with a lecture on the ''Development of the Locomotive.''

It is in the Department of Correspondence-Study, however, that the greatest work is done in technical instruction. Every man in the engineering profession realizes the great desirability and the possibilities of increasing the technical knowledge of the men in the engineering trades. At present these men, the foremen, inspectors, stationary engineers, etc., acquire their training only through the school of ''hard-knocks.'' That this process can be greatly aided and hastened by a system of vocational instruction and that the efficiency of this class may be greatly increased, is readily conceded by all engineers.

The present system of industrial organization does not make provision for the development of a class of skilled employes from which to select the foremen and inspectors. As a result, men qualified to fill these positions are rapidly becoming harder to find. The system by which a man becomes a part of a single machine and, in many cases, performs but a single operation day after day gives no opportunity for the development of talents which would qualify the man to assume charge of a department. Except in the largest plants, the apprentice system has been abolished and the man who is ambitious to advance must acquire his training outside of the shop. The commercial correspondence schools were the first to realize the needs of these men and as a result hundreds of thousands of men have been enrolled in their technical courses. On the whole, these schools have done good work but there is no reason why the states should compel this great mass of citizens to acquire their educations from institutions organized on a commercial basis.

The University of Wisconsin aims to fill this need through the Correspondence-Study Department of the University Extension Division. So great is the demand for this instruction that the larger part of the work of this department has been in the line of vocational training.

In this work the University supplements the correspondence work by personal contact with the instructor. Wherever the number of students warrants it, they are organized into classes and are met at regular intervals by instructors who explain difficulties encountered in their studies. This method overcomes the greatest discouragement in correspondence study, the necessity of writing for explanations of the difficulties met by the student.

In carrying out this work, the state is divided into districts and a University representative placed in each district with such instructors and other assistants as he may require. In most cases the men are organized into classes in the factories where they are employed. The managers have in nearly every case fitted up class rooms in the plants and have given the men time for their class meetings during the day at the expense of the companies. In some cases the firms have paid all or part of the cost of the courses and have otherwise taken an active interest in the progress of the men in their employ. In one class, made up of a selected group of apprentices, the boys are sent to the class room for a full half day each week for instruction in Shop Mathematics and Mechanical Drawing. For the men who are not fortunate enough to be in one of these classes, night classes are organized either at the extension center or at a convenient public school building or library.

The first course taken by these men is in Shop Mathematics or in a similar course in mathematics planned to teach those principles which apply directly to work which the men are doing and the machinery which they use. Machinists are taught the uses of their instruments, such as the micrometer, the calculations of cutting speeds and feeds, the principles of screw cutting, the mechanism of their machines, the principles of trigonometry as applied to the laying out of work, the use of formulae, and numerous other applications of mathematical principles to every day work. Although a systematic development of the instruction in mathematics is maintained, yet the student is taught at all times the application to his work of those principles which he is studying. This method of treatment maintains the interest by showing the value of the principles taught and aids the student to understand them by applying them to things of which he already has some knowledge. This course is, in many cases, accompanied by a course in drawing which develops not only manual dexterity but an ability to read working drawings and to make presentable drawings when necessary. For those who wish to become draftsmen more advanced courses are available.

Likewise, men employed in central stations or other power plants, or those men who wish to prepare themselves for such work, take first a course in Power Plant Mathematics after which they study the principles of Heat as applied directly to their work. Following this, courses are available in Boilers, Steam Engines, Gas Engines and Gas Producers, Refrigeration, Heating and Ventilation, Compressed Air, etc.

In like manner those interested in electrical work are given first the principles of mathematics as applied to calculations in electrical work, followed by a study of Electricity and Magnetism, after which there are available courses in all kinds of electrical machinery and in the principles which are involved. The man in structural work follows his mathematics by a study of Strength of Materials and the Elements of Structures which gives him a knowledge of the materials he is using and of the methods of construction used in the shop and in the field. More specialized advanced courses may then be taken dealing with the different classes of steel, timber, and concrete structures.

In practically every case, the student who has finished one of these vocational courses has so thoroughly acquired the habit of utilizing his spare time in studying that he voluntarily enrolls for more advanced courses without solicitation. Furthermore, the men acquire a different attitude towards their daily work. They become interested in the operations they are performing and study these processes instead of doing them in a perfunctory manner. The instances of financial benefit obtained and promotion gained as a result of this work are many.

As yet, district organizations have been perfected and classes organized in but two districts of the state, the first district comprising Milwaukee and the surrounding counties, and the second made up of the cities in the Fox River Valley with the district headquarters at Oshkosh. The students in other localities are taught by correspondence methods alone. As the work develops, instructors will be placed in every part of the state with local laboratories and class rooms in every city where they are needed.

The problem of laboratory facilities does not offer the difficulties which might be expected. Most of these men are working with the kind of machinery which they are studying and need only the theories of their work to enable them to put them into practical use. In Milwaukee the laboratory of the city gas inspector has been used in demonstrating the methods of making calorimeter tests and analyses of gases and a fuel testing laboratory is proposed, to be installed in the University Extension headquarters in that city. Some of the students have taken advantage of the Summer School for Artisans to take laboratory work at the University and they are urged to do this whenever their circumstances will permit.

These vocational courses are by no means all of the work of the Extension Division. Besides these, courses are offered under the following heads:—elementary, high school and preparatory, special advanced, and regular university grade.

Many prospective students of engineering are taking advantage of the elementary and high school courses to complete their preparations while at the same time earning money for their university courses. Others who have been out of school for some time take these courses as a review to prepare them for the entrance examinations.

This work also offers a ray of hope to the large number of men who leave school before completing their high school work and later in life find that they desire and have the means for a university course but have not the training required for entrance.

In the special advanced courses we find students enrolled whose qualifications enable them to take courses more advanced than the vocational courses and who desire special instruction along some line of engineering work but who do not care about receiving credit towards a degree. In these courses we have enrolled graduates of the colleges of engineering of Wisconsin and of other universities as well as men who have had part of a university course. These men desire work that is of practically university grade and yet is planned to fill more particularly their immediate needs in some special line of work.

In offering courses of university grade we find many opportunities for the extension division to be of service. The greatest number of these students are men who have finished their high school courses and must stay out of school for a year or more for financial or other reasons. To these men we can offer the studies which they would pursue in the first year of their university course. In this way they are encouraged and their interest maintained in the university.

A smaller number of students taking work for university credit are men who have been compelled to drop from the university for a period, but are in good scholastic standing. In many such cases the Extension Division is able to offer courses which they may pursue while not in residence. This plan aids in maintaining the interest of the student in completing his university course. In all such cases the consent and approval of the student's adviser and the head of the department which gives the desired course in residence must be obtained. Likewise, we have students who have completed satisfactorily part of an engineering course at some other institution. By taking work through the extension division, these men are attracted to Wisconsin and in most cases have expressed intentions of entering this university.

Another case where university courses are taken to advantage through the extension division is found where men wish to attend the university for a short time with the idea of pursuing certain courses having a direct bearing on their work. In most cases the extension division is able to give them the necesary prerequisite courses so that they can enter immediately upon the desired studies upon coming to the university.

In all work given for university credit, great care is taken to maintain the standard set by the residence departments and a student's work is at all times open to the scrutiny and supervision of the residence department. The student's previous record is carefully examined to make sure that he has completed satisfactorily the prerequisite courses. It is safe to say that in no instance has a student who has completed a course by correspondence failed to make good records in his residence work.

SUPERHEATERS.

R. D. Lewis, '09.

Superheating as applied to locomotives is a comparatively new phase in steam enginering. Although German locomotives have been equipped with superheaters for six or seven years, not until very recently have superheaters come into use in the United States. This is a discussion on results, rather than the design of superheaters so that I shall not go into the details of the design.

The essential features of all the different designs are these: The steam is taken from the niggerhead and returned through the large flues by means of steam elements, coming into contact with the hot gases. Every superheater has its own method of taking steam from the niggerhead, superheating it, and delivering it to the cylinders, but a general idea of the different designs may be had from the following:

Saturated steam is taken into the "headers," practically nothing more than boxes divided into different compartments. A number of return steam elements are arranged so that from here the steam is taken from one compartmnt, brought back through the large flues and then delivered to the superheated compartment. From here it goes to the cylinder. The large flues are usually about 5″ in diameter. The number depends upon the superheating surface desired.

The following discussion of results is based upon tests made, using the Emerson superheaters. The first engine equipped was a consolidation of the type 2-8-0. Original cylinders were 20″ by 32″; steam pressure 210 lbs. tractive power, taking 80% of boiler pressure, 39090 lbs.

A new set of cylinders were used, 26″x32″ and the slide valve replaced by a piston valve. The boiler pressure was decreased to 155 lbs. using 85% of boiler pressure; the tractive power is 51800 pounds.

A number of tests were made on this engine, 1148, and then on two other engines of the same class but non-superheating. The character of these tests was as follows:

Coal and water used, together with indicator diagrams; then a dynamometer car was used and the fuel consumption figured per pounds drawn bar pull. These results might be interesting to follow, so a partial summary is given below:

	Engine 1148 superheat	Engine 1205 non-sup.	Percent
Lbs. coal per 100 ton miles	4.68	5.33	12.2
Lbs. water per 100 ton miles	32.58	37.60	13.4

These figures show a saving of 12.2% in fuel and 13.4% in water in favor of the superheater. Figuring the fuel consumed per 100 draw bar miles, we have 1.35 lbs. coal per 100 D. B. miles for engine 1205 and 1.14 lbs. coal per 100 D. B. miles for engine engine 1148, giving a saving of 15.5% in favor of the superheater.

The maximum pull in pounds obtained from the dynamometer record for engine 1148 was 51900; for engine 1205 was 36560.

To give a more general idea of the tractive power of these two engines, the 1148 would take a train of eighty ore cars over a hill four miles long with a grade of 1.7% at a minimum speed of six miles per hour. Engine 1205 had to "double" this hill every trip with sixty-five cars. Understand these were twin engines, one superheating and one non-superheating. So superheat shows up to a good advantage in this case, not only in fuel economy but in power. This is a very important factor. The average superheat obtained in this engine is 180°. As a result of these tests, thirty-eight engines of this type were equipped with superheaters.

The next engine to be tested regarding superheat was of the 4-8-0 type. This showed a saving of 21% in fuel and an increased tractive power of 17%. Following upon these tests, we received twenty new passenger engines, all superheaters. Testing these showed an average saving of 13% in fuel, with 130° superheat. Next we built an engine of the Mallet, articulating compound type 2-6-8-0. In connection with a superheater we put in a feed water heater. The steam is superheated before entering the high pressure cylinders. This is a very important point, as superheating steam leaving high pressure cylinders for the low pressure is absolutely a failure. We obtained a maximum superheat of 232 degrees in the high pressure and 130° in the low pressure cylinders. The feed water temperature averaged 260°. Assuming every 11° rise in feed water temperature gives a saving of 1% in fuel; it is easily seen that a large saving results.

A very interesting problem made its appearance in the tests of this engine 2000. The high pressure cylinder has a slide valve; the low pressure, a piston valve. There was considerable trouble at first in keeping the slide valve from cutting. A brass valve was tried but was not a success; the difficulty was found to lie with the valve oil. A special grade of this oil was obtained and since then there has been absolutely no trouble in this respect.

This engine is now in ore service on the range, hauling 120 cars of ore, a tonnage of about 7400, over a ruling grade of .7% and making the remarkable record of about four pounds of coal per 100 ton miles. Our next new lot in equipment consisted of forty Mallet articulating compounds of practically the same type as the 2000, save that they were a larger engine. Both valves are piston valves. The maximum degree of superheat in their case is 190°. The average will be about 180°. Most of these engines are used in the Rockies and Cascades. One in service on the iron range hauls 130 cars of ore over this .7% grade and 130 empties over this 1.7% grade.

In passenger service we now have 63 engines that are superheating. Twenty of these are used in the mail service, where the speed between St. Paul and the Coast *averages* about sixty miles per hour. Another twenty are used on the transcontinental limited. There has not been *one single* engine failure due to a superheater since we have had this equipment. Superheater engines will handle a train in a way that non-superheating engines cannot approach.

Our last set of forty new passenger engines, being delivered now, give an average superheat of 190°. Probably by this time you are interested in the cost of maintenance and operation of superheating engines as compared with non-superheating. We have kept an accurate detailed record of the performance and upkeep of superheating and non-superheating engines of the same class in freight and passenger service. Accordingly I can give you some figures as to this.

In passenger service the cost of fuel per 100 passenger car miles for superheaters for the entire system will average $1.70; for non-superheaters $2.13; cost of valve oil per mile, superheating $.00180; non-superheating $.00120.

Cost of repairs, total, per mile, superheating $.040, non-superheating $.101.

In freight service, for the system, the cost of coal per 100 ton miles, superheating $.0170, non-superheating $.0182; repairs, cost per mile, superheating $.091, non-superheating $.132.

These figures show very plainly the advantages of superheaters applied to locomotives. The advantage in the cost of repairs, lies in the fact that the decrease in cost of repairs to boilers due to a lower boiler pressure, more than compensates for superheaters and repairs. In conclusion, the advantage and disadvantages of superheaters are as follows:

First, superheat makes a more powerful engine; then a marked saving in fuel and water is obtained. A lower boiler pressure is obtained, decreasing cost of boiler repairs.

The disadvantages are mainly, the care that is to be exercised in lubrication and increased cost of lubrication.

Everything is in favor of superheating as applied to locomotives and it is only a short time before all the railroads in the country realize it and design their equipment accordingly.

THE MILD PROCESS OF WHITE LEAD MANUFACTURE.

A. R. WHITE, '10.

In 1906 the Acme White Lead and Color Works of Detroit, Michigan, constructed a new plant, which was to manufacture 15,000 tons of white lead per year by an entirely new and simple commercial method, known as the "Mild Process."

In order to show the merits of the new method, it seems advisable to briefly state the principles of the older processes. The white pigment, which is most commonly employed for paints is a mixture of various basic carbonates, but largely of the composition $Pb(OH)_2\ 2\ PbCO_3$. It is obtained in general by allowing carbon dioxide to act upon lead oxide. To facilitate the reaction acetic acid is often used as an auxiliary substance.

Of the old methods there are several of importance besides numerous patent processes. The Dutch, or Stack process consists in exposing sheet lead to the corrosive action of moisture, acetic acid vapors, and carbon dioxide. The process is slow, a large plant is required, and the capital invested lies idle a great part of the time. Although a good grade of white lead may be obtained by the Dutch process, certain requirements are necessary of the lead employed. The lead must be pure. If any silver, copper or iron is present, the color of the final product will be damaged.

The German, or Chamber process, is an artificial method of producing about the same conditions as prevail inside the stack in the Dutch method. This is much more rapid than the Dutch method, usually requiring about five weeks; but the quality of the product is not as satisfactory.

The French process or Thenard's method, depends on the precipitation of a basic lead carbonate from a solution of a basic salt by means of carbon dioxide. The solution generally used is a basic lead acetate, prepared by boiling litharge with neutral acetate. The white lead separates in a granular crystalline form. It has a less covering power than the amorphous powder produced by the Dutch process.

Several patent electrolytic processes have been proposed for the precipitation of the basic carbonate of lead; but thus far these have not been used for the production of white lead in commercial quantities.

The *Mild Process* for the manufacture of white lead is the only one in practical operation which does not require the use of acids, alkalies, or other chemicals in the process of manufacture. Every trace of impurity should be removed from the final product, which necessarily involves the use of certain methods which are in themselves expensive, and which if not complete will cause a marked deterioration in the quality of white lead produced. The process derives its name from the very fact that it is the simplest and most natural process possible for the manufacture of white lead. Metallic lead, air, water, and carbon dioxide are the only substances required.

The attention of Mr. Thomas Neal, of the Acme White Lead and Color Works, was attracted to this process and a deal was effected which resulted in the adoption of the process by the owners of the above named plant in 1906.

This process does not require the use of the extremely high refined lead used in the Dutch process, but an ordinary grade of lead may be used. Some of the hard grades of lead, however, do not undergo conversion as easily as the softer varieties, although there is little or no difference in the color of the product obtained, provided the silver content is kept below one ounce per ton. A low silver content means that the lead is pure, for in the elimination of silver, impurities must be removed.

In the Mild Process the pigs of lead are melted in large kettles holding about 5,000 pounds each. From the bottom of these it is conveyed through heated pipes to the "atomizers," which are similar in principle to the ordinary laboratory blast lamp. In the "atomizers" the molten lead comes in contact with a current of steam. The expansive force of the steam disintergrates the lead into exceedingly minute particles, which in the course of their descent solidify. Each of the four "atomizers" in the plant has a capacity of 1500 pounds of atomized lead per hour. The streams of "atomized" lead are directed downwards into a large steel room or blow chamber, in the bottom of which is about two feet of water.

By means of a drag and screw conveyer, the lead in the form of a heavy, soft mud is delivered from the bottom of the blow chamber to the pump-feeder. The pump-feeder keeps the particles suspended in the water so that the material can be readily and conveniently handled by a rotary pump which forces the lead and water through a pipe line to the float-boxes where the lead is deposited in the desired compartments. These compartments of the float-boxes have a higher level than the bottom of the blow chamber and are piped back so that the water returns again to the blow chamber, which insures against any loss of lead.

By means of gate-valves the lead is discharged into the oxidizers, directly underneath the float-boxes. The requisite amount of water is added, a current of air under low pressure from a fan introduced and the contents agitated mechanically from twenty-four to thirty-six hours. The particles of lead from the "atomization" process have already become coated with a thin pellicile of suboxide, which renders the lead very active chemically, so that within a few hours after the beginning of the agitation a strong chemical action sets in, accompanied by a marked rise in temperature, which results in the formation of any of the several basic hydroxides of lead as may be desired.

At the expiration of the twenty-four to thirty-six hours, according to the size of the charge, about 80 per cent of the lead will have been converted; and then the oxidizers are discharged into a trough emptying into the float system on the floor below, where the metallic lead is completely separated from the basic oxide. It is then automatically conveyed to the small pump-feeder, from which the pump returns it again to the float-boxes. In the float-boxes it is to be added as a small increment to fresh charges of "atomized" lead, which secures a practically complete conversion of the returned lead.

The separated basic hydroxide, after flowing over the tables, is conveyed by means of pumps to the fourth floor where it is deposited in a series of large tanks. The water is returned to the separating system again, thus avoiding any mechanical loss of lead. The above mentioned tanks also act as a storage for the basic hydroxide, which is drawn as required into the carbonators.

The carbonators, located on the floor below the storage tanks, are large wooden cylinders somewhat similar in construction to the oxidizers but of a less capacity. In the carbonators the basic hydroxide of lead is agitated in the presence of carbon dioxide gas from fire gases of the boiler plant, which by means of scrubbers has been thoroughly cooled, desulphurized, and freed of soot particles. In approximately thirty-six hours the carbonation is complete, resulting, if the operation has been properly conducted, in an exceedingly white basic carbonate of lead of very closely theoretical composition. As there are no impurities present, no washing or floating is necessary. The thin semi-paste mass is drawn from the carbonators and pumped directly into the drying pans and dried in the usual manner. When dry, the white lead crumbles instantly under the slightest pressure into a very fine amorphous powder.

The carbon dioxide gas used is produced by the combustion of a selected grade of coke, very low in sulphur and volatile matter. The furnace is so constructed that 90 to 95 per cent of the oxygen of the air which enters the furnace is converted into carbon dioxide and the combustion is so controlled that there is a practical absence of carbon monoxide. The efficiency of the furnace is therefore very high. The heat produced is utilized in assisting the production of steam for power purposes.

The "Mild Process" is under almost perfect control, as any slight variation that may take place in the chemical reactions involved can be easily corrected and balanced. The completion of the carbonation is very clearly indicated by certain distinctive characteristics and its behavior at the time, so that there is no danger of an over carbonation under competent supervision. The gas is tested at regular intervals, and the changing condition of the lead is carefully noted. The composition of the basic hydroxide formed in the oxidizers indicates a hydration of 10 to 12 per cent or only about one-third of the combined water which is found in the finished white lead. Therefore the largest part of the hydroxide portion of the white lead molecule is formed during the carbonating process and has much to do with the apparent increase in volume exhibited during the carbonating which in itself serves as a close check upon the completion of the carbonation.

The merits of this process of white lead manufacture over other processes may be summed up as follows:

(a) The raw material, pig lead, is used in its original form from the smelters, and does not need to be cast into special forms for the exposure of a large surface to corrosive action.

(b) The "atomization" of the lead by the expansive force of steam puts it in the form of maximum surface exposed, and in this form is very susceptible to the chemical action of such simple agents of nature as air, water, and carbon dioxide.

(c) There being no chemical substances used, there is no cost for removal of impurities such as lead acetate, which is usually present where acetic acid is used.

(d) The great advantage of this method is from the standpoint of time taken to manufacture. The process is continuous and there is no long waits for complete corrosion of lead as is the case with the other methods.

It is not the purpose of this article to advertise Acme White Lead, so nothing will be said concerning the merits of the finished product. It may be said, however, that the white lead produced by this process is very similar to that produced by the older methods in respect to the quantity of oil thinners required for grinding and reducing to painting consistency.

The Wisconsin Engineer

Monthly Publication of the Students of the College of Engineering, University of Wisconsin.

EDITORIAL.

In a speech before the students of the Colorado School of Mines, John Hays Hammond stated that from his experience of men he had learned that the successful engineers owed seventyfive per cent of their fortune to personality and twenty-five to technical knowledge. In the engineering supplement of "The Times" of London, there appeared once a rather remarkable paragraph, written by one of the leading engineers of England, in which young engineers were assured of success if they were "mannered" as well as technically educated. There is an old college in England, whose alumni are distinguished in all professions and callings of life, which still uses the motto of its founder, "Manners Makyth Man." It is probable that Mr. Hammond would term "personality" that which William of Wykeham called, in quaint English, "manners." Most engineers have realized the force of these axioms. The engineer must be a man of personality, of individuality, if he is to rise to the top of the profession. He must carry the "Hall Mark" of capability, he must be different from, and yet one with and of, the general crowd. And for lasting success this mark, which was originally used by the Honorable Company of Silversmiths to brand sterling silver, must remain through life. His quality must not alloy through much mixing with the different foremen, mechanics, and laborers, with the prospectors and backwoodsmen; must not lose color by being left for months or years in a lonely gulch or exposed mountain side, must stand travel, heat, cold, and exposure.

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Personality does not lend itself to definition. It is easily recognized and always respected. It does, in fact, divide the mediocre men from the leaders, just as the mediocres are differentiated from the poor and mean, by their integrity, application and useful knowledge. We may watch the ways of the men of strong personality and emulate them. They are thorough in thought and in deed, they are correct in form of speech and of dress. They are men of manners. They may, and often do, despise the mediocre, and have in many cases acquired by hard work their second nature of leadership, through sheer abhorence of the moderate capacity, through gnawing ambition to be different, to realize the highest latent values in themselves. Generally the process of making the sterling article is commenced in college. By wise division of time to study, to the best forms of recreation, of social entertainment, the refining of the individual is commenced; personality results. The course of study of a serious student may not become special for many years. There is too much of elementary knowledge to acquire. Letters must have their influence before the higher technical work is commenced. Some knowledge of History, of Literature, both of the day and of the past, a fair understanding of Greek, Roman and Medieval society, an acquaintance with the development of the free and mechanical arts, and a knowledge of the elements of pure science, are necessary before the student attacks the hard work of the applied mechanical sciences in the College of Engineering. He should leaven this engineering work by mainainting some association with the College of Letters, by interesting himself in the current literature, and above all, by reading modern languages. His hours of recreation may wisely include some club life and association with congenial men of other colleges. He should welcome every opportunity, especially in vacation, to make the acquaintance of older men in the field, and become versatile, informed, and slowly but thoroughly cultured.

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The greatest benefit of the training may not be gauged in any utilitarian measure. He will become reflective, independent of society, if needs be, superior to the conditions accompanying misfortune and over-bountiful fortune or wealth. He will be happy up a gulch, on a lonely mountain top. His joy in building bridges will be doubled; the pride of the engineer will be second to the delight of the artist, the application of the mechanical will be helped by the judgment and taste of the aesthetic. Work will become a pleasure, the free Sunday a real vacation, a relief and change of thoughts and ideas, and not a weary void. The lights on the brown mountain range will suggest comparisons grand and not profane, and will stimulate the mind and emotions. But to specify the value of the literary and artistic training is unnecessary. It is too real and too obvious. The developed professional man only will understand the meaning of Kippling's millenium:—a time "when none shall work for money, and none shall work for fame, but each for the joy of the labor."

* * * * * * * *

The value of practice in writing cannot be sufficiently emphasized among Engineering students. Writing, actually writing with a pen or pencil, then correcting and rewriting technical or general articles for the press will develop literary form and ease. Good reading should accompany these efforts. Not the reading of the daily paper alone, but of such reviews as "The Forum," "The Dial," "The North American Review," and the leading technical papers, will help the Engineer in using right English in the right way. Correct speaking at all times should be a habit; choice and terse forms of words, a source of joy. Sallies of quick wit, frank appreciation of good humor, intelligent questioning of lecturers and ready response to speeches are the best means to develop ease in speech and mastery of expression. Let him speak English, use English terms instead of French and Latin. Huxley says that "Every English (speaking) man has in his native tongue an almost perfect instrument of literary expression." Let him learn the use of the instrument and disprove Barrie's statement that although in this age of Science, the Scientist is the only man who has anything to say, yet he is the one who does not know how to say it. Be a master of English, a Bachelor in Letters, as well as an Engineer, and the world will really be, if not at your feet, at any rate at your office and hall door. When Engineering students can do so much well, why shall they fail of the goal for lack of so little extra training.

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The problem of giving students opportunity for field work is becoming more difficult to solve every year as applications in larger numbers are made to companies which are in a position to employ and give students good experience. There is no question of the value of this practical work. It is probable that the solution may be in students taking more initiative in the matter; in personally securing the kind of work which will prepare them best for the time when they shall start out into the world from college. The personal application may, in many cases, bring the student more directly under the notice of, and in touch with, the superintendents, and establish for him valuable connections which he might otherwise miss. Certainly he will in this way become more reliant on himself, more able to set a proper valuation on his services, more ready to realize his deficiencies.

DEPARTMENTAL NOTES.

MINING ENGINEERING.

The registration of mining students in the three upper classes this fall shows an increase of fifty per cent over that of a year ago.

A paper on the neutralization of furnace gases by Mr. Havard appears in the current bulletin of the American Institute of Mining Engineers.

The new ore dressing laboratory is to be in operation next semester. Among the equipment already received are: a Johnston banner, a Wilfley table, a Richards pulsator jig and classifier and three callow settling cones.

TOPOGRAPHIC ENGINEERING.

The Sophomore Civil Engineers are now putting on the finishing touches on their field work. Immediately after Thanksgiving the field work will be replaced by drafting room work, Course T. E. 1. In this course the Sophomores will make maps for surveys executed in the Freshman and Sophomore years.

One of the new and greatly appreciated features of the summer camp at Devil's Lake included a number of lectures by members of the University faculty on topics other than engineering but suggested by the environment of the camp or the speaker's department. A lecture was also delivered by a professor of Geology from the University of Chicago on the Geology of the Baraboo region.

The completion of the new wing in the Engineering Building provides ample quarters for the Topographic and Geodetic Engineering Department. In the basement provision has been made for the instruments in a large room. Here also is found Mr. Cutler's office, the key room, and store room. On account of the unfinished condition of the North wing the work of the department has been seriously interfered with during the past season.

CHEMICAL ENGINEERING.

Mr. Alcan Hirsch, who is carrying on an investigation in the Electro-chemical laboratories on the electrolytic production of cerium, is credited recently with the production of 150 grams of of this metal. This is remarkable in that this quantity undoubtedly represents the largest amount of this material in existence in this country, and it is doubtful even whether anyone else has ever produced any of this metal in the state of purity which Mr. Hirsch's metal apparently possesses. Cerium is one of the very rare metals, and the further production of it and the study of its properties will lead to interesting results.

The Chemical Engineering laboratories have recently been moved into the space on the second floor of the Chemical Enginering building formerly occupied by the electrical testing laboratories and offices. In these rooms are now being installed electro-chemical equipment and the Electro-plating and Metal Refining Department. Two of the rooms are devoted to metallography and the microscopic study of alloys. Space is also provided for advanced research work. The main floor is devoted mainly to gas and fuel work and calorimetry, while in the basement are located the electric furnace, pyrometric and chemical manufacturing equipments.

The eighteenth general meeting of the American Electrochemical Society was held in Chicago on October 13, 14, and 15. Those in attendance from Madison were: Dr. O. P. Watts, O. L. Kowalke, W. B. Schulte, Dr. L. Kahlenberg, Dr. David Klein, and Charles F. Burgess. Among the papers on the program were the following from Wisconsin authors: "Magnetic Properties of Electrolytic Iron Alloys" by James Aston; "Practical Significance of 'Over-voltage' " by Carl Hambuechen; "Relative Basicity of Metals" by Dr. L. Kahlenberg; and "The Effect of Water in Causing Chemical Reactions" by Dr. David Klein. Other Wisconsin Alumni who presented papers were Prof. A. R. Johnson, '06, Prof. O. W. Brown, '05, H. E. Patten, '02, W. R. Mott, '03, and R. S. Wile. Of the twenty-five papers presented at this meeting, ten were under the authorship of Wisconsin men. Mr. A. B. Marvin, '00, was secretary in charge of the Chicago arrangements for the meeting. It was one of the most largely attended meetings the society has held, there being nearly three hundred on the registration list.

STEAM AND GAS ENGINEERING.

Several important changes have been made in this department. The laboratory has been enlarged by a 50 foot extension towards the north, 30 feet wide, for the accommodation of gas producers, gas engines, and a new Foster steam superheater. This space has been much needed, and will relieve the previously crowded condition of the steam laboratory. A new 20 H. P. Foos gas engine has been obtained in exchange for the 3 cylinder vertical engine formerly installed and which has been too large for laboratory experiments. The new engines embodies many new features, and can be operated by almost any of the liquid and gaseous fuels. One of the most needed improvements has been completed in the construction of a new steam "loop," around the laboratory under the gallery, but well above the head room required on the lower floor. The piping is thus made accessible for repairs and for regular operation. It is proposed to describe these and other improvements in an early issue of THE WISCONSIN ENGINEER.

DEPARTMENT OF MACHINE DESIGN.

Mr. A. L. Goddard, B. S., M. E., '96, is now Superintendent of Shops, having taken up the duties of this position at the beginning of the college year.

Mr. W. G. Lottes, instructor in forge practice, is on a year's leave of absence, during which time he is the expert on steel working for the International Harvester Co. Mr. Lottes visits the various plants of the company, making at each a study of the steel treatment and materials, with a view to improvement in the quality of the product and cost reductions.

A four story building is being completed near the new University Heating Plant for the utility shops which are now located in various buildings. Space is being provided for the carpenter, pipe-fitting, plumbing, paint, and electrician's shops.

The present carpenter shop, in the first floor of the east wing of the machine shop building, will be used as a shop and laboratory by the Manual Arts Department, which was organized this year under the direction of Mr. F. D. Crawshaw, formerly of the University of Illinois and Bradley Polytechnic.

Prof. Crawshaw is a graduate of Worcester Polytechnic, B. S. in E. E., 1896; M. E., 1897.

HYDRAULIC ENGINEERING.

Mr. Charles I. Corp, Junior Member Am. Soc. M. E., Assistant Professor of Mechanical Engineering in the University of Kansas, is taking a year's leave of absence, which he is devoting to experimental research in the Hydraulic Laboratory at the University of Wisconsin, having been appointed Research Assistant in Hydraulics at that institution. Mr. Corp was graduated from the University of Kansas in 1903. He has charge of the work in hydraulics, the materials laboratory and some of the work in the mechanical laboratory at that place. He spent the summer of 1908 experimenting with turbines in the Wisconsin Hydraulic Laboratory. His present study will be directed towards a determination of certain hydraulic losses in reciprocating pumps.

Mr. Geo. E. P. Smith, Associate Member, Am Soc. C. E., Irrigation Engineer at the Agricultural Experiment station of the University of Arizona, is taking a year's leave of absence, which he is devoting to irrigation investigations. The past summer he spent in Italy studying irrigation practice in that country. He has received an honorary fellowship in hydraulic engineering at the University of Wisconsin where he will spend the present school year making an experimental study of centrifugal pumps in the Hydraulic Laboratory. Mr. Smith was graduated from the University of Vermont in 1897, receiving his second degree there in 1899. After teaching engineerng in the University of Vermont for three years, he was appointed Professor of Civil and Mining Engineering in the University of Arizona, which position he held for six years, until appointed to his present office.

WISCONSIN STUDENT SECTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

As the name indicates, this society is one of the student sections of the American Society of Mechanical Engineers which within the past few years, has recognized the importance of the technical colleges of the country, and made provision for student sections to be established at technical schools of good standing. The local section is under the supervision of the national society, and its members are granted the following privileges; to receive the journal of the American Society of Mechanical Engineers at the yearly rate of $2 while the regular price is $5; to continue their subscriptions at this rate for two years after graduation at which time they may make application for junior membership in the national society; and to take part in, and derive benefit from, the meetings of the local student section.

The Wisconsin student section was organized about a year ago and since organization has held about one meeting per month. Some outside speakers of considerable note have addressed the section, and some of the students have given talks on practical subjects in which they were experienced.

A few changes have been planned for this year's work. Efforts are being made to make the programs unusually attractive, and a change of meeting place is being contemplated. Formerly the society has met in the engineering building, but it is thought that meetings held in one of the Union rooms would be more conducive to good fellowship and larger attendance.

Anyone interested in the work which the student section of the American Society of Mechanical Engineers is doing is cordially invited to be present at these meetings which are advertised by poster and by Cardinal announcement.

TAU BETA PI ELECTIONS.

At the semi-annual initiation of Tau Beta Pi, held at Keeley's on the eleventh of November, the following were initiated:

W. Graetz, of the class of 1912; G. Cowan, J. Slade, M. Lamont, C. Scudder, J. Schwada, A. Ludberg, J. H. Johnson, S. Stanley, J. Langwill, J. Lightbody, W. V. Bickelhaupt, of the class of 1911.

WHAT THE GRADUATES ARE DOING.

This section is conducted with a double object in view—First, to give the alumni professional news of each other; second, to give the undergraduates an idea of the possible fields of employment open to them in the future.

Wm. O. Krahn, '09, is designer of mill buildings with the International Harvester Co., Milwaukee office.

Wm. C. Penn, '07, former instructor in topographic engineering is now with W. G. Kirchoffer, consulting engineer, Madison.

A. M. Wolf, '09, is assistant engineer with W. G. Kirchoffer, consulting engineer, Madison.

Oscar Rohn, '95, is manager of the East Butte Mine, and has just suceeded in developing an important ore body.

That Wisconsin graduates in Chemical Engineering work are finding Madison an attractive field for employment is shown by the following record:

Carl Hambuechen, '99, and O. E. Ruhoff, '02, Chemical Engineers, are associated with the Northern Chemical Engineering Laboratories.

B. B. Burling, '06, is superintendent of the French Battery and Carbon Co.

J. G. Kremers, '98, is manager of the Wisconsin Sugar Co., having their principal plant located in Madison.

Louis Witt, '08, resigned his position with the Aluminum Co. of America to take up work with the Forest Products Laboratory.

E. L. Leasman, '08, formerly superintendent of the French Battery and Carbon Co., is in Chemical Engineering work for the Forest Products Laboratory.

J. H. Thickens, '08, as Chemical Engineer for the Forests Products Laboratory has been transferred recently to Wausau, Wis., where he has charge of a branch laboratory just installed there.

George C. McNaughton, '09, is gas inspector for the Railroad Commission of Wisconsin.

W. J. Huddle, chief gas inspector for the Railroad Commission, is carrying on graduate work in Chemical Engineering. He is at present on a leave of absence, being engaged upon a valuation of the plant of the People's Gas, Light, and Coke Co. of Chicago.

Other graduates include members of the Chemical Engineering faculty, O. P. Watts, Ph. D., '05, O. L. Kowalke, '06, James Aston, '98, Charles F. Burgess, '95, and W. B. Schulte, '10.

F. H. Cenfield, '09, and F. E. Bates, '09 and '10, returned to Madison for a short visit with friends November 6.

Ralph R. Birchard, '10, now Manager of the Wray Publishing Co., Chicago, returned for the Chicago-Wisconsin foot-ball game. Mr. Birchard is promoting "Data" a new publication giving the latest engineering data in filing cabinet form.

A large delegation of enthusiastic alumni from Milwaukee returned to see Wisconsin humiliate Chicago. Among them were A. E. Kringel, '10, Erwin Knebes and R. A. MacLaren.

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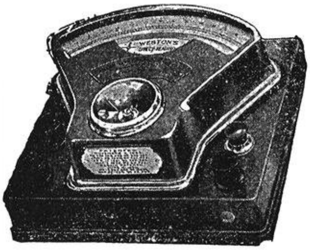

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