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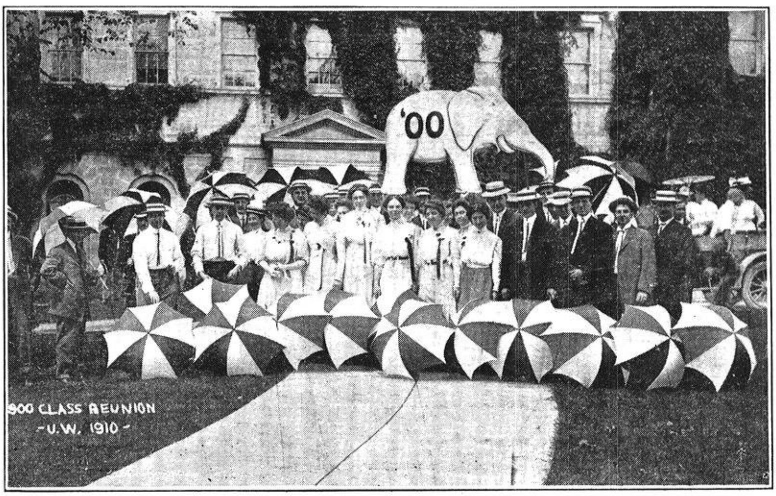
The Wisconsin Engineer



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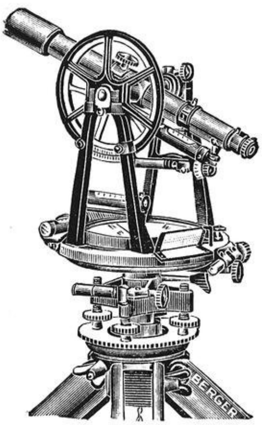

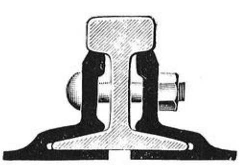

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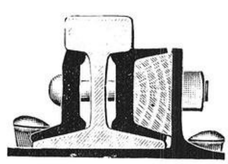

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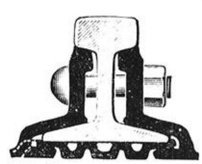

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The Wisconsin Engineer

VOL. XV OCTOBER, 1910 NO. 1

THE IMPROVEMENT OF STEAM PLANT EFFICIENCY

WITH SPECIAL REFERENCE TO THE USE OF SUPERHEATED STEAM.

CARL C. THOMAS,
Professor of Steam Engineering.

In the early part of the last century a well known writer in New England wrote a communication to an English engineering periodical describing new machinery which was built at Newport, R. I., by John Babcock and Robert L. Thurston, for one of the first steamboats that ever ran between Newport and the city of New York. This writer prefaced his description with a remark which has been often quoted, but which is nevertheless in error, to the effect that "even as Minervå sprang, mature in mind, in full stature of body, and completely armed, from the head of Jupiter, so the steam engine came forth, perfect at its birth, from the brain of James Watt." The fact is that James Watt was a very great man and a great inventor. He was one of the inventors of the steam engine. He improved in almost every essential particular the crude and wasteful steam engine which had been developed before he first directed his attention to the problems of using steam. He invented the separate condenser, the fly wheel, the crank shaft, the centrifugal governor, the steam engine indicator and its operating mechanism, and the expansive use of steam. He outlined many of the thermal conditions most essential to economy of fuel, he invented the steam-jacketed cylinder, and he suggested to the well known inventor Hornblower the use of more than one cylinder in a single engine for the purpose of lessening the temperature range and therefore the wasteful condensation of steam in each cylinder.

The only thing which Watt apparently did not think of, which has since become of great importance in increasing the economy of reciprocating steam engines, was heating the steam to a temperature above that of saturated steam at the same pressure; or what is generally called superheating the steam.

The development of this feature of steam engineering dates back to about 1827, and the honor of the invention is claimed for one Becker, a mechanician of Strasbourg. He obtained a French patent covering his invention. There have been many other claims made for the honor of first suggestion; for example, in the Life of Richard Trevethick, of the Binner Downs Mines in Cornwall, it is stated that a Captain McGregor, in 1828, in order to compete with the record of an engine in a neighboring mine whose cylinder had been insulated with sawdust, built a brick jacket outside the cylinder of his engine and kept a fire burning in the space between the brick work and the cylinder wall. It is said that he increased the duty of his engine from 41 million foot pounds to 63 million, per bushel (86 lbs.) of coal. Trevethick tested this engine, which had a cylinder 70 inches in diameter and made eight strokes per minute under 48 lbs. steam pressure, and found that by using five bushels of coal in 24 hours under the cylinder he reduced the consumption of coal for steam making from 108 bushels to 67 bushels for the same work. This represented a saving of 33 per cent.

John Ericsson is said to have experimented in about 1834, but no records are at hand regarding his results. Longridge experimented with superheated steam at low pressures in 1845. A patent on a steam superheater was granted in 1851 to one Rafford in France. The great scientist Faraday did extensive work in investigating the possibilities of using superheated steam He was apparently stimulated in this work by the British Board of Trade. It was feared by that body that at the temperatures proposed for superheated steam dissociation of the steam would take place, and that dangerous explosions would follow, from the presence of free hydrogen and oxygen. Faraday fully investigated this matter, and was able to convince the authorities that such danger did not exist.

To the great Alsatian scientist, G. A. Hirn, undoubtedly belongs the honor of the first invention of practical means for superheating steam. A patent granted to him on Nov. 12, 1855, describes a "Hyper-thermo Generator," formed of a group of tubes placed in the middle of the gases of combustion, hot enough to impart to the steam a high degree of superheating.

From 1860 to 1870 superheating was principally confined to marine work; the pressures used were from 20 to 60 lbs. by gauge, and in certain cases very high degrees of superheat were used. The gain in economy obtained at that time is stated at from 20 to 30 per cent. Probably no work ever done on this subject has been of greater value in the development of superheating than that of Chief Engineer Isherwood of the U. S. Navy. In 1863-4 he tested the engines of the steamer Eutaw, which had puppet valves and were fitted with Stevens' adjustable cut-off. He reported a gain in economy of 18 per cent in steam and 15 per cent in coal. Isherwood suggested that superheating be limited to 100 deg. F. because of possible injury to materials of the engine.

From the first application of superheated steam two important results, diametrically opposed to each other in desirability, have been noted. The first result obtained, and that desired, was increase of economy in fuel. The second and accompanying result was interference with the satisfactory mechanical operation of reciprocating engines. Excess of superheating carbonized lubricating oils, caused deformation of cylinders, valves, pistons and other parts, destroyed the packing in stuffing boxes, and accelerated general deterioration of parts subjected to the high temperature steam. Hence the return, or change, about 1868, from superheating to extensive compounding of engines, the use of higher steam pressures, and to steam jackets, etc., in order to obtain satisfactory economy without the use of high temperature steam. It was necessary to reduce the degree of superheat, and in general superheating was discontinued, as the gain due to very low degrees of superheat was found to be relatively small, and the expense of maintaining superheaters high.

But the desire for a high initial temperature has always lingered in the minds of engineers, since Carnot pointed out the limits of maximum efficiency of heat engines as depending upon temperature range of the working substance. For many years following the unsuccessful attempts to use superheated steam, the high initial temperatures desired were sought by the use of unsuperheated steam of high pressure. The increase of pressure involved additional weight and expense of engines and boilers, and increased liability to accidents. The gain due to increasing steam pressure reached its limit late in the 1890's, and engineers began again to turn their attention to superheating. The development and adoption of the steam turbine is principally responsible for the great increase in the use of superheated steam during the past ten years. The absence of rubbing surfaces, with the exception of external bearings which do not come in contact with the steam, has made it possible to use at least moderate degrees of superheat; but it has been necessary for engineers to bring into use methods of design and to develop materials, especially suited to superheated steam, in order to use it with any degree of satisfaction, even in turbines.

The result of nearly a century of experimenting with high initial temperatures, produced alternately by using superheat and by using high steam pressures, has for the present resolved itself into the acceptance of moderate steam pressures, from 150 to 200 or 250 lbs. per square inch, and moderate superheat of from about 75 deg. F. to 150 deg. F. With these conditions a kilowatt hour can be delivered at the switchboard for about 1.60 to 1.75 lbs. of coal, and a steam consumption of from 13 to 15 lbs. per K.W. hour. It is generally conceded that superheating the steam causes a large part of the increase of economy, and it is interesting to consider the probable causes of the increase in economy due to superheating. Whether the economy ensues because the steam is hot and a high initial temperature tends to increase thermal efficiency, or whether it is because the steam is dry for a considerable period of time after it reaches the engine, is perhaps not so important a question to have answered as is the more immediately practical question, How much does this superheated steam cost at the coal-pile? The latter question depends for its answer upon at least two factors, namely, the specific heat of superheated steam, and the expense of installation and maintenance and the efficiency of superheating apparatus. I will review briefly some of the recent theories which have been advanced in explanation of the increased economy due to superheating steam, and in doing so will make use of several articles and reviews which have recently appeared in technical publications.

The data that are available as to the definite amount of saving to be effected by the use of a given degree of superheat, are up to the present time either insufficient, or else they have not been analyzed with sufficient consistency to enable one to state positively what gain in thermal efficiency can be obtained by the use of a given steam temperature. Analysis of a large number of carefully conducted experiments in Europe, where superheating has been employed much more extensively than in this country, shows that with the best types of reciprocating engines, 1 per cent saving results for each 5 to 6, or perhaps 5 to 7, degrees of superheat. It appears also that with steam turbines and locomotives, 1 per cent gain in economy is obtained for each 8 to 10 degrees F. of superheat. But in making such statements it is necessary to start with a knowledge of the conditions under which the steam works in the particular engine considered. The following quotation from "Power and the Engineer" illustrates this point:

"Suppose that an engine is wastefully using wet steam; that in order to increase the economy, superheating is adopted, but no other change is made. A saving of thirty per cent. may result. If, however, the engine had previously been economical, working with steam as nearly dry as possible, then the saving might not have been more than say 10 per cent. This is a very important point. The benefit derived from moderate superheating will depend largely on the initial quality of the steam. The dryer the steam is initially, the smaller will be the percentage of saving due to the installation of superheating apparatus. The gain that will be attained by adopting 100 degrees superheat, for example, in an engine which formerly used unsuperheated steam, will be much greater than that obtained by increasing the superheat in the same plant from 100 up to 200 degrees. That is, it seems probable that the gain will be represented by a curve rather than by a straight line. It is highly desirable that tests should be made with such analysis as this in view. The first increment of temperature is effective in drying the steam that would otherwise be somewhat wet upon reaching the engine or turbine. The higher increments of superheat cause the steam to remain dry during a considerable portion of its path through the engine. The result of both these conditions is a saving of steam. It seems probable that the increased thermal efficiency due to superheating would reach a limit beyond which it would not pay to superheat, even if the question of maintenance did not enter in to prevent excessive superheating from being practicable. The higher the superheat the larger must be the superheater; and the transfer of heat from one hot gas to another, through metal, is a slow process. High superheat demands large surface exposed to hot gas or to radiant heat. But recent experiments have shown that in order to obtain high efficiency of heat transference, both the steam and the hot gases from the furnace must travel at high velocity. This fact increases the length of the path necessary for the steam and gases to travel, and therefore calls for extensive heating surface and long steam passages. However, the best modern practice in boiler design calls for a large amount of work to be done by each square foot of heating surface. But this applies to the boiler itself, and not necessarily to the superheater. A very large number of German and French steamers have been fitted with superheaters, and a number of American ships use superheated steam. The claim is made in general that a saving of about 20 per cent. in fuel is the result. But fifty years ago as much as 25 per cent. saving was obtained in Cunard steamships, and still superheating apparently did not pay. However, improvements in design and material have been made in recent years to such an extent that greatly increased durability and compactness have been secured, and superheating has been put upon a sound commercial footing."

While this is so, and while designers have attained considerable success in providing for the deteriorating effect that superheated steam has upon many of our materials of engineering, many cases of failure in pipe lines, valves, fittings and the like, are reported from time to time by those in charge of plants using superheated steam. It appears that cast iron fittings, for example, frequently show cracks after six months or even less of service, and that castings grow in length and otherwise change dimensions, due to repeated exposure to high temperatures. Valves get to leaking, and their seats become loose or crack. Apparently some materials become weak in spots, due to superheating, and this leads to deformation of lines of piping. Cracks appear in flange connections. The question has frequently been brought up, Should cast iron be used at all for superheated work? Steel is a good substitute in some respects, but frequently unreliable. Steel valve-bodies get to leaking. The porosity is often and perhaps generally initially present in the casting, and is not initiated by the superheated steam. When steel fittings are under test, if they are rapped with a hammer, faults frequently appear. It seems that if faults do exist initially in a steel casting, they are more likely to develop into dangerous defects when used with superheated than with unsuperheated steam. This seems to apply also to cast iron fittings, superheated steam apparently bringing out the objectionable features of any defects that exist. It appears that the material known as gun iron is quite successful as a material for use in connection with superheated steam. This is simply a high grade of cast iron which was developed by foundrymen in the days of iron cannons. It is an iron having low silicon, low phosphorus and low total carbon content. Recent experience along this line has pointed out that a good iron for use with superheated steam would resemble this so-called gun iron in these respects. It is said that in Germany high grade cast iron has proved entirely satisfactory for use in superheated steam work, but it is probable that the iron used is of unusually good quality. The following analysis is given by Mr. A. S. Mann, and represents an iron said to have been successfully used during four years, with steam of 300 deg. F. superheat.

Silicon	1.720 per cent.
Sulphur	0.085 per cent.
Phosphorus	0.890 per cent.
Manganese	0.480 per cent.
Total Carbon	2.450 per cent.
Combined Carbon	0.170 per cent.

Mr. Mann gives the following as practicable and satisfactory from the standpoint of the foundryman and the user:

Silicon	1.40 to 1.60 per cent.
Phosphorus	0.02 to 0.04 per cent.
Sulphur	0.06 to 0.09 per cent.
Manganese	0.45 to 0.75 per cent.
Total Carbon	3.00 to 3.25 per cent.

It will be noted that the percentages of silicon and phosphorus are low.

Various mixtures of iron and steel, called "semi-steel," are used in superheated steam work. It seems probable that steel castings will continue to be used, and such material, when free from the defects customarily found in it, is exceedingly satisfactory for superheated steam work.

There is little reason to question the statement frequently heard, that the use of superheated steam is increasing. The obstacles which have been encountered have never been sufficient to blind engineers to the real merits of superheated steam, or to the fact that the cost of power production can be materially lowered by its proper use. It has from time to time been tried, but necessarily abandoned because of the difficulties encountered with the materials used in engines, boilers and pipe lines. With improvements which have been made along these lines, however, there is reason to believe that engineers will find it possible to avail themselves of the advantages that certainly attach to the superheating of steam.

The use of superheated steam has progressed from the crude attempts cited at the beginning of this article, to the quite general acceptation which it now finds, simply because improvement in fuel economy has so generally attended its use. Many attempts have been made to formulate reasons for the increased economy, but no generally acceptable and comprehensive theory seems to have been forthcoming. The following additional quotation from "The Engineer" of London sets forth with remarkable clearness, however, many of the considerations upon which a satisfactory theory of superheating must depend.

"As a matter of fact, there are three general reasons given for the economy secured by superheating steam between the boiler and the engine. The first is that it prevents cylinder condensation, and so gets rid of the 'missing quantity.' The second is that by superheating steam its volume is greatly augmented; and the third is a combination of both. A fourth reason deserves mention here. It is that superheated steam is much more 'lively' than saturated steam. It flows more rapidly through ports and passages, and as one result back pressure is reduced. The late D. K. Clark found in his experiments that locomotives with outside cylinders, other things being equal, always had a sensibly higher back pressure than had those with inside cylinders, simply because the exhaust steam from the former was more sluggish than that from the latter. In the present day, engine drivers remark that whether fuel is saved or not, at all events there is 'more life in the engine.' It will be seen that it is not easy to eliminate the consideration of the question of activity, particularly from triple-expansion engines, in which the distances to be traversed are considerable, and the passages are crooked and somewhat contracted.

If we take up the anti-condensation theory we find it very difficult to formulate any definite figures, because too little has been determined as to the nature and causes of initial condensation. Its amount varies in a way that really defies all calculations, and the most we can do is to provide a sufficiently high temperature to prevent condensation. So far, practice in this direction has been pure empiricism. The general rule is to make the steam as hot as it can be made without doing mischief, either to the superheater or the engine. Much depends on the nature of the oil used as a lubricant, and the rate at which the superheat departs. In many instances a superheat of 250 deg. F. has, it is said, disappeared entirely before the piston has made one-fourth of its stroke, and it is worthy of notice that it is not easy to detect the difference between diagrams with and without superheat. The broad fact is that, be the diagrams what they may, less feed-water is used per horse-power with than without superheat.

The theory of superheating on this basis is that each pound of steam takes in an additional quantity of heat, depending for its amount on the temperature and the specific heat of the steam. Thus, for example, let us suppose that an engine is supplied with 15 lbs. of steam per horse-power per hour, the pressure to be 150 lbs. absolute, and the feed-water temperature 100 deg. The total heat supplied to each pound by the coal will be, in round numbers 1123 degrees, or, to be accurate, B. T. U.'s, and $1123 \times 15 = 16845$ as the quantity from which to get as much work as we can. The temperature of 150 lbs. is 358 deg. F. If now we superheat it by 200 deg. F. we have a temperature of 558 deg. F. The quantity of added thermal units will be found by multiplying 15 lbs. into the specific heat of the steam; what the specific heat of gaseous steam is has not yet been conclusively determined. Under constant pressure—the condition with which we have to deal—Regnault found it to be .475. There is reason, however, to believe that it is higher, and we shall not be far wrong if we take it in round numbers as .500. We have then $200 \times .5 \times 15 = 1500$ units, and the total stands at 18,345. It will be seen that the expenditure of heat in raising the temperature of the steam is very small as compared with that required to make it. It amounts to only about 9 per cent. But the loss by initial condensation may amount very easily to 30 per cent. If this is avoided by superheating, it is no wonder that a marked economy follows the use of superheated steam."

(However, the net gain, from the standpoint of the coal-pile, depends largely upon whether an independently fired superheater is used, or whether the superheater is placed within the main boiler setting and therefore obtains its heat from the gases generated on the same grates as are those used for the purpose of evaporation. An independently fired superheater might have an efficiency of 50 per cent, or perhaps more, depending upon design, efficiency of furnace, etc. Assuming this efficiency, if the saving in steam consumption due to superheating is 20 per cent, or 1 per cent for each 10 degrees of superheat, it has cost

3,000 B. T. U. to save 20 per cent, and the actual saving is only 10 per cent, or ½ per cent per 10 deg. A saving of 10 per cent might have been effected by using an "economizer," or feed-water heater, placed in the path of the escaping gases from the main boilers, and without any superheater. It then becomes a question between the desirability of an economizer and an externally fired superheater. But if the superheater is placed within the boiler setting it may effect a saving of 10 per cent in addition to that due to an economizer. Besides this saving, some of the heat in the exhaust from auxiliaries may be recovered in an exhaust steam feed water heater, which raises the feed temperature above that of the water coming from the condenser. *Author.*)

"As we have said, it is impossible to predicate in any case what the saving will be, because of the lack of the necessary data. There, however, is the theory, as far as it goes. A small quantity of heat expended in raising the temperatue of the steam will obviate the phenomena, whatever they may be, which bring about the 'missing quantity'; and it is worth notice that this condition holds good whether the missing quantity is explained in the normal way, or by valve leakage as supported by Messrs. Callendar and Nicholson.

We may now proceed to the consideration of the second theory, which is that the saving effected is mainly due to the augmentation of the steam volume, and a general all-round improvement in the quality of the steam. This may be termed the physical theory, and it possesses several ramifications. Thus, cylinder condensation is not prevented by the augmented temperature of the metal, but by the circumstance that dry steam parts with its heat much more slowly to metal than does wet steam. The experiments of Siemens and Fairbairn and Tate go to show that at first the rate of increase of volume is very rapid—as much as five times that of air. The rate tapers off, however. Thus with 95 lbs. steam the rate of expansion up to 331 deg. was nearly three times that of air, and for the next 25 deg. only one-sixth greater. Rankine held that ordinary steam became gaseous when superheated 40 deg. F. D. K. Clark held that this result could be obtained when the superheat lay anywhere between 10 deg. and 20 deg. He writes: 'It is thought that the rapidity of expansion by heat near the boiling point is to be accounted for by the supposed insensible moisture of steam in the saturated condition, as generated from water, being evaporated and contributing to increase the quantity of steam without raising the temperature. The argument is plausible; but it might be argued on the contrary that in the converse process of abstracting heat from superheated steam, the accelerated reduction of volume when it approaches the point of saturation is due to incipient condensation, which would be absurd.' It does not appear, however, that the statement is really absurd at all. The total withdrawal of superheat ought to leave the steam in its original condition, and if it originally contained free water, that water would of necessity be found at the end of the operation, as there would be no heat available to maintain it as steam. Fairbairn wrote in 1860: 'Close to the saturation point we find a very high rate of expansion, but this rapidly declines as the steam superheats, and at no very great distance above it the rate of expansion nearly approaches that of a perfect gas. Thus, for instance, in experiment (6) where the point of maximum saturation was 174.92 deg., between this and 180 deg. the steam expanded at the mean rate of 1/190 whereas air would have expanded 1/634 only; but on continuing the superheating, the coefficient was reduced between 180 deg. and 200 deg., from 1/190 to 1/637, and for air the coefficient would have been 1/639, or almost exactly the same, and this rule holds good in every experiment; a high rate of expansion close to the saturation point diminishing rapidly to a close approximation to that of air.'

It is not quite clear where Fairbairn got the coefficient 1/634, but it is immaterial. It may be taken as proved that the rate at which steam expands while being superheated is not less than that of any permanent gas. Applying this to the case we have stated above, we have 15 lbs. of steam at a pressure of 150 lbs., and an absolute temperature of 819 deg. F., and a volume of 44.4 cubic feet. Adding 200 deg. F. superheat, we have, acording to Regnault's tables, an augmented volume of about 1/6, or say 17 per cent. If, however, the steam was in the ordinary condition before it went into the superheater, it is probable that according to Fairbairn and Tate, the increase in volume would be much larger. We shall not be far wrong, we think, if we assume that superheating steam by 200 deg. F. will augment its volume 20 per cent. How much heat will be expended in doing this depends on the specific heat of gaseous steam. It is evident that we have apparently a very important factor here. The augmentation of volume may be counted upon, and that too of perfecly dry steam which can lose a good deal of heat before condensation will take place. Nevertheless it is frequently argued that the increased volume is a wholly negligible quantity, and is never found in the cylinder, a statement which can only be true if the whole of the superheat disappears as soon as the steam enters the clearance space. For the case we are considering it amounts to 1500 units per horse-power per hour. No one has the smallest knowledge what becomes of it. Liquefaction due to the performance of work takes place with saturated steam because the steam loses latent heat. But is it not possible that when superheated steam is in the cylinder the action is that which occurs when a permanent gas does work? And the first loss is represented by drop in temperature and not by the sacrifice of latent, or it may be said structural, heat—that is, the heat expended in producing the highly unstable fluid known as saturated steam.

The third theory is, as we have said, a combination of the two views. Superheating augments the volume of the steam produced from the feed-water, and it raises the temperature of the cylinder and piston surfaces so high that initial condensation is prevented. We believe that this represents the facts better than either alternative theory taken alone. But none the less it is certain that some anomalies exist which have yet to be explained. One is the exceedingly small effect of superheating on indicator cards. Nominally this means, of course, that the same average pressure is obtained with a less weight of superheated than saturated steam. But so far as is known, the only difference in the cards seems to be a reduction to a small extent in back pressure. This can of course be explained by saying that superheat is quite ephemeral. The experiments which have so far been made as to the temperature inside the cylinder are very imperfect. We do not refer to the cylinder walls, but to that of the steam, which is quite another matter. No doubt in many cases superheated steam is carried through considerable distances in badly clothed pipes, and the most that it can accomplish is effecting some reduction in the condensation which would otherwise go on in these pipes, the superheat never reaching the cylinder.

We have failed to find any record of detailed experiments made with really large engines to settle numerically the effect on the consumption of fuel, save those conducted by Isherwood and recorded in 'Experimental Researches in Steam Engineering', published as far back as 1865. They were made with paddle-wheel beam engines of great size; thus the S. S. Adelaide had a single cylinder 50 in. diameter and 12 ft. stroke, driving paddle wheels 31 ft. in diameter. Another ship, the Georgeanna, had a cylinder 44 in. diameter, 11 ft. stroke. The general result was a saving of over 20 per cent. secured by moderate superheating. This investigation was conducted with great care, and Isherwood's report is worth very careful perusal by engineers interested in superheating. We cannot better conclude this paper than by the following extracts from it: 'The very great increase of economic effect practically resulting from even such moderate degree of superheating as will just prevent condensation in the cylinder, can be easily understood when it is considered that—supposing the condensed steam to be precipitated on the metallic surfaces and not suspended like a mist or fog in the steam remaining in vaporous form—this condensation counts twice against the fuel; once in the reduction of the power, and again in the quantity of heat which has to be imparted to these surfaces by the boiler steam to re-evaporate the water of condensation from them. In other words, all the steam condensed in the cylinder has to be twice evaporated, while no useful effect whatever is obtained from it. Practically, however, it appears that the whole of the steam condensed in the cylinder, due either to the production of power or the expansion per se, is not precipitated upon the metallic surfaces. The condensation due to these causes takes place uniformly throughout the whole mass of steam in the cylinder, and the portion which remains in the vaporous form is able to hold a certain weight of it in suspension, while the remainder must fall upon the surfaces. All the condensation, however, due to external radiation, and to the coldness of the interior metallic surfaces, after their exposure to the condenser temperature and action, must be deposited on those surfaces and re-evaporated by the heat of the boiler steam entering for the next stroke of the piston; consequently all such condensation certainly counts twice against fuel, while the previously described condensation, due to the production of power and to the expansion of the steam per se, may count only once or they may count in any proportion between once and twice against the fuel.'

We have referred above to the smallness of the effect of superheating on indicator diagrams. Referring to his experiments with the S. S. Georgeanna, with various changes of superheating, Isherwood writes: 'It will be seen that the expansion curve formed by the steam pressure in the cylinder after the closing of the cut-off valve, was almost identical with what it should be according to the simple law of Mariotte; that is to say, the pressures were inversely as the volumes, without regard to the variation of temperature. The same coincidence will be found in steam engines in good condition, working without air leaks and with saturated steam; and it is interesting to note the agreement in cases of extreme diversity in the kind and pressure of steam used, size of cylinder and measure of expansion. It obtains whether the steam pressure be high or low, whether it be saturated, slightly superheated or greatly superheated, and whether the measure of expansion be great or small. Of course it is purely a coincidence, but being a constant one, it has its practical value for approximate results from boiler pressure when the indicator evidence is wanting.' "

Such, then, is, in brief outline, the history of the invention and early development of superheating, together with a review of some of the difficulties encountered in its application, and of general considerations bearing upon the theoretical or scientific aspect of the subject. At the present time superheated steam is in successful use in many stationary power plants, on steam locomotives and aboard ship. Aside from the question of economy, engineers realize from long experience that water carried with steam frequently does serious injury to engines, turbines and pipe lines. When superheated steam is used, water is almost certainly absent from the steam, and the latter is dry upon, and generally for some time after, reaching the engine. The development of satisfactory lubricants for superheated work has done much to bring superheated steam into general use.

The improvement in economy actually attained is well illustrated by comparative tests made by Prof. D. S. Jacobus on the machinery of the steam yacht Idalia with saturated and with superheated steam. Quoting from the report made by Professor Jacobus:

"The engines are of the four-cylinder triple expansion type, with cylinders 11–1/2″, 19″, 22–11/16″ and 22–11/16″ diameter by 18″ stroke, the steam being supplied by a Babcock and Wilcox marine boiler having 65 sq. ft. of grade surface, 2500 sq. ft. of heating surface and a superheating surface of 340 sq. ft. * * * With 105 deg. F. superheat the saving in steam consumption was 15.3 per cent. and in heat consumption about 10 per cent."

The principal results are given in the following table.

Results of Idalia Tests.

Date, 1909	Oct. 11	Oct. 14	Oct. 14	Oct. 12	Oct. 13
Degrees of Superheat, F.......	0.	57.	88.	96.	105.
Steam pressure by gage, pounds sq. in.	190.	196.	201.	198.	203.
Vacuum, inches mercury,.....	25.5	25.9	25.9	25.4	25.2
Revolutions per minute, ...	194.3	195.1	195.1	191.5	193.1
Total water per hour, lbs......	9397.	8430.	8234.	7702.	7790.
Water per I.H.P. hour, lbs ...	18.3	17.0	15.8	15.8	15.5
B.T.U. per I.H.P. per min....	314.	300.	284.	286.	283.
Per cent saving of steam,......	....	7.1	13.7	13.7	15.3
Per cent saving of fuel, calculated	....	4.4	9.5	8.9	9.9

In conclusion it should be repeated that the saving in steam consumption is usually not a true indication of the actual fuel saving due to superheating, but at the same time it is generally recognized that superheating does result in an actual saving of fuel. This has not always been true in the past, and it has been a common experience that a saving equal to that due to superheating could have been, and later was, effected by other and more easily operated means than superheating. For example, in the early days of superheating, steam pressures were low,—25 to 50 lbs. per sq. in. by gage. Superheating then showed in the neighborhood of 20 per cent fuel saving. But it was soon found that increasing the steam pressure to 75 or 80 pounds gage caused about as much increase in economy as had been caused by superheating, and also greatly increased the power that could be obtained from a given weight of machinery. Of course materials and designs had to be developed to meet the demands for increased strength as the pressures increased, but these requirements were met, and superheating was for a long while not used. With the increase in steam pressures came the development of compound and triple expansion engines which produced a very marked saving in fuel consumption, and, where several cranks were employed, steadier working engines than those formerly used. When superheating was applied in the case of compound engines, a saving resulted, but it was found that the same amount could be saved by the simpler expedient of jacketing the cylinders with steam. The saving accompanying the use of superheated steam in triple expansion engines has generally been considered too small to pay for the added outlay required, but the results of Prof. Jacobus' tests on the Idalia point in the other direction. Superheated steam appears to good advantage when used with steam turbines, and it seems probable that its use in this field, as well as in that of the reciprocating engine, will steadily increase.

In the case of the steam turbine the lowering of back pressure in condensers is at least equal to superheating in effectiveness, and in general is more easily applied. As a matter of fact, however, the high vacuum is usually employed at the low pressure end of the system in conjunction with superheating at the high pressure end.

The present aspect of the problem of increasing efficiency in the steam plant involves as a first consideration that of furnace efficiency, and next, that of the boiler heating surface. Both the gases and the water must be kept up to speed by proper proportioning and arrangement of the heating surface, each square foot of which can advantageously be made to transmit at least twice the amount of heat that was formerly thought advisable. A matter of first importance in this connection is that of accessibility, so that both sides of the heating surface can be frequently and thoroughly cleaned.

THE TRAINING AND WORK OF AN ELECTRICAL ENGINEER.

Murray C. Beebe,
Professor of Electrical Engineering.

It is probable that the majority if not nearly all the students who select engineering courses have ill defined notions not only as to the character of the work they will be called upon to perform after leaving college but also as to the importance of some of their college work.

The field of the engineer is now so broad that the engineering courses must prepare the students for a correspondingly wide range of work. As with other engineers, the electrical engineer meets a wide variety of problems, and the problems of the near future will be somewhat different from those of today.

Of necessity the courses are planned to train the students in the fundamental studies rather than to impart to them specific information and data concerning engineering practice with the idea that it might be useful after graduation. So far as concrete data is made to illustrate and explain principles, it may be of use to you, but to attempt to make engineering handbooks or encyclopaedias of yourselves is to woefully miss the purpose of your education. Your endeavor should be to fit yourselves to make intelligent use of the vast accumulation of knowledge, to reduce each problem as it arises to the few fundamental principles underlying it, and to come to a correct conclusion by the exercise of good common sense and judgment acquired by experience, for the answer to the important problems to be solved in practice cannot be determined by manipulation of a slide rule.

The one fundamental study of the engineer is Physics, which in its broad definition includes Chemistry. Mechanics, Thermodynamics, Electro-magnetism, Metallurgy, and related branches are simply developments of special branches of physics in a way suited for useful and commercial application. The physicist is mainly interested in investigating, defining and correlating the laws of nature into a concrete whole, while the engineer's chief interest lies in applying these laws to the direct use of mankind.

Mathematics is a fundamental study in a somewhat different sense, in that mathematical formulae are an exceedingly convenient and exact method of expressing and applying the laws of Physics. Curves, which are often more directly useful to the engineer, are properly classed as mathematical expressions of natural laws.

To make intelligent use of the vast accumulation of knowledge of utility to the engineer, it is necessary to be able to interpret the mathematical language in which they are and will continue to be written, by the masters of the science, just as one should have a working knowledge of foreign languages to make use of the information written in such languages.

A study of the literature bearing upon a certain problem in hand may yield information which would require a prohibitive amount of time, effort and expense to work out independently. A little reflection will make it clear that it is almost solely by the force of accumulated knowledge that we are able to advance civilization.

While a working knowledge of Mathematics is intensely practical, there is required in the acquirement of such knowledge a training of the reasoning powers, which is unequalled to the engineer who must carefully weigh and decide important problems often involving the expenditure of vast sums of money.

Much as Mathematics expresses thought in abbreviated form, drawings present definite ideas in a form in which they are readily grasped by engineers and mechanics constructing the work. To reduce ideas to the form of a mathematical formula or a drawing the ideas must be definite, and the very attempt to so reduce them requires completeness of analysis, which they would not otherwise receive and which is essential before attempting to work out the ideas in material form.

The shop work offered in the engineering courses serves to illustrate the principles of machine design, and gives the student a certain amount of confidence to actually do things with his hands and he more readily appreciates the necessity of careful planning before construction. A large amount of laboratory work is prescribed in other studies for much the same reason.

In addition, students cannot be too strongly urged to gain field experience during vacation periods, for it is from field experience that the student will learn to appreciate the nature of the problems to be met later, and with truer perspective and a serious purpose he is better able to profit from his University work.

A good engineer must be capable of expressing his ideas in good English, for his specifications must be capable of but one interpretation, and his report upon a project must generally be clear and definite and so worded that non-technical men can understand it. An engineer may have excellent ideas, but if he cannot express himself clearly no one else but himself will know how good an engineer he is. Clear writing, however, is not a difficult accompaniment of clear thinking.

The studies above mentioned are the ones most important in the technical training of engineers. Other studies which give one breadth of view and better fit one to be a man among men are fully as important to the engineer as to any other professional or business man.

It is probably true that electrical design is somewhat more closely related to pure physics than some of the older branches of Engineering. This may be explained partly by the fact that electricity lends itself admirably to exact measurement, and partly by the fact that the study of electrical laws has attracted for three centuries many brilliant mathematicians and physicists who worked out and correlated its fundamental laws long before any commercial importance attached to it.

In dealing with electrical theory one must exercise his imagination to a considerable extent, for in some important electrical machines, such as the transformer, there are no moving parts. While a steam engineer must have accurate knowledge of thermodynamics to design an engine intelligently, it is somewhat more apparent what the mechanism is by an observation of it. In dealing with the electrical apparatus one is dealing with things no less real, but the imagination is called into play to form a physical idea of what is taking place. The study of Descriptive Geometry is an excellent training to develop this imaginative power.

Creative men have imaginative minds, and the world needs such. The opportunities for men who are not of a creative temperament is dependent largely upon how fast men of creative ability can provide opportunity by developing new avenues of progress.

The coming creative men need more than ever the best and broadest training which can be given them. It is the function of a University to attract, stimulate, and develop as many men for leadership as possible, and to this end should offer opportunity and facilities for each student to progress as far as his abilities will permit it. To excell it is necessary to specialize, but intense specialization should not be attempted by the undergraduate.

With a fundamental training as outlined above the graduate is prepared to accumulate experience and profit thereby at a rapid pace, whether it be confined to the domain of electrical engineering or the allied engineering branches.

As to the electrical engineer's work, the distinction should be more generally recognized between the term electrician and electrical engineer. As now used, the former term designates the mechanic and the latter the designer or planner of the installation or apparatus or investigation. The distinction is similar to the one more generally understood, that between the architect who plans and the mechanic who constructs.

One frequently hears the phrase "electricity is in its infancy" and hence offers untold opportunities to those who interest themselves in it as a business or profession. It is true that electrical industries and enterprises are growing very rapidly, and hand and hand with other engineering works, and that electricity is destined to play an ever more important part in our industrial growth and our civilization than it does today.

The possibility of transmitting electrical power over long distances with little loss means the further development of many lines of industry which require cheap power. A mutual relationship thus exists between electrical engineering and other engineering pursuits. The use of electricity stimulates the growth of the other industries, and in turn its growth is dependent upon the advance made in the other lines. It is thus important for the electrical engineer to be familiar with other phases of engineering work, just as it is for others to have some knowledge of electrical matters.

The popular idea that we do not know what electricity is is hardly correct. We may not know just what it is, just as we do not know what matter is, but we do know a great deal about its laws, and we know much more about its nature than we do of gravitation. We do not have important sources for the direct production of electrical power aside from primary batteries which yield very small amounts. Electricity is rather to be regarded as a useful link or agent in transmitting power from one point to another, just as a belt and pulleys are useful for transmitting power. Where heat is to be transmitted, steam or gas is unquestionably superior for the purpose. In most cases where mechanical power is to be transmitted, it is frequently found that electricity is the most flexible and satisfactory agent for the purpose, except for very short distances, where shafting and belts, gears or similar devices still continue to have their great field of usefulness. In general, power must be developed by water, steam or gas prime movers and transformed to electrical energy, transmitted as such, and retransformed to the form desired at the receiving end. The range of applications is very wide. The power may be used for driving machinery, railways, for electric lighting, and miscellaneous domestic uses, for electro-chemical or electro-metallurgical processes, or for electrical signalling by wire or wireless systems. Besides these there are many other important miscellaneous applications of electricity, and more will develop as fast as the creative genius of interested men can develop and perfect the devices necessary. As the field of application broadens there will be needed more men with proper training to design, construct, sell, install, and maintain the necessary equipment. Electrical apparatus for generating electrical power has become fairly well standardized. The designer of a new line of apparatus must have an intimate knowledge of the theoretical principles of electro-technics, and experience not only to enable him to design one good machine, but to design a line of machines, using as few standard parts as possible, which can be sold and stay sold in competition with others as to performance and price.

There appears to be an increasing opportunity for technically trained men in manufacturing plants as superintendents of production, and similar positions calling for a combined technical and executive ability. Knowledge of electrical matters is likely to be of considerable use to such men since electricity is frequently used in the manufacturing processes, and electric motors are very generally employed in driving the machinery.

In the electrical manufacturing industries the force of sales engineers is more and more being recruited from the body of technical graduates. The large electrical manufacturing industries have well developed apprenticeship courses, from which men are selected for the various positions which occur in the engineering, research, production, construction, and sales forces.

Technical men are demanded and succeed well in central station work, where a variety of special problems is presented, from those of plant maintenance, economical and uninterrupted operation, to those of the improvement of the load factor and the sale of power. The latter requires knowledge of the possible applications of electricity for all sorts of purposes.

State and city commissions regulating public utilities require the services of electrical and other engineers. In the sales department of manufacturing or generating plants the combination of technical knowledge with good business ability is a most advantageous asset, and whether it be in the sales or other departments, the most indispensable, and hence the best paid men are those combining with their technical training, business and executive ability.

As yet technical men do not seem to have entered as generally into the railway field as will probably be the case in the future when electricity becomes more widely used for railway work and no doubt great advances will be made in this direction within twenty years.

For the man of thorough training and wide experience there is the work of the independent consulting engineer, who is called upon to do such a wide variety of expert work that there are specialists in this field also.

Men with investigative instincts, inclined to research work, may find opportunities in developing new processes, and in scientific investigation of the many problems which confront the progressive manufacturers seeking to perfect their products or searching for new fields of application for their apparatus. Many of the large manufacturing companies maintain large and well equipped research laboratories.

A great proportion of so-called inventions are in reality developments of ideas that are old. The conception of the idea may require little effort, but the development of the idea into a commercial reality always requires painstaking and intelligent work —or expensive blundering. Many inventions have been made before there was a field for them. For example, the single phase motor was conceived many years ago but has only recently come into use, and its perfection was demanded only when inter-urban lines became of such length that the power transmission problems favored the use of alternating current motors.

The opportunities for the man who invents by main strength are decreasing, and the opportunities for the trained investigator are increasing.

The fields of telegraphy and telephony in themselves have a range of activity in research, design, construction, sales, maintenance, and operation as wide as the manufacture of heavy electrical apparatus.

There is still vast room for improvement of the efficiency and methods of artificial illumination in spite of the great activity in this field during the past decade.

The use of higher voltages will extend the sphere of usefulness of electricity. Such advances are made only by painstaking study of the properties of insulating materials and the phenomena of leakage of electricity from conductors. These phenomena are closely related to the newest researches in the domain of pure Physics, which involves a study of the very nature of electricity and matter.

Some of my readers may be temperamentally fitted to teach Electrical Engineering. Many opportunities present themselves in this field. The mutual stimulating effect that teaching and research work have upon each other presents many attractions, and it is certain that there will continue to be demanded many men to train others for the ever widening and more exacting duties of the electrical engineer.

The possibilities of producing electricity direct from coal or the sun's energy now seem rather remote, but it is not too much to hope that progress may soon be made in this direction. Such possibilities, if they do develop, would not overthrow existing methods of power generation at once, for it is seldom indeed that new inventions are at first perfect and inexpensive enough to immediately revolutionize existing conditions. Their development must be a matter of gradual growth.

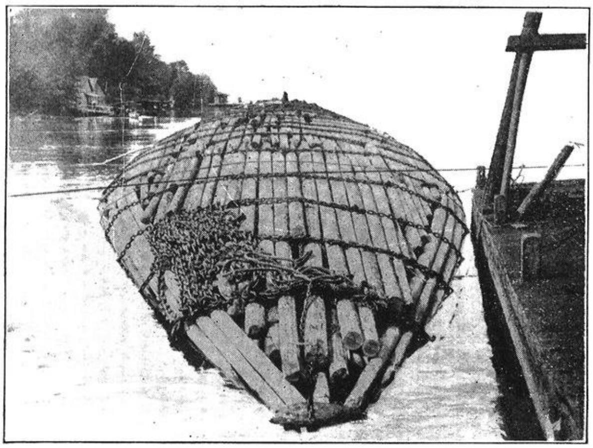
The idea in mind in offering this brief discussion on the training and work of the electrical engineer is not to give the impression that this field presents more or greater opportunities than others, but to urge those who contemplate entering this field to fully appreciate the value of obtaining a thoroughly good foundation and equipment for the future work. Five years, and in some cases more time, in securing such a foundation will not be an excessive amount of time to devote to such training for it will more than be regained a few years later.

Competition will be plentiful and from men who have had technical training, and, as in other lines of work, success follows ability, integrity, good judgment, and tact.

THE CIGAR RAFT.

C. E. Jones, '10.

The Cigar Raft, like many other branches of the logging industry of the Pacific North West, is very little understood and numerous items in regard to its size, method of construction and strength have been greatly misrepresented in certain of our scientific journals. These misrepresentations have been due, no



The Cigar Raft

doubt, to a general misunderstanding of the raft, and possibly because the writers were usually men whose technical training was along other lines. Be this as it may, this branch of a great western industry is generally misunderstood and the following article was written with a desire of correcting certain erroneous impressions which have actually crept into the public mind.

The Cigar Raft proper is an example of a well-named portion of man's handiwork in that it resembles, to a striking degree, an ordinary cigar, not only in shape but also in method of construction. It might better be compared to a whale-back steamer, stripped of her rigging and running very low in the water. A more definite idea, however, may be had by reference to the accompanying cuts.

Very little is known of the history of the Cigar Raft, save that its inventor, a Nova Scotian, conceived the idea of shipping round timbers in compact form, and to meet the requisite of his idea built a cradle in which to stow and subsequently bind the logs securely enough to withstand the shocks of water transportation. His idea met with little success along the St. Lawrence river and was almost forgotten after a few years. However, Captain R. G. Robertson, of the Robertson Rafting Co., of San Francisco, saw its practibility with the long slender Oregon and Washington timber and accordingly utilized it for Pacific coast trade, secured a patent in his name and began building the massive seagoing rafts. In this connection it must not be inferred that these rafts go to sea prepared to meet the ravages of the ocean regardless of weather conditions. No such thing is true even though articles have appeared in which it was stated that, "These rafts will withstand heaviest seas because of a peculiar method of construction." The fact is, it requires the calmest of weather, before a journey is undertaken and the promotors of this industry anxiously watch the weather conditions until the raft is safely anchored in the "wrecking-ponds" at San Francisco.

The Pacific ocean is never quiet along the north-western coast of the United States and during the entire voyage from the Columbia river to San Francisco the huge raft groans, creeps and twists like a slow moving monster. This movement is continuous and oftentimes sets up such stresses in the heavy circle chains, which are herein later described, that they are often snapped like mere threads even though made of the very best 1½ inch Norway iron. This raft movement is very much increased with increasing swells of the ocean and sometimes results in the complete breaking up of the raft. Another result of this serpent-like motion is to grind piles, in the main body of the raft, to a mere pulp, while a great number are always worn from their pencil-like roundness into pentagonal or hexagonal sections. The raft as a whole often creeps some fourteen or fifteen feet over its entire length, while every now and then some lone pile will worm its way free and drift to a neighboring beach, or to sea.

With such unsafe conditions to meet it seems almost ridiculous to state the sea-worthiness of such a "craft." Nevertheless, these rafts usually make a safe journey and but two or three of them have gone to pieces during the past ten years of Pacific Coast experience, out of eighteen or twenty that have been built and sent to sea during that time.

It is claimed by the promotor of this rafting scheme that a reasonable profit can be made if one raft in three makes a completely safe journey, disregarding the fact that several hundred tons of the best chain goes to the bottom of the sea with every raft that is lost. The above statements seem almost fabulous, yet some idea of the profits on a single raft can be had if the reader understands that the piling shipped are received at the place of stowing at a price of five to six cents per linear foot of pile and are sold in San Francisco at an average of almost fifty cents per linear foot. One raft contains some three million linear feet of piling and the larger rafts have practically reached the four million foot mark.

The specifications applying to these piles are not very numerous but cover the requisites of the market.

"No pile must be shorter than 30′ with a butt measurement not greater than 18″ or less than 10″. The small end must not be greater than 12″ or less than 6″. If there is any curvature in the pile it must not be greater than 1½″ in ten feet and the piles must be nearly round in section.

"The piles must be either yellow fir (Douglas Fir) or cedar. All other kinds are rejected.

"Not more than ten per cent of the raft shall consist of piles less than 35′ in length."

It will also seem somewhat fabulous when piles are referred to that answer the above specifications and are yet from 120′ to 135′ in length. Still the writer has actually stowed hundreds of such piles some of which were perfectly straight and almost as round as pencils. Such timbers, however, are fast being consumed and there is very great doubt that any such piles will be found a few years hence.

The importance of the cradle lies mainly with its use as a frame or body in which to stow the piling. Naturally the cradle's form bears a great importance to the raft's shape, consequently it is built of great timbers so constructed as to give its interior a long, cigar-shaped space in which the piles are laid.

In building the cradle the work is begun very much the same as laying out a ship, save that a keel is not laid. Timbers are spaced twelve feet apart from centre to centre and at right angles to the length of the cradle. These are known as tongues and extend the entire width of the cradle proper. At right angles to these tongues and parallel to the length of the structure are two heavy mud-sills shown in sectional view in the accompanying sketch. At right angles to both tongue and mud-sills is a rib or post extending between 22′ and 24′ upward thus completing the principal frame-work of the cradle. A regulation bent is shown in elevation in the sketch, while the plan of the entire cradle may readily be understood by reference to Fig. I. Twenty-eight bents are thus built each identical and connected by the heavy mud-sills shown in section "A," "B." These sills extend the

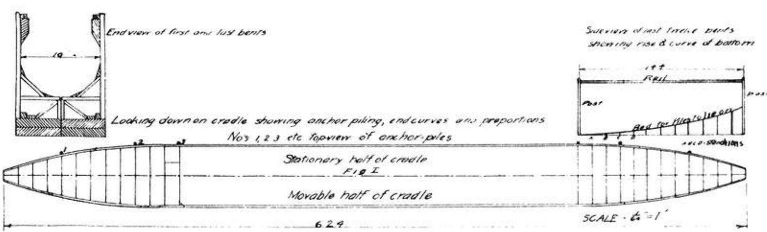


Fig. I

entire length of the cradle and serve to connect the various bents into a single unit, the cradle. The principal bents of the cradle are not round but elliptical in shape, as shown, until within 144′ of each end, where twelve bents extend from the regulation bent to the end, each end being a duplicate of the other. These last twelve bents begin to approach a circle in form and finally the shape of the last bent is a circle. To meet this requirement, the bottom rises gradually and the sides are drawn in until what was a regulation bent of elliptical section, 52′ wide by 24′ high, is now a circle of 10′ diameter.

This change is shown in the end view elevation, and plan in the drawings and reference to them will give a definite idea of the bents as they change from a regulation bent to the end. If now the reader can imagine this great mould split from end to end through its centre, he will understand the meaning of stationary half and movable half. The stationary part is held in place by anchor piles which are put through anchor pockets at the end of the tongues, shown in plan in Fig. II. These anchor piles are driven at each bent except the last three at each end, after the cradle has been launched and properly stationed for loading. Thus the cradle is held firmly and the anchor pockets permit it to sink as it is filled.

One might ask why the cradle does not fall apart. It would, only the tongues, which extend the entire width of each bent,

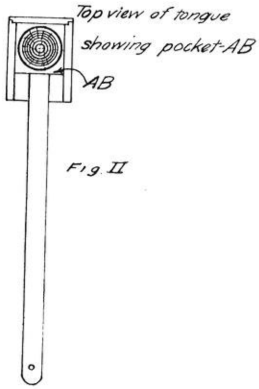


Fig. II

are keyed through a hole in their extreme end, by a large iron pin, or key, which holds the cradle together. This key is shown in Fig. III, in elevation, as is the hole through which it extends in Fig. II. One can now see that the cradle is of a definite form, and must realize that its strength is sufficient to withstand the outward pressure of the logs, when he considers that the mud-sills made from 12″x12″ and 6″x16″ yellow fir timbers, are so bolted and spliced together as to be almost as strong as though solid. The cradle is now ready for launching and is tilted on to temporary skids and slid or launched just as a ship, save that the cradle enters the water broad-side on rather than end-wise. After launching, it is placed in the stream at sufficient distance from shore to allow a flat river-raft to come beside it, and all is ready for stowing the piles save one little detail. A very insignificant thing apparently, yet of vast importance to the binding of the raft when the stowing is completed, namely,—the "chain-wires." These wires are stretched from the rail, or top-chord of one side to the rail of the other side, extending beside the posts along mud-sills "C" and up the opposite post. Here they are permanently tied and every care exercised to keep them from harm. They are made from ordinary galvanized wire size 10 and their function is to pull a 2″ rope under the piles when the cradle is filled, the rope in turn is provided with a pair of sister hooks

Regulation bent showing mud-sills, anchor-piles in pocket, side view of tongue, tongue pocket and level of cradle in water, also key and chain-wire A.B.C. Mud-sills

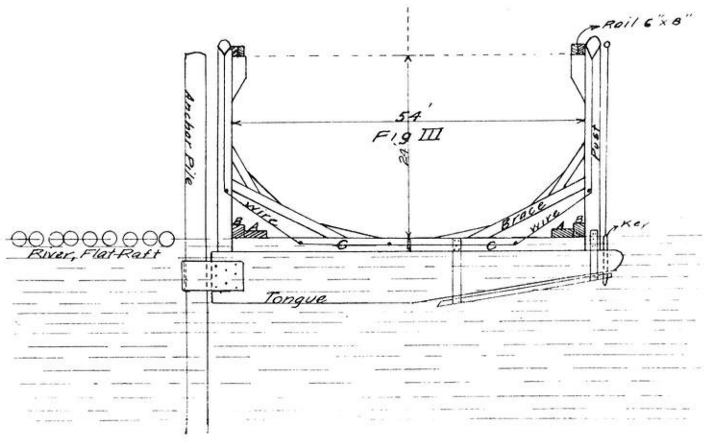


Fig. III

which are fastened to the circle, or binding chains and serve to draw them around the raft. With this last detail completed, the raft is now ready to be stowed and constructed.

The method of stowing the piles is very simple but the similarity it bears to a cigar is here best shown. As a cigar is filled in a mould, so is a cigar raft filled in its cradle. A cigar has a wrapper; the same thing is true of the raft and though not a tender fiber like the wrapper of a clear Havana, it is equally as important in its functions. A large derrick scow is provided for picking up the piles from the river-raft and lifting them over the top chord into the cradle where a crew of men receive the pile and put it in place. Thus the bottom layer is laid and the wrapper of the raft begun. Each succeeding layer adds to the wrapper by its extreme outer piles, which are always selected to fit, as made to do so by very slight alterations, and are known as the wing-piles. In stowing, every layer of piling is started at each end of the cradle and, in the first layer, meet in the centre. The next tier of piling will be spliced or joined, simply by putting butt to butt, near one end, while the following layer will be joined near the opposite end. The splices are never allowed to fall one above the other, and are seldom made without sawing off several piles necessary to make the butts join end to end.

In the extreme ends where the greatest curvature of the cradle, and consequently of the raft, occurs the piles are laid with their butts inward, that is, pointing toward the opposite end, the tops of the piles thus laying outward at each end. This is only true at the ends, for through the body proper the butts and tops alternate. The wing piles are simply bent by force to meet the end curvature, while the other piles are laid in side by side just as close and neat as sardines are packed in a can. Each successive layer of ends are spiked and drift-bolted together and every third layer is, in turn, bolted with the three lower layers. This makes the ends very substantial.

When the cradle is just half filled a large centre chain and two sets of herring-bone chains are placed and the stowing goes on over these just as before. These chains as a unit are very essential in binding and holding the raft together. The centre chain is laid the entire length of the raft and weighs from 90 to 100 tons, the links being made of 2¼″ wrought iron with cast iron studs in the centre. The herring-bone chains are attached to the centre chains and extend at an angle of 45° from the centre chain outward to the sides of the raft where stirrups are attached through which the first twelve circle chains pass. The herring-bone chains always point their vertices away from the in conjunction with the centre chain, to the back bone and ribs of the herring. The angles made with the centre chain by the herring bone chains always point their vertices away from the end of the cradle.

The purpose of this arrangement is best understood by referring to the creeping of the raft while at sea. It is true that rafts have been known to stretch some 14′ during a voyage. If it were not for this combination of herring-bone chains, fastened to the centre chain and drawing inward, and the end circle chains passing completely around the raft and through the stirrups at the end of the herring-bone chains, the raft would soon part and go to pieces. As it is, the more the raft creeps, the tighter these chains become, and very often some of the heavy chains are broken because of the heavy stresses to which they are subjected.

The remainder of the work is identical with the first half save that the upper surface of the raft must be laid to complete the elliptical sectional form of the raft. When the raft is completely stowed the cradle chains or circle chains are all placed and the binding commences.

Binding the raft is a very simple affair if the chain wires are intact, and they usually are for the builders fully realize their importance and jealously guard them. When a circle chain is placed one end is hooked into a chain tong and the derrick lifts the chain its entire length in mid air. The chain wire has already been attached to a heavy rope and this rope drawn under the raft. On its end is the pair of sister hooks, mentioned before, which are clamped to the lower end of the chain. The rope is then run to the gypsy head of the hoisting engine on the derrick scow and, as the gypsy head draws in the rope, the hoisting drum is slowly released and the circle chain played out until it comes from under the raft. The two ends are now joined together and especially heavy turn-buckles attached to them and the circle chain then cinched by means of the turn buckles until the very oil is squeezed from the piles, so great is the stress. This process is repeated at every bent until every one of the fifty-two bents has its separate circle chain thoroughly bound, thus the big cigar raft, bound in its wrapper of piles and chains, is ready to be launched.

Launching the raft merely consists in pulling, by means of the derrick, the keys attached to the long iron rods shown in the sketch. Four cables are now fastened to the quarter lengths of the movable half and a main lead run to the donkey engine. A heavy pull is now taken on the main lead and the cradle slowly parts, letting the raft settle down and allowing the halves of the cradle to rise and topple inward. The raft soon floats free and is attached to the towing line of a big ocean tug to begin its sea voyage.

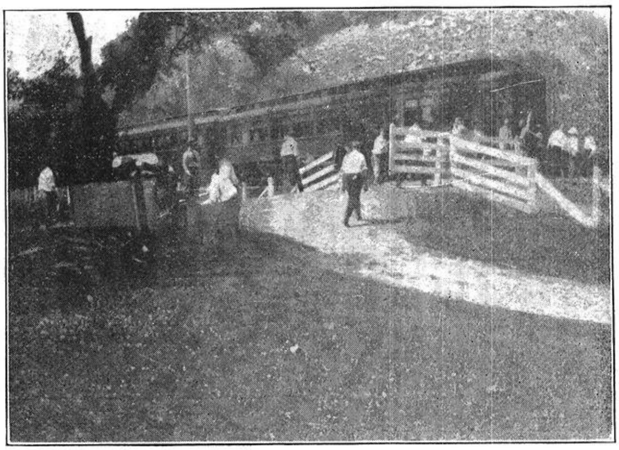
On reaching San Francisco the raft is towed into the "wrecking ponds" where workmen unfasten the turn buckles allowing the big circle chains, in fact all the chains, to sink to the bottom of the pond from which they are later recovered.

The raft soon starts to break up when the circle chains are removed, but very different than most persons would think. In place of the top and sides spreading out, the bottom piles start to rise and the raft actually breaks up from the bottom upward. and slowly spreads over the pond surface ready for the San Francisco buyers' inspection.

WITH THE CIVIL ENGINEERS AT DEVIL'S LAKE.

S. H. Ankeney, '12.

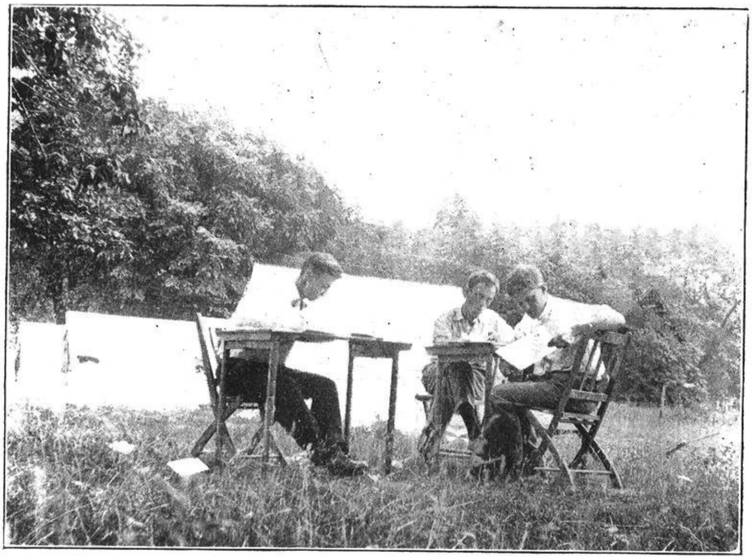
It was at noon on the sixteenth of June that two coaches loaded with many and various surveying instruments pulled out of the Madison depot bearing a half hundred coatless and hatless young men on their way to the first Wisconsin summer school of surveying camp at Devil's Lake. On each side of the coaches were long banners bearing the inscription, "Engineers' Special.



Unloading at the Lake

Look-out for the Cars," that all who thronged the depot platforms en route might know that at last the long-heralded engineers were on their way to discover the true depth of the "bottomless" lake. But the joy of this ride was short-lived. Once at Devil's Lake, all hands assisted in unloading the cars, building tent floors and erecting tents. Then suit-cases were unpacked and everyone was off to inspect the camp or to try the swimming.

The inspection of the camp revealed that the site chosen was on the grounds of the Hotel Kirkland. Three cottages close to the shore of the lake, each capable of accommodating nine or ten men, had been rented and it was decided by lot which members of the party should be allowed to occupy them. A dozen tents, erected behind the cottages, had been provided for the remaining members. To room in the cottages was a little the more desirable because of a few extra conveniences in the way of washbowls and pitchers, spring beds instead of army cots, and screened windows and doors in case mosquitoes became pestiferous.

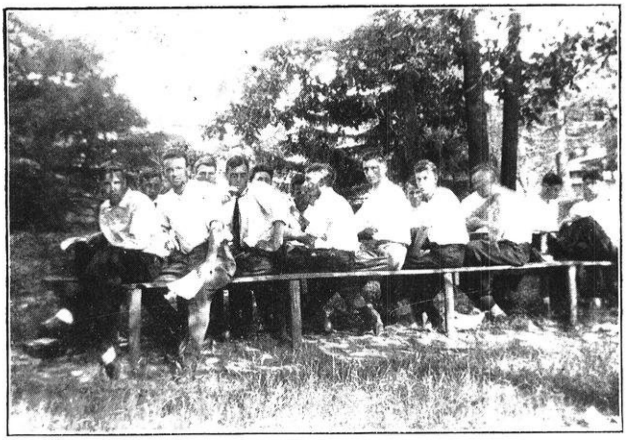


Sunday in Camp

The latter, luckily, were conspicuous by their absence. Meals, all were not long in finding out, were served in a summer dining hall apart from the hotel building proper.

The first lecture was held after dinner that evening in a long, rough room over a cellar-like place used as an office for the rental of boats and the sale of soft drinks. At this lecture was given an outline of the four weeks' work, the routine of the daily reports explained and assignments made for the first day's work.

The next day was scorchingly hot. The sophomores had been assigned level lines and it was a foot-sore, weary and sun-blistered lot of students that came back to camp that night. Lack of water to drink was the universal story. Many parties had gone from early morning to the middle of the afternoon over the rough quartzite boulders of the Devil's Lake hills or down the unshaded railroad track without sighting a farm house or a spring. Unused to the long tramping, some had really suffered greatly from thirst. Devil's Lake did not seem such a delightful place that first day. The juniors fared better than the sophomores as they had been, with few exceptions, assigned to the



Computation Party

construction of a pier or a base line for triangulation of the lake.

The harrowing experiences of the first day were largely avoided afterwards by acquiring a knowledge of the location of numerous springs along the line of survey or by carrying water from camp. The equipment of future classes will include a canteen for each individual. A few days of hard work and exposure soon toughened the fellows and they acquired complexions that might be poetically spoken of as bronzed but in many cases, I fear, were simply gloriously blistered and red. Then the diversions of the lake began to be more in evidence and camp life had a rosier hue.

Devil's Lake and vicinity provides an ideal place for a practical course in all the various branches of surveying. The work assigned to each party of two students consisted of a long and a short line of levels for each man, one of the lines generally running over the steep hills nearby with a difference of elevation of sometimes 300 feet while the other line was longer in length but on the gentler grade of the railroad. Topography of some neighboring farm or village was taken by each student either by the plane table or stadia methods. Also a magnetic traverse of a river or lake was required. Practical experience in base line construction on a large scale was given at Merrimac by the accurate measurement of a line over 6600 feet long. On this line was based a triangulation system covering an area of about 15

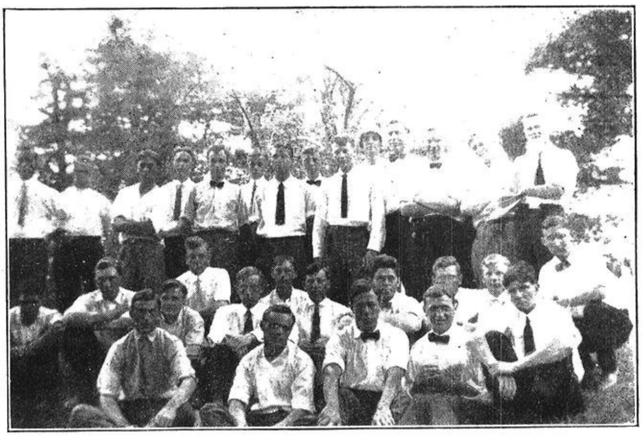
The Three Friends to the Hungry

square miles. Experience in U. S. C. & G. S. methods of triangulation was given by the use of precise instruments on this system.

Facilities for the hydrographic work were amply provided by the lake and the Wisconsin river at Merrimac and the Baraboo river at Baraboo. The rating of the current meter was done on the lake. Then the discharge of both rivers was computed by this method and, at Baraboo, by the rod float method. Soundings of the lake were made by various methods and the nature-faking advertisements of the hotel-keepers concerning its bottomless depth were exposed. The greatest depth discovered was 54 feet.

The last three days of the four weeks were given over to computation, mapping and the final reports. In comparison with Portage, Devil's Lake offers many advantages as a site for a student surveying camp. The character of the surrounding country makes the work more than ordinarily difficult. It is a healthy place and the natural outdoor pleasures of the lake make an ideal change for the student who has been closely confined throughout the long winter. The only disadvantage seems to be a slightly greater cost for board and room. The necessary expenses of board and room, tuition, railroad fare, etc., average about $40.00 per student for the four weeks' course.

Chief among camp diversions was swimming. The lake was clear and warm, a spring board was built on the pier, and everyone took a plunge as soon as they returned from the work of the



Waiting for Dinner

day. If the party was lucky and worked around camp, sometimes another short swim was squeezed in during the dinner hour. One party was even rumored to have lost a sounding lead overboard and thereby managed to secure a third swim by diving for the lead. Fishing was good and the three boats kept by the university for use in the hydrographic surveys were kept busy evenings by the fishing parties. Many of the fellows, however, preferred to spend the evenings before and after lectures by gathering in groups and singing or quietly reading and smoking. Fussing, in spite of the Professor's near-joke,—"now that I have you here where no one can fuss with you"—was in evidence in the expected quantities. The fact that the boys were Wisconsin students was sufficient for many of the best families to open, with very few formalities, the doors of their cottages or residences in hospitable welcome.

Several dances were given in the dining hall with music generally furnished by some of the fellows, to which cottagers, hotel guests and picknickers thronged alike. The Engineers' Prom, given on the eve of departure, was quite the swell affair of the social season. The students provided a Baraboo orchestra for the occasion. One unfortunate incident, which can best be explained by a clipping from the Baraboo News, would have passed unnoticed in Madison but as student pranks were a novelty in Devil's Lake this stunt, done thoughtlessly and without malice, might have resulted in the early cessation of the work but for the promise to the angered proprietor of the grounds to avoid any repetition of the occurrence.

REPORTERS IN HARD LUCK

One of Them Gets the Measles and the Other Gets a Potato.

Tuesday was a terrible day for Baraboo newspaper reporters. The high school class of 1909 decided to enjoy a little private dancing party at Devils Lake and along in the afternoon a peculiar feeling came over The News man, which developed into measles and he had to give up the joys of the occasion. The reporter on the other paper joined the class frolic and was the gatekeeper at the party. Early in the evening some of the university students at the lake became intoxicated with the music and joined in the mazy waltz. It is stated that they were charged 50 cents per and later others were charged 25 cents. It is claimed this caused some dissatisfaction and to compromise the matter it was decided that the pencil pusher roll a potato about the pavilion with his nose, which he proceeded to gracefully do. Of course the university lads were not looking for money but merriment. The class enjoyed a delightful evening.

Altogether, the trip was a delightful experience and outing for the students and it was with many expressions of regret at having to leave that the cars were loaded for the return trip and, with a final yell and "hoo-cha-coo," the bunch waved good-bye to the first summer camp at Devil's Lake.

The Wisconsin Engineer

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

EDITORIALS

BACK AGAIN.

Glad to see you back, old man!

Doesn't it sound good to hear that again? Statisticians have figured that but one person in three hundred enjoys the privilege of a university education. Aren't we lucky to be here?

ALUMNI REUNIONS.

The classes, whose numerals are multiples of 5, from the old guard of '75 to the recent graduates of '05, held reunions in Madison last commencement. The occasion was one of much merry-making. The "naughty-naughts" far surpassed the dreams of the most hilarious underclassmen in the undignified stunts that they performed. It was the biggest dose of rejuvenating medicine ever given to Wisconsin's somewhat sickly alumni spirit. If this custom of returning every five years is continued by the other classes Wisconsin will never suffer, as in the past, by lack of alumni interest. Preparations are already being made for a reunion of the class of '08 in 1913. The class of '10 appointed representatives before graduation last spring who will plan the reunion in 1915. The present senior class will probably follow suit. It remains to be seen what '01 and '06 are going to do next June.

ALUMNI REPRESENTATIVES.

It is obvious that a magazine fulfilling the mission of that of THE WISCONSIN ENGINEER has a great need of alumni interest and support. It is in a well-meaning effort to get in closer touch with the alumni, to try to get them to understand that we desire their personal interest and advice, that we have inaugurated this year a staff of alumni representatives. These men who have consented to aid us in this plan were prominent as students in university activities and have not lost interest in their Alma Mater since graduation. They realize that such assistance as they render us is not alone for our benefit but for the students and university as a whole. Single-handed, these half score of men can do little among the thousands of graduates. With your assistance much can be done. We will not consider the plan a success until we have each one of you an enthusiastic alumni representative.

THE MONTHLY ENGINEER.

We make our bow to you as a monthly. In a new cover, which we hope is in keeping with the Fall fashions, we will come to you on the first of each month hereafter, instead of quarterly as has been our custom for many years past. This is a big undertaking for us. It means a great deal of unrewarded labor and a considerable financial risk. We have felt in the past that we were not giving you the full value of your subscription price when we were compared with magazines receiving greater advertising support. It is for this reason alone,—to make THE WISCONSIN ENGINEER worth a dollar of anybody's money,—that we have doubled the number of issues without changing the subscription price.

Cornell supports two, Harvard, Iowa State, California, Kentucky State and others each support one engineering monthly. Wisconsin is certainly no less able to do so than these universities and colleges. But it will need *your* subscription. We are meeting you half way in a square deal. Will you back down on your part?

We want to say, by the way, that positions on the staff are open to all engineering students who are willing to begin at the bottom and work up. There is much work to be done and there is a place for you. If interested, just speak to some member of the staff.

Help us, by your interest and subscription, make THE WISCONSIN ENGINEER known far and wide as the best engineering students' publication in the world.

NEW BUILDINGS.

Many thousands of dollars are being spent annually by the university to increase its efficiency as an educational plant. This year there has been added to the campus five large buildings and additions besides several smaller buildings such as poultry houses and green houses. Chief among the new buildings is Lathrop Hall, which opened its dining hall and cafeteria the first time to the summer school students. This immense building offers advantages as a club-house for women students unequalled by any educational institution.

The engineering college has received its share of the improvements. The old heating plant has been remodeled into a laboratory for mining engineers and the latest equipment installed for their proper instruction. The large wing to the engineering building, which will shortly be ready for occupancy, allows the necessary room for the continued growth of the engineering college. The most noticeable change is on the fourth floor where now three large drafting rooms supplant what was almost unavailable space before.

The foundations of a magnificent Biology building will be in place before winter. The excavating has been in progress all summer and there will be no break in construction until cold weather.

Dormitories for men is the next greatest need. President Van Hise urges their erection but has been baffled in his desire by a legislature unwilling to appropriate more funds. With the ever increasing price of rooms and board, with the amount of heat, comfort and nourishment in inverse proportion, a large building, well heated and lighted, with a dining hall capable of seating several hundred students, is not an idealistic dream; it's a necessity.

DEPARTMENTAL NOTES.

SUMMER SCHOOL OF MINING.

The summer field work for the Junior class in Mining Engineering was done this year at Butte, Mont., and in the Coeur d' Alenes, Idaho. The class assembled in Butte with Professor Holden on the first of July, and for their inspection work spent two weeks visiting various mines, taking notes on the local geology and the equipment and mining methods employed.

During the course of this work they became familiar with underground conditions in the Leonard, the High Ore, the Gagnon, the Diamond, the Butte & Superior, and the East Butte Mines. The ore dressing and smelting works of the Pittsmont plant were inspected, and under the guidance of Professor Havard the great plant at Anaconda was visited.

To fulfil the requirements of the course the members of the class then went to work in various mines, positions being secured through the generous co-operation of several mine managers and superintendents. Two members of the class spent the summer working in the Morning Mine at Mullan, Idaho, the others being in mines at or near Butte.

The practical work required in the summer school of mining has not proven too severe for our professional students, and, in fact, most of them worked beyond the required period. As a result they are now prepared to do their thesis and other Senior work most efficiently.

As a further result of the summer school session the department has secured donations of several tons of copper and lead ores for use in the ore dressing laboratories, besides arranging for future summer work.

The department gratefully acknowledges the generous co-operation of numerous mine managers and superintendents, and more especially of Mr. Oscar Rohn, an alumnus, manager of the Pittsmont Co., Messrs. John Gillie, B. H. Dunshee, and other members of the Boston & Montana staff, Mr. Atwater of the Butte & Superior, Messrs. Miller and Burbidge of the Federal Lead Co., and Mr. Easton, manager of the Bunker Hill & Sullivan property, and his mine and mill superintendents. E. C. H.

CHANGES IN THE ENGINEERING FACULTY.

A number of changes in the faculty of the engineering college mark the opening of the new year. Probably the one most important addition to the faculty is Professor F. W. Doolittle who comes to succeed Professor C. H. Burnside as Assistant Professor of Mechanics. Professor Doolittle is an Iowan who holds the degrees of Bachelor of Arts from Princeton university and Civil Engineering from the University of Colorado. He is a man of much practical civil engineering experience and has spent a number of years in the service of the Union Pacific Company. He has taught one year each at Illinois and Colorado, substituting at the latter place for Dean Ketchum and teaching his classes in structures. Professor Burnside was on a leave of absence at Columbia university last year and has resigned to accept a permanent position at that institution. Another important change in the Mechanics department is the resignation of Mr. F. M. McCullough, Instructor in Mechanics, who goes to the same department of the Carnegie Institute, Pittsburg.

Mr. J. C. Steen, for a number of years Superintendent of the Machine Shops, has resigned and will be succeeded by Mr. A. L. Goddard, M. E. '96 Wisconsin. Mr. Goddard is a man of large experience in manufacturing establishments, designing offices and as superintendent in charge of construction. While a student he was an assistant in the shops. Since then he has spent much time in the employ of a ship building concern, and watch and automobile manufacturing establishments. A skilled machinist himself and well informed in modern phases of shop practice, he is particularly successful in the use of the new varieties of special steel used in the manufacture of tools and instruments. He is well known personally to a number of the present members of the faculty.

In the Steam Engineering department, Mr. E. J. Kunze and Mr. E. M. Shealy, Instructors in Steam Engineering, have resigned, the former to go to Michigan Agricultural college and the latter to the University of Montana. Mr. A. E. Birggren, a graduate of Iowa State college at Ames, has been appointed to fill the vacancy. Mr. Birggren has had eight years active shop work and for the past two years has been a member of the faculty of the University of Colorado.

F. W. Ives, '09 Wisconsin, and O. C. Berry, Instructors in Mechanical Drawing, will be absent from the teaching staff this year. Mr. Ives leaves to accept a position in the same department of Ohio State university at Columbus, Ohio, and Mr. Berry will continue some investigations begun in the laboratories here. W. A. Klinger, of Milwaukee, who took his Bachelor of Science degree last June, and E. S. Maclin, from the University of Tennesee, will succeed Messrs. Ives and Berry. Mr. Maclin has had experience as a teacher in the Technical High School of Atlanta, Georgia.

In the Electrical Engineering department, Messrs. Johnson and Hovey, Assistants, have left. Mr. Johnson has located with the Cutler-Hammer Co. C. J. Belsky, a 1910 graduate, has been made assistant in their stead and Mr. F. A. Kartak raised in rank from assistant to instructor. W. F. Lent, '10, returns to the university as research assistant in this department.

Walter E. Jesup, a graduate of the University of Southern California, and who has done summer graduate work here, has been appointed to the position left vacant by W. C. Muehlstein, Assistant in Railway Engineering.

In the Chemical Engineering, Machine Design, Topographic Engineering and Bridge Engineering departments there has been no change. A research assistant in the person of Professor Charles I. Corp has been appointed in the department of Hydraulic Engineering. Professor Corp is from the University of Kansas where he has held the position of Assistant Professor of Mechanical Engineering. He has done summer graduate work at Wisconsin.

Fellowships have been granted as follows: William A. North, University of Illinois, in Hydraulic Engineering; James N. Lawrence, Syracuse university, in Chemical Engineering. Three scholarships were given to Marcus S. McCollister, University of Illinois, in Hydraulic Engineering; George C. Phillips, State College of South Dakota, in Electrical Engineering; Walter B. Schulte, '10 Wisconsin, in Applied Electro-Chemistry.

ALUMNI NEWS.

ANNUAL BUSINESS MEETING.

At the largest annual meeting of the University of Wisconsin Alumni Association in its history, held on June 21, the association was reorganized and greatly strengthened by the adoption of a new constitution. The officers elected for the ensuing year are:

Graduating Class in Review

President—Lynn S. Pease, '86, Wauwatosa.

Vice-president—Mrs. Imogene Hand Carpenter, '87, Racine.

Secretary—Willard G. Bleyer, '96, Madison.

Treasurer—Mathew S. Dudgeon, '95, Madison.

Executive Committee—Elizabeth Waters, '85, Fond du Lac; J. G. Wray, '93, Chicago; Dr. A. J. Ochsner, '84, Chicago; Lynn A. Williams, '00, Chicago.

Louis P. Lochner, '09, was re-elected to the alumni fellowship in journalism, created by an unknown donor and alumnus, and was made editor and business manager for The Alumni Magazine for next year.

During the progress of the meeting great enthusiasm was caused by the unceremonious entry of the class of 1900, headed by a band and followed by the famous elephant, led by J. S. Lyle in costume of the Far East. Proceedings were suspended until the class' enthusiasm had spent itself and order could be restored.

ANNUAL BANQUET.

Eclipsing anything of its kind yet attempted, the University of Wisconsin dinner in armory hall on June 21 attained a success which far surpassed all anticipations. Five hundred and twenty-one persons, most of them graduates from the university, were gathered about the tables, the arrangement by classes being carried out in the seating. Some fifty alumni had to be turned back because they had failed to reserve places. The number of banqueters was 275 more than at any previous banquet.

Deafening class yells, varsity toasts, locomotives and rahs, with a great many popular college songs followed one another in rapid succession, and kept the assemblage in a state of continual merriment. Everybody was there for a good time, and nothing which would contribute to the informality of the affair was spared. The class of 1900 had the largest representation, 89 places being occupied at their tables. The table plan was that of a hub in the center, with spokes radiating out in all directions. The hub was formed by a large round table, at which were seated the toastmaster, Dr. A. J. Ochsner, '84, retiring president of the Association, President C. R. Van Hise, '79, and the regents. In the character of the attendance. nothing of the kind has been seen since the jubilee of 1904. Men high in the life of the state and city, of whom one was a candidate for governor, and one a former candidate for the presidency of the United States, composed the throng of enthusiastic graduates.

The big stir at the dinner, as at every function during the commencement festivities, was made by the class of 1900, who, with the omnipresent elephant and the band, marched into the hall, paraded about the tables, and finally took seats in the center of the east side. Then the yelling started. It was taken up by nearly all the classes, large and small, the smallest being that of '59, whose yell was given by its sole representative, Judge Elbert O. Hand, Racine.

Commencement Procession

The class of 1900 and members of old glee clubs led in the singing of college songs, copies of which were at each place. This proved to be one of the most delightful features of the evening.

In Eugene W. Chafin of Waukesha, law '75, who was the Prohibition candidate for president in the last campaign, the Wisconsin spirit was exhibited in a remarkable manner as the well known orator led his classmates in the slogan, "We're alive, we're alive. How we thrive, how we thrive. We're the class of '75." Before leaving to catch a train, Mr. Chafin was called upon by President Ochsner for a few words, and mounting a chair made a felicitous short speech. He said the class of '75 was the noisiest in the university and that it hasn't stopped since it left college halls. If ever elected president, he said, he would find jobs for every alumnus of the university.

Colonel George W. Bird of Madison, '60, the representative of the oldest class present, was another guest of note. Colonel Bird was one of the "boys" and took an active part in the informal celebration. During the course of the banquet he at one time arose and shouted the '60 class yell so that it was heard in every part of the hall. This brought forth a flow of enthusiasm and the colonel was cheered loudly. The guests then arose and sang the varsity toast.

Judge E. O. Hand, the first speaker, was heard with the closest attention. He told of early days in the university, when all the students lived in a dormitory, North hall, and when the institution was satirically called the Madison High school because of the preponderance of Madison boys as students. Chancellor Lathrop was nearly the whole faculty. Board cost $25 for 13 weeks in North hall. In the class of 1859 were 12 students.

Lynn Williams, '00 booster, was greeted with wild yells. Leading off with "Mr. Centerpiece, Ladies and Gentlemen," he uttered the sentiments of his classmates in their alumni day joys, and asked for loyal support for the university of every alumnus.

James S. Thompson for the class of 1910 told of the accomplishments of the seniors in providing a generous share of the fund necessary to support the new general secretaryship. In the future the class of 1910 will be to the forefront at alumni reunions. Other speakers followed.

ALUMNI REUNIONS.

'75.

The thirty-fifth anniversary of the graduation of the class of 1875 was celebrated by a reunion of the class at luncheon at 1:30 p. m. Tuesday, June 21, in the green room of Lathrop hall. The following members of the class were present: Mrs. William H. Baily, Des Moines, Ia.; Mrs. Webster E. Brown, Rhinelander; Mrs. Charles L. Harper, Madison; Mrs. Perry Williams, Milwaukee; Mr. and Mrs. Charles F. Harding, and Mr. and Mrs. Charles E. Pickard, Chicago; Mr. and Mrs. Clinton H. Lewis, Milwaukee; Mr. and Mrs. Isaac S. Bradley and Mr. and Mrs.

James Melville, Madison; Mr. and Mrs. Fred S. Luhman, Manitowoc; Percy F. Stone, Rockford, Ill.; William Street, Chicago; Eugene Chafin, Waukesha; and William P. Gundry, Mineral Point.

In addition to a few invited guests, the following members of the faculty of 1875 were present: Prof. and Mrs. J. B. Parkinson, Prof. and Mrs. W. W. Daniells, Prof. Alexander Kerr and Mrs. D. E. Carson.

'80.

The class of 1880 celebrated their thirtieth anniversary by gathering at the home of Mr. and Mrs. Magnus Swenson, both of whom are members of this class. Luncheon was served on the veranda overlooking Lake Mendota. Reminiscences of college days, the reading of the class prophecy written by Henry Goodwin of Milwaukee thirty years ago, and plans for the future occupied the time until three o'clock. At that hour the members of the university faculty of thirty years ago, still resident in Madison, had been invited to meet the class. Professor J. C. Freeman, Professor Alexander Kerr, Professor and Mrs. J. B. Parkinson, Mrs. D. E. Carson and Professor W. W. Daniells responded to the invitation. A letter of greeting and appreciation signed by all the members of the class was sent to Dr. and Mrs. John Bascom. In the evening the class attended the alumni banquet. Those present were Mr. and Mrs. Charles Lamb, Mr. and Mrs. J. H. Hutchison, Mr. and Mrs. J. E. Hoyt, Mr. and Mrs. Magnus Swenson, all of Madison; Dr. Charles Sterling, Indianapolis, Ind.; Jay W. Hicks, Phillips, Wis.; Mr. and Mrs. Humphrey Desmond, Milwaukee; Dr. John M. Dodson, Chicago; Mr. and Mrs. Waldo Fisher, Alton, Ill.; Frank B. Brundage, Dawson, N. D.

'85.

Varsity '85ers to the number of thirty or more, some with wives, others with husbands and not a few with so-called "samples" in the form of offspring,—the whole party numbering about forty—had luncheon in Lathrop hall as the central incident of their quarter-century reunion, and reminisced, sang and faithfully endeavored to appear formal while transacting the little business essential to the maintenance of class solidarity.

Dr. A. J. Ochsner of Chicago provided American Beauty roses in liberal quantity to embellish the various tables and the function. which was given by the Madison members, swung off in the merriest manner imaginable.

At a business meeting Charles I. Brigham was chosen class historian and George E. Waldo elected secretary. Volumes of class letters were distributed—the letters written every five years—and it was voted to send a telegraphic greeting to Former President John Bascom, at his home in Williamstown, Mass. The telegram read as follows: "The class of '85 on its twenty-fifth anniversary sends you greetings. Your teachings and their influence are with us still. We are grateful to you.—Class of '85, U. W."

A group picture was taken and the class prophecy, written twenty-five years ago, was read.

At the alumni banquet in the evening the members sat together.

'00.

The alumni of the class of 1900 made the biggest splurge in years in the Commencement Week's doings. The Chicago committee organized the members and published a paper to boom the reunion. This paper was called *The Reveille,* "Ten-Year Alarm Clock of the Class of 1900," and contained songs, editorials to boom the reunion, letters from President Van Hise and other distinguished alumni, and a 1900 class directory.

As a result over fifty of the old grads were on hand and held high carnival. The headquarters were the Mahoney apartments at State and Lake streets, gaily decorated in class colors, white and green. Socks in these colors hanging on the line on the porch, white and green parasols which every member carried, neckties and even hosiery were emblematic of the return of the naughty-naughts.

On Class Day the grads formed a procession and with a "German" band at the head marched to the upper campus for the ivy exercises. A paper elephant carried by four graduates reminded many of the real elephant that once was a mascot of this class. They finally ended their promenade in front of Main Hall, where a group picture was taken.

In the afternoon an exciting baseball game was held with the members of 1905. The contest was productive of a great deal of amusement for the large crowd of spectators as well as the players. It terminated in an easy victory for the older class, the score being about 13 to 7. The teams lined up as follows:

1905—Bartlett, Schreiber, Walton, Neckerman, Cronk, Bolte, Weld, and Goodnea and Storey, the last two being non-members of the class.

1900—Lyle, Metzler, Emerson, Tannig, Minch, Granke, Von Briesen, Whomes and Seaman.

The invasion of the annual business meeting of the Alumni Association by 1900 is elsewhere described. At 12 o'clock the members met at the university pier and there boarded one of the large boats for a lake party. This event proved a jolly affair and was thoroughly enjoyed by all. A reunion luncheon was served at the Maple Bluff golf club.

The class also edited a special edition of the *Daily Cardinal* on Alumni Day. The paper was filled with live news from the alumni and commencement activities. They also put on some interesting entertainments during the glee club reunion. In the evening they were present at the banquet in a body. During the three commencement days over 125 members of the class registered. (Wisconsin Alumni Magazine.)