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NOVEMBER, 1912

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The Wisconsin Engineer

VOL. XVII NOVEMBER, 1912 NO. 2

REPEATED STRESS TESTING.[1]

J. B. Kommers,
Instructor in Mechanics.

During the last two years the writer has been carrying on an investigation which had for its object the study of an alternating stress test which stressed the material beyond the elastic limit. Any test similar to that of Wohler is evidently not expeditious enough to be used commercially, and for that reason it seemed desirable to investigate the important factors entering into a test which might prove to be satisfactory for commercial purposes.

It seems desirable at this time, in view of some of the other papers that are to be presented, to publish the results obtained from the preliminary experiments.

In carrying out the investigation it was decided to try out one of the commercial machines already on the market rather than design a new one; and the choice of the particular machine used was based mainly upon the simplicity of the specimen required and the fitness of the machine to do the work which had been outlined. After considering the various machines available, the Landgraf-Turner alternating-impact machine was chosen, since for this machine the specimen required is simply a round rod, 3/8 in. in diameter and about 8½ ins. long. In a specimen of this length, also, both ends can be tested, giving two results for each specimen. Furthermore, this machine could be quite easily modified to do the work required.

Figs. 1 and 2 show end and side views of the Landgraf-Turner machine. Fig. 3 shows the essential part of the machine for

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[1] Presented before the Sixth Congress of the International Association for Testing Materials, New York, Sept. 2–7, 1912.

performing the test. The specimen is held vertical as a cantilever beam and is deflected on either side of its neutral position, thus subjecting the specimen at A, first to tension on one side and then to compression. The specimen is held firmly in the vice at AB over $1\frac{1}{2}$ ins. of its length. The rocker arm C causes

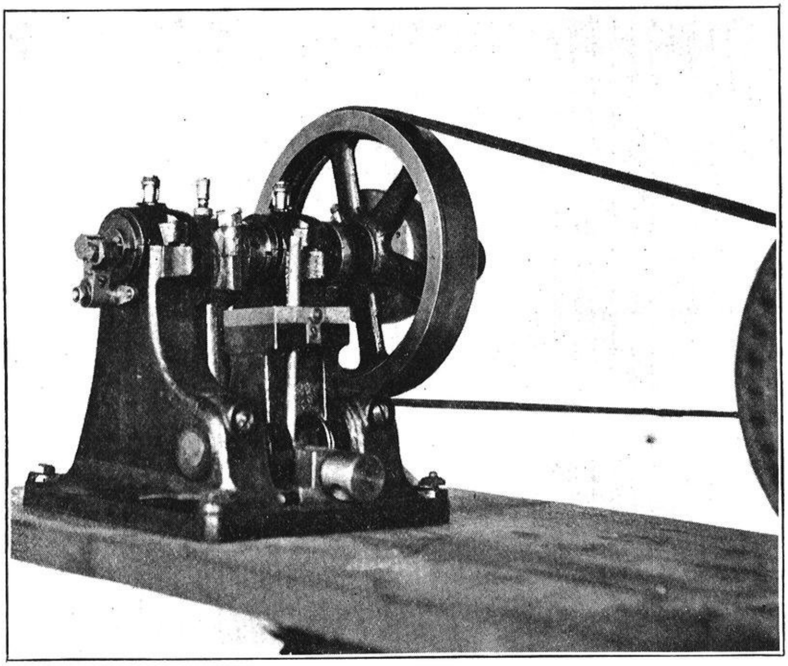

FIGURE 1.

the specimen to be deflected. The top of this rocker arm is fitted with two hardened steel hammer dies D and E. It can be seen that when the hammer dies are more than $\frac{3}{8}$ in. apart (as in the sketch) the specimen will receive a certain amount of impact before it is deflected. The free length of the specimen, from the top of the vice to the hammer dies is 4 ins. The frame carrying these dies may be adjusted so that the amount of deflection is the same on either side of the neutral position of the specimen.

The rocker arm which deflects the specimen is driven by a crank. In the experiments which had been outlined it was necessary to change the stroke of the machine, and this was done by providing suitable double eccentrics on the crank shaft. By this means, for example, it was possible to vary the deflection while the distance between the hammer dies D and E remained constant. Also by providing various sets of hammer

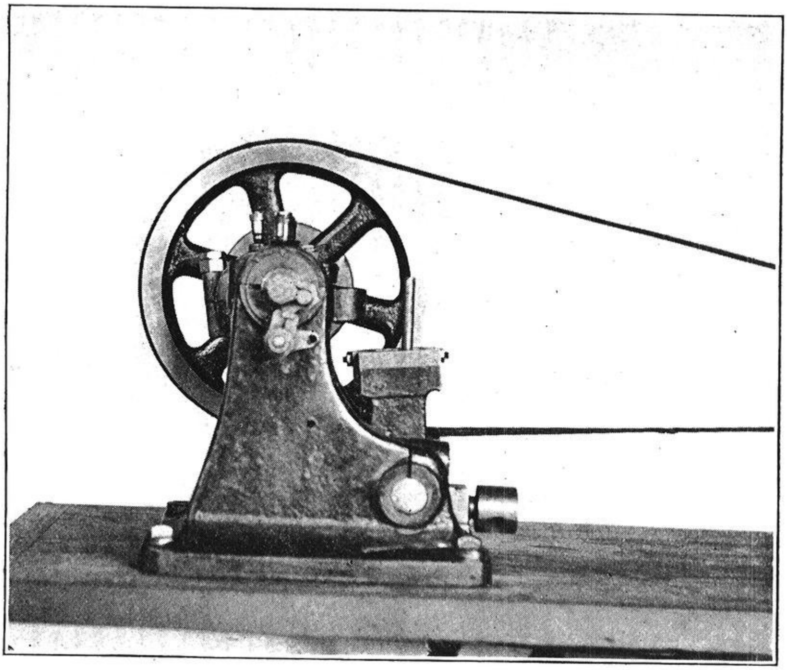

FIGURE 2.

dies it was possible to vary the distance between the hammer dies.

Since hundreds of specimens were to be tested, the experiments would have been quite expensive if each specimen had been turned up in a lathe. To eliminate this expense it was decided to make use of 3/8 in. cold-rolled steel which had been annealed. The steel was bought in the open market and was annealed at a red heat in a gas furnace, at the University laboratory for testing materials. As a check on the uniformity of the steel, three tensile tests were made on each batch of steel after it had been annealed. Table I gives results of tensile tests on one of the batches of steel, and also the chemical analysis of the steel used.

It may be said in passing, that when any sets of data were to be obtained for comparative purposes, care was taken to have all the specimens from one batch of steel, so that any slight variation between the different batches would not affect the results. It was found that any slight change in diameter of specimen did not seem to affect the results. The greatest variation of this kind was about 0.004 in., while the average variation was probably half that amount.

In making the preliminary tests it was found that shortly before complete rupture the specimen seemed to weaken or

TABLE I.

Tensile Test of Cold Rolled Steel After Annealing.

Material	8th Batch.		
Mark or Number	1	2	3
Yield Point, lbs. per sq. in.	39.600	39.200	39.600
Ultimate Strength, lbs. per sq. in.	60.300	61.000	60.300
Elongation in 2 ins., per cent	38	36	38
Reduction in area, per cent	63.2	64.4	63.2

CHEMICAL ANALYSIS OF STEEL.

Carbon	.10 %
Manganese	.57 %
Silicon	.005%
Sulphur	.108%
Phosphorus	.109%

give way. This was generally quite distinctly noticeable by the change in the "song" of the machine. This matter was further investigated and it was found that when a specimen was taken out of the machine just after this "weakening" it showed distinct cracks or openings on both sides at the grips, as shown in Fig. 4.

Furthermore, when this "weakening" stage was passed the specimen could be completely ruptured by bending it forward and back by hand. When the other end of the specimen was

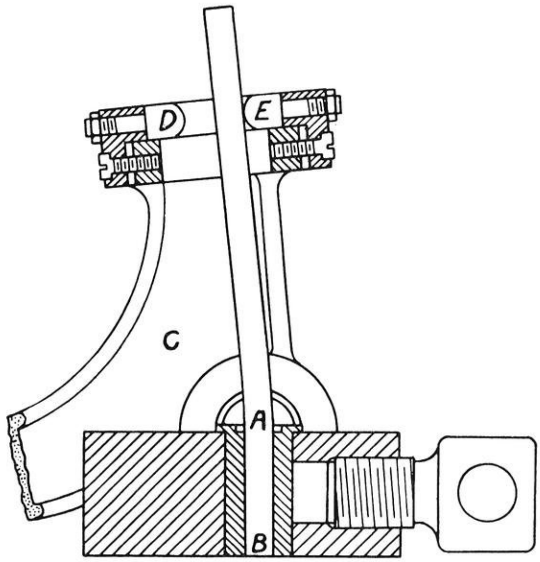

Fig. 3.—*Essential Part of Landraf-Turner Machine.*

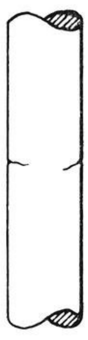

Fig. 4.—*Appearance of Specimen at Point of "Weakening."*

tested and taken out of the machine just before "weakening" was expected, it was found that the specimen showed either no sign of cracking or merely an incipient crack on one side. Moreover, in this condition the specimen was altogether too strong to be ruptured by hand. Further experiments along this line seemed to demonstrate that the point of "weakening" was really the important point of failure, and that after this stage was passed the specimen was held together near the middle of the cross-section by a small strip of metal which had no real strength. For instance, when there was a certain amount of impact the upper part of the specimen would soon become loosened due to the blows received, while when there was no impact it might require from 25 to 100 additional cycles after "weakening" in order to produce final rupture. For the reasons given above it was thought that a fair comparison should depend upon the real point of failure, which is the point of "weakening," and the results from which the curves were drawn are based upon this consideration.

Fig. 5 and Fig. 6 show the general relation between deflection and the number of cycles required for failure. The small arrows on the diagrams indicate places where two points coincide. By one cycle is meant the deflection of the specimen from the vertical first to one side, then to the other side and back to the neutral position. Fig. 5 is drawn for various speeds and no impact and Fig. 6 for various speeds and ¾ in. impact. By speed is meant the rate per minute at which the cycles of stress were applied to the specimen. Amount of impact here means the space between the specimen and the hammer D when in the position shown in Fig. 3. These curves show how rapidly the cycles required for rupture increase as the deflection of the specimen is decreased.

If the elastic limit of the steel used in these tests is 35.000 lbs. per sq. in., it would require a deflection of only 0.0332 in. to stress the steel to this limit. An inspection of the curves indicates that for this deflection millions of cycles would probably be necessary for rupture. Many experiments within the elastic limit have demonstrated the same thing, showing that such a test is out of the question for commercial purposes.

It may be well to state here that in order to get a good average, the tests were in all cases repeated, so that practically every point plotted on the various curves is the average of four tests.

Figs. 7 and 8 show the effect of ¾ in. impact as compared with no impact. Fig. 7 is for a speed of 200 and Fig. 8 for a

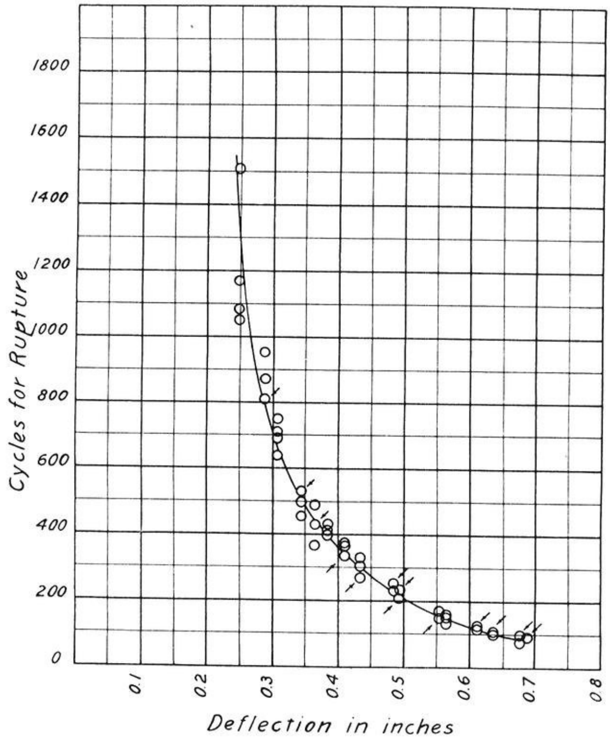

FIG. 5.—*Relation Between Deflections and Cycles for Rupture. Speeds Ranging from 150 to 500 Cycles per Minute.*

speed of 300. The curves show that for all practical purposes the effect of impact as applied within the limits of these tests is negligible.

These curves do not prove that impact has no effect, but that impact as applied by this type of machine has no effect. When the machine is running free the reactions at the crank take care of any unbalanced forces due to the motion of the rocker arm. When the machine is deflecting a specimen the pressure between the specimen and the hammer die will at any time be just sufficient to deflect the specimen—that is zero when the specimen is in a vertical position, and a maximum when the deflection is a maximum. In other words, the phenomena are much the same as in the deflection of a beam in an ordinary cross-bending test. The test in the Landgraf-Turner machine

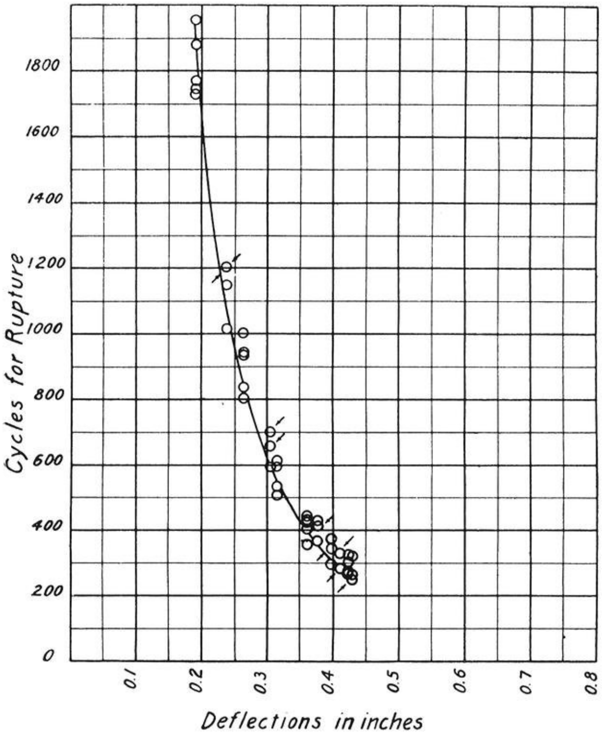

FIG. 6.—*Relation Between Deflection and Cycles for Rupture. Speeds Varying from 150 to 700 Cycles per Minute. Impact 3/4 In.*

is not at all comparable to the case of gravity acting on a load which is suddenly applied to a beam. In that case it can be shown that the deflection would be twice as great as in the case of an ordinary cross-bending test where the load is gradually applied. The effect in the Landgraf-Turner machine is therefore probably very little different than if the specimen had suffered the same deflection without the original impact. If the effect of impact is to be studied, the impact must be applied in quite a different manner than it is in this type of machine.

Figs. 9, 10 and 11 show the effect of different speeds upon the number of cycles required for failure. Fig. 9 shows the effect when there was no impact and Figs. 10 and 11 when there

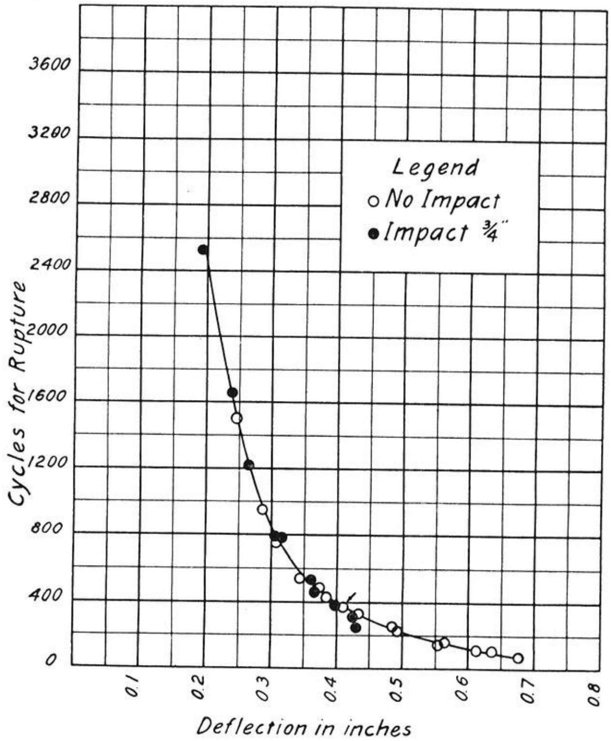

FIG. 7.—*Impact as compared With no Impact. Speed 200 Cycles per Minute.*

was ¾ in. impact. Fig. 9 shows that for deflections ranging from 0.35 in. to 0.50 in. there seems to be a slight decrease in the cycles for rupture in the case of the higher speed. Fig. 10 seems to show the same effect to some extent. In Fig. 11 the curve for the speed of 150 is inconclusive, but the other two curves again show the same effect due to the higher speed. All the curves show, however, that the effect due to increase of speed is very small even for great changes in speed.

To investigate this matter further, specimens were tested with a constant deflection at speeds of about 150, 300, 500 and 700. Furthermore, these tests were made with various amounts of impact and also with no impact. The second curve in Fig. 12 shows the results for a deflection of about 0.30 in. In order to

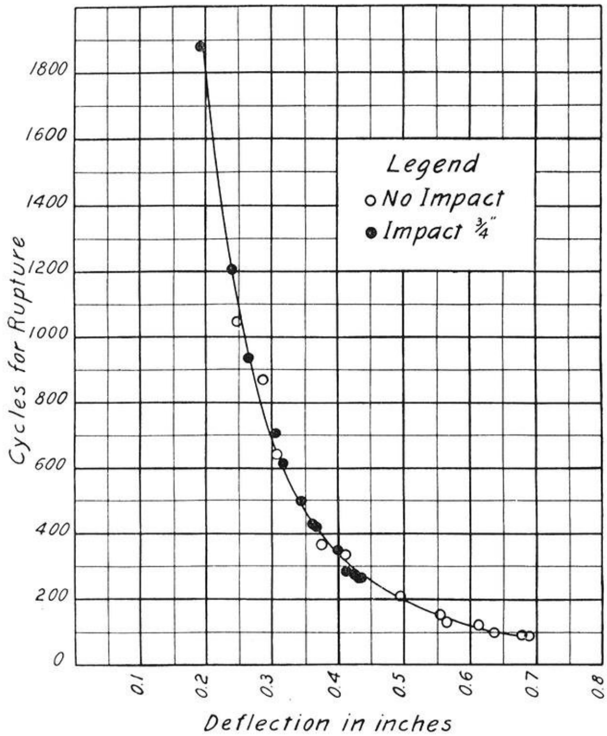

FIG. 8.—*Impact as compared with no Impact. Speed 300 Cycles per Minute.*

get results covering the field of deflections fairly well, the same tests were repeated with deflections of about 0.36 in. and 0.24 in. The results are shown in the second and third curves of Fig. 12. In both the second and third curves of Fig. 12 the general slope is slightly downward as the speeds increase, but again it is seen that the effect of variation in speed within these limits is negligible. The curves also show again that the effect of impact as applied in these tests is negligible.

The first curve of Fig. 12 shows the results for the deflection of 0.24 in. and is not so conclusive, the curves showing greater variation of results. The writer is of the opinion that this variation is due to the fact that a smaller deflection was used, and that in general it will be found that at small deflections results on the same material are not as uniform as they are at

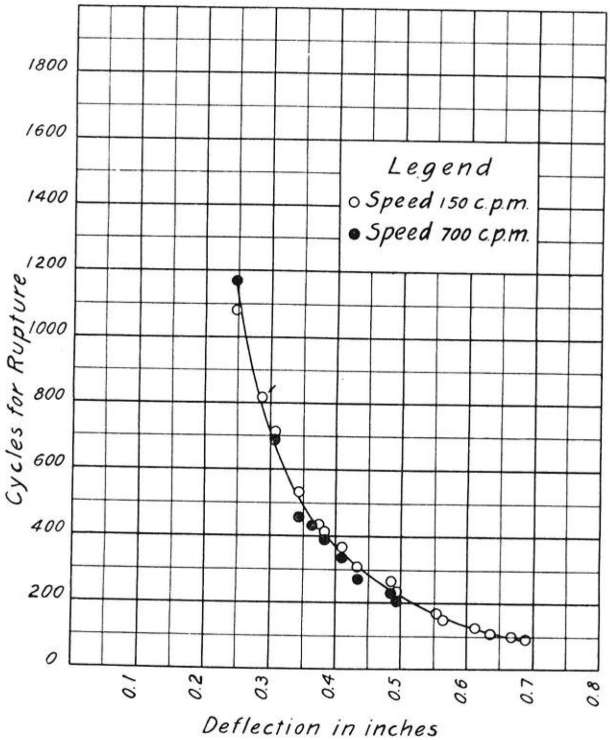

FIG. 9.—*Effect of speed on Cycles for Rupture. No impact.*

greater deflections. That this variation is not due to variations in the steel itself is shown by the dotted curve in Fig. 12. This curve was obtained by taking some of the same material used before, but with a deflection of 0.313 in., and with ¾ in. impact. The results at this greater deflection are again like the second and third curves of Fig. 12 and do not show the variation in the slope displayed in the upper curve.

Tables II, III, IV, and V, show the effect of the condition of the surface of the specimen on the number of cycles required for rupture. Four kinds of surfaces were investigated: 1. specimens merely turned in a lathe, resulting in a finely grooved surface; 2. specimens turned in a lathe and then filed with a fairly

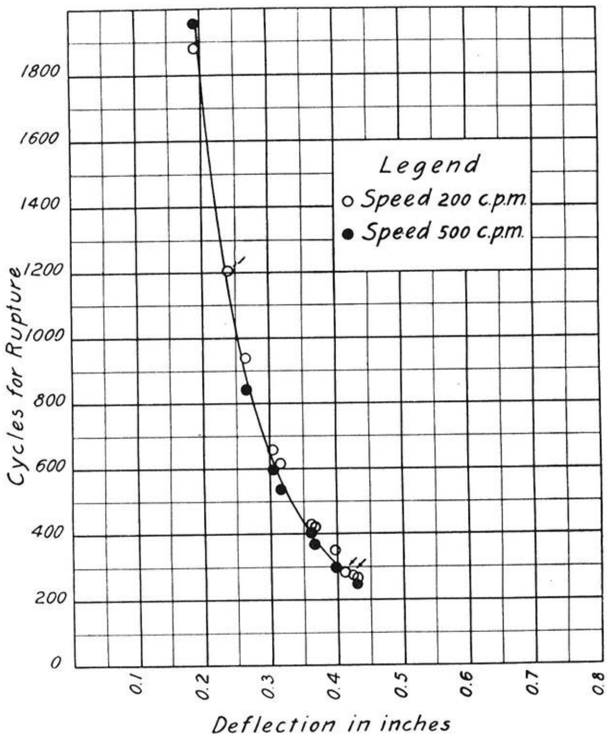

FIG. 10.—*Effect of Speed on Cycles for Rupture. Impact 3/4 In.*

fine 10 in. file; 3. specimens turned in a lathe, filed, and then polished with emery cloth of increasing fineness until quite a high polish was obtained; 4. specimens turned in a lathe and then ground to size.

The tables show that the condition of the surface undoubtedly has a marked effect, since the polished and also the ground specimens show an increased resistance to rupture of between 45 and 50 per cent. The results also indicate that ground specimens would probably be most desirable for commercial tests, since they show a strength equal to the polished specimen, and a mean variation from the average and a maximum variation from the average about as low as those of the filed specimens. Furthermore, the low cost of preparing ground specimens for commercial work would be a decided advantage over the polished specimens.

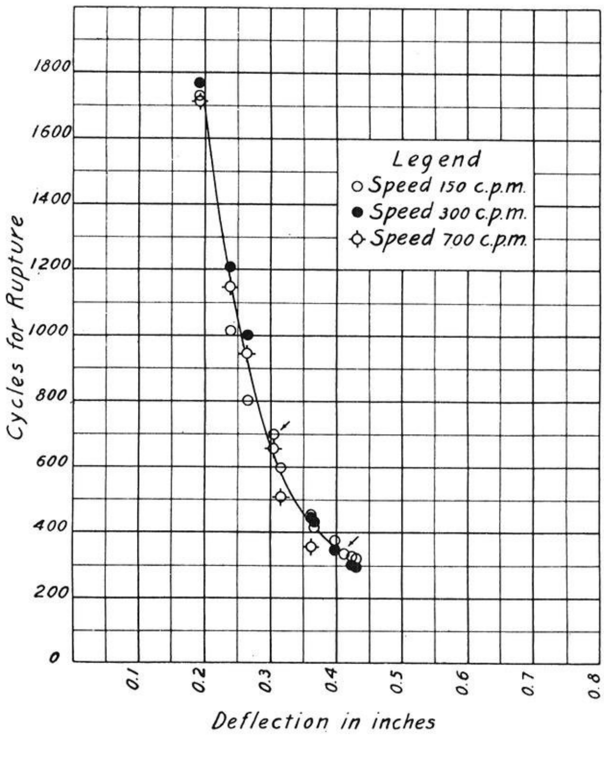

FIG. 11.—*Effect of Speed on Cycles for Rupture. Impact ¾ In.*

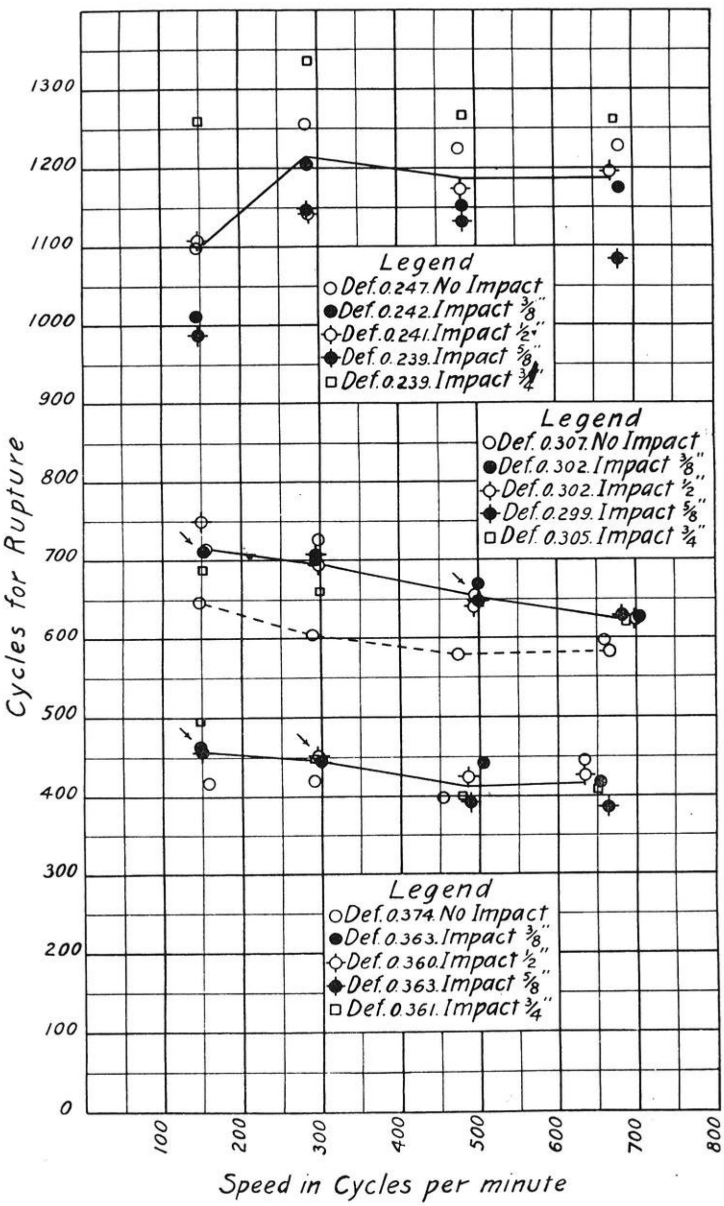

FIG. 12.—*Effect of Speed Upon Cycles for Rupture.*

TABLE II.

Specimens Merely Turned in Lathe.

No.	Diam. in inches	Speed per Minute	Cycles for Rupture	Average Cycles	Mean Variation from Average per cent	Maximum Variation from Average per cent	Increase in cycles for rupture over turned specimens per cent
No. 1	.378	284	375	....	....	....	....
No. 1	.376	....	452	....	....	....	....
No. 2	.376	284	412	....	....	....	....
No. 2	.378	....	341	....	....	....	....
No. 3	.380	283	467	....	....	....	....
No. 3	.375	....	407	409	8.4	16.6	....

TABLE III.

Specimens Turned in Lathe and Filed.

No.	Diam. in inches	Speed per Minute	Cycles for Rupture	Average Cycles	Mean Variation from Average per cent	Maximum Variation from Average per cent	Increase in cycles for rupture over turned specimens per cent
No. 4	.375	.281	567	....	....	....	....
No. 4	.375	....	572	....	....	....	....
No. 5	.373	285	527	....	....	....	....
No. 5	.375	....	508	544	4.77	6.62	33

TABLE IV.

Specimens Turned in Lathe, filed, and polished with emery cloth.

No.	Diam. in inches	Speed per Minute	Cycles for Rupture	Average Cycles	Mean Variation from Average per cent	Maximum Variation from Average per cent	Increase in cycles for rupture over turned specimens per cent
No. 6	.375	282	609	....	....	....	....
No. 6	.375	....	592	....	....	....	....
No. 7	.375	282	515	....	....	....	....
No. 7	.375	....	662	.595	6.88	13.5	45.3

TABLE V.

Specimens Turned in Lathe and Ground to Size.

No.	Diam. in inches	Speed per Minute	Cycles for Rupture	Average Cylces	Mean Variation from Average per cent	Maximum Variation from Average per cent	Increase in cycles for rupture over turned specimens per cent
No. 8	.375	....	590	....	....	....	....
No. 8	.375	285	627	....	....	....	....
No. 9	.375	282	565	....	....	....	....
No. 9	.375	....	654	609	51.7	7.38	48.8

NOTE.—The steel used for the above tests had the following composition:

Carbon	.10 %
Manganese	.44 %
Phosphorus	.019%
Sulphur	.035%

Summary.

The preliminary experiments discussed thus far may be summarized as follows:

1. A very important factor in a repeated-stress test similar to that performed by the Landgraf-Turner machine is the amount of deflection which the specimen receives. When the deflections are less than 0.30 in. the change in the number of cycles required for rupture is very great even for small changes in the amount of deflection.

2. Impact applied to the specimen as in the Landgraf-Turner machine has practically no effect upon the number of cycles required for rupture.

3. At speeds of about 700 cycles per minute the number of cycles for rupture is slightly less than at speeds of about 150, but for small changes of speed this effect is practically negligible. When the deflection is small the results on the same material do not seem to be as uniform as when the deflection is about 0.30 in. or a little more.

4. The condition of the surface of the specimen has an important effect upon the number of cycles required for rupture.

There is one factor entering into the test which was not investigated, because of the fact that the machine did not lend itself to such investigation. This factor is the method of gripping the specimens. Experiments will probably be made in the near future to determine whether this element affects the results appreciably.

THE MAKING OF MAGNESIA CRUCIBLES.

OLIVER P. WATTS.
Assistant Professor of Applied Electrochemistry.

In the preparation of the thousand alloys of electrolytic iron, which have been made and tested in the Department of Chemical Engineering during the last few years, it was necessary to melt the material without contamination by carbon. Since suitable crucibles could not be purchased it was necessary to make them, and at the end of four months of constant experiment, the first successful crucible was turned out.

In view of the difficulties to be overcome, and the inquiries received from time to time in regard to the method of making these crucibles, it has seemed advisable to publish the results of our experiments along this line.

At the outset Dixon graphite crucibles, as well as crucibles turned from bars of Acheson graphite, were lined with calcined magnesia to which some binder, such as a solution of sodium silicate, magnesium chloride or tragacanth was added. The lined crucibles were allowed to dry, and were then heated in a gas oven to drive off all moisture before use. They were then charged with the desired metals, and the melt made in an electric arc furnace. After months of experimenting with these materials, fifty per cent or more of the linings failed in the electric furnace. Success was finally achieved through modifying our process in three particulars, viz.: the elimination of all binding materials, except water, the baking of the magnesia lining *in situ* to a temperature as high as that at which it was to be used, and finally the substitution of an electric furnace of the resistance type for the arc furnace.

The process as finally worked out is very simple. The calcined magnesia is moistened with water, and tamped around a core of wood set in a crucible turned from a bar of Acheson graphite. The core is withdrawn and the crucible set in an oven heated by gas, until thoroughly dry. It is then covered by a thin graphite cap, buried in a granular carbon resistor, and heated to a tempeature a little above that required to form any of the alloys. After so baking, the magnesia linings are readily removed from the crucibles. They are hard and stone-like, and show a crystalline fracture. For use, they are replaced in the graphite crucibles, charged with the desired metals, covered with a thin disc of magnesia, and the graphite cap placed on top, when they are ready for the electric furnace. A description of the furnace used has already been published.[1]

Commercial calcined magnesite was found to vary greatly in the amount of iron oxide, and carbon dioxide contained, no two lots proving alike in these respects. The iron oxide is detrimental, because in baking the linings, it distils out, is reduced to iron in contact with the inner wall of the crucibles, and this iron is then likely to corrode both the crucible and the lining by carrying carbon from one to the other.[2] Any considerable amount of carbon dioxide indicates insufficient calcining, and such material will show excessive shrinkage in baking, and in extreme cases the lining may crack. Average linings, 6 inches high and 3⅛ inches in diameter, showed a shrinkage of 12 per cent in both outside and inside diameter, and 17 per cent in length. One lot of magnesia contained so much carbonate that it was impossible to use it without calcining it. This was done in the electric arc, and the fused magnesia produced was then pulverized for use. Linings made from it shrink so little that it was sometimes difficult to remove them from the crucibles after baking. This may be remedied by the addition of 2 to 10 per cent of magnesia which has not been fused.

The extreme temperature at which such magnesia linings may be used in graphite crucibles is fixed, not by the melting of the magnesia, but by its reduction by the graphite. On account of this action, the granular resistor should never be allowed to come in contact with the magnesia linings.

In view of the hardness, mechanical strength, and high melting point of such magnesia linings, it would seem that they needed only to be given the form of commercial crucibles, to replace completely the latter for very high temperature use. Unfortunately magnesia loses its strength at a white heat to such a degree that the crucibles will not bear handling; hence

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[1] Electrochemical and Metallurgical Industry, 4, 273.

[2] Trans. Amer. Electrochem. Soc. 11, 279.

they can be used only as linings when the crucibles must be handled at, or near, a white heat. The writer has tried additions of various other refractory materials to magnesia in hope of increasing its strength at high temperatures, so that crucibles full of melted metal may be handled directly, without the use of a graphite casing, but so far these experiments have not been successful.

A similar method of manufacture is outlined in U. S. patent 1022011, recently issued to G. Weintraub, and assigned by him to the General Electric Co. Carbon or graphite cores are, however, used instead of wooden ones, and these are left in place during the baking, which is carried only to a temperature of 1500° C. To prevent the breaking of the crucibles by the contraction which occurs during cooling, several layers of paper are wound over the cores before these are put in place. The process is applied to crucibles of magnesia, alumina, and thoria.

For magnesia at least, the patented process appears to have no advantage over the earlier method evolved at Wisconsin, while it involves the additional expense of a considerable number of carbon cores, and the likelihood of the cracking of many crucibles during cooling, in spite of the cushion of paper put around the unyielding cores.

A good market awaits the manufacturer of a crucible free from carbon, which shall be as cheap and refractory as magnesia, and strong enough to be handled when full of molten metal.

OPPORTUNITIES IN THE COMMERCIAL SIDE OF THE CENTRAL STATION BUSINESS.[1]

HENRY HOLTON SCOTT, '96.

In recent years large numbers of graduates of the leading technical schools have entered the central station, telephone and street railway fields and the company with which I am associated alone numbers over 150 technical engineering graduates. In our New York office alone we have 16 engineering graduates.

Each year of late we have taken twenty to twenty-five graduates and we send them to what we call our Denver Apprentice School, and here they have two years work in all the departments of the Denver Gas & Electric Light Company. At the end of this period we transfer these men to the various properties and they ultimately become the Superintendents and Managers of the local properties. It might be of interest to state that of the twenty odd properties which we operate there are only four where the Superintendents are not college graduates.

This condition was not true ten years ago, but in recent years there has been a constantly growing demand for college graduates, and I look for even a greater acceleration in the future.

I noticed recently that the *Electrical World* of November 11th, 1911, states that the number of electrical graduates of the leading Engineering Universities and Colleges was for 1911, 633, and that the total graduates to June, 1911, was 8,752. The Electrical World groups a second class of schools which give a complete electrical course, and the number of graduates in this group last June was 678, and the total to June 1911, 6,066. The total graduates therefore last year of all schools giving a complete electrical course was 1,311, and the total to June, 1911, 14,818.

I am reliably informed that no more than 30 per cent enter

[1] An address delivered by Mr. Scott before the local chapter of Tau Beta Pi, May 31, 1912, on the occasion of his initiation as an alumnus member.

the public utility field, which includes central stations, telephones, telegraph and electric railway companies. I have no figures to show the number of graduates in the central station field, but I believe that 2,000 would fully cover the number.

If so, it is interesting to note that there are over 6,000 central stations in the United States, and it is my opinion that every central station can well afford to have at least one engineer graduate and some of the large companies could possibly afford to have fifty or more such men. It is my firm belief that the central station industry could at this time employ profitably 10,000 engineering graduates, or, in other words, the places that might be filled number five times the number of graduates now engaged in this field.

I know of no business which has changed and is changing so rapidly as the central station business and this of course presents great possibilities for men who can and will take the initiative. The number of central stations in the United States in 1885 according to Mr. Samuel Insull was only eighty, whereas today there are over 6,000 central stations doing a gross annual business of over $325,000,000 and which represent an investment of $2,500,000,000. That means that the investment is almost $30.00 for every man, woman and child in the United States. I am pointing out this feature to emphasize the fact that the central station business is not only a combined technical and commercial business, but is primarily an investment business and therefore calls for the highest type of combined business and technical skill. I will, however, touch upon this feature later.

During the past twenty-five years the standards of electrical generating apparatus have repeatedly changed, but it is the opinion of the leaders in this field that electrical generating apparatus has reached a point where standards will not change, or, at least, will not change very rapidly. Prime movers will undoubtedly change from time to time, for we still have very inefficient machines, but the margin for improvement in better efficiencies of electrical apparatus is very small. But there will be other remarkable changes in the industry along the lines of grouping smaller stations and supplying the requirements from one source of supply. This means that the number of stations will not increase in the future as in the past, and in fact may decrease, but this does not mean that opportunities for men like yourselves will lessen, but on the contrary will be materially better. Some examples of central station companies that are now doing this very thing are the San Francisco Gas & Electric Company, which supplies in excess of fifty per cent of the whole population of California, the Southern Power Company, which distributes power over the entire State of South Carolina. The Commonwealth Edison Company, of Chicago, which supplies power for many towns in Northern Illinois, and many others which I could mention. We operate a company at Joplin, Mo., which supplies a dozen towns in two States—Kansas and Missouri—and also the great lead and zinc mining country in and about Joplin. This company has now 210 miles of high tension distribution.

I was very much impressed with something I saw in the main sales offices of the General Electrical Company, at Schenectady, a short time ago. It was maps of all the States, and upon each map were pins of various colors representing the existing central stations, and the pins comprising the natural groups were tied together with strings. One could almost tell at a glance the stations throughout the United States that should be tied together for economic reasons, and Mr. Haskins, the head of this department (since deceased), told me that whenever his salesmen, scattered all over the country, had a breathing spell they were instructed to keep busy doing the proper missionary work in these various groups. It was a very striking example of the possibilities for effective work along this field.

I said awhile ago that the central station business is primarily an investment business, and I can illustrate this at this point very well. Usually a public utility company is mortgaged for an authorized amount to cover the estimated amounts of money required for improvements and extensions for a period of time, usually twenty, thirty or forty years. Usually the condition is made that bonds may be taken down and sold for say eighty per cent of the improvements made. Now the amounts of money needed for improvement in growing towns and cities is enormous, and I think I am safe in saying that the average necessary is \$2.50 to \$3.00 for every dollar of gross increase in business. The sale of these bonds to investors to provide the required capital becomes of prime importance and until recently this was a great handicap to the small companies, for the banking houses and bond selling houses would not and could not sell bonds on public utilities in towns and cities of 10,000 or less. But by grouping say five or six towns with an aggregate of 50,000 people they welcome the opportunity to purchase such bonds. Thus you see the grouping of the smaller stations is bound to come, primarily because of necessity, and secondarily because of economic reasons.

The commercial side of the business offers untold opportunities for the technical men in the central station field. In the early days of the central station business it was customary for the stations to operate only during the hours between dusk and midnight or dawn, but after awhile some stations started to operate for the full twenty-four hours. At first no effort was made to solicit business and the station simply (reluctantly in some cases) took whatever business was offered to it. Then came a time when some enterprising station men realized that the sales end of the business, like every other commercial business, was highly important; efforts were made to increase the lighting business, and the growth of this business was very marked. This resulted in a very high load for a comparatively few hours in the year. Then a further step was made to solicit power business to keep the machinery and distribution systems busy, and today it is no uncommon thing to see a central station with a day load in excess of the night load. And there are many stations today with a revenue from the power business in excess of what was considered possible to obtain in the lighting business not over five or seven years ago.

I have in mind a central station located in a manufacturing town in Ohio which because of lack of aggressiveness in the commercial side of the business was not earning its fixed charges. The management was turned over to experienced operators, no change was made in the personnel of the operating staff, but several experienced solicitors were added, among them being an engineering graduate who combined technical skill with commercial ability. In 4 months time an 1,800 horsepower power load was added and the net earnings of the property for the four months following the acquisition of this power load were fifty per cent over the preceding corresponding period. This station now has a greater day load than lighting load, and to make a better load factor, the company is endeavoring to contract to supply the various smaller central stations in the immediate vicinity.

The growth of the sales in the industry has been phenomenal, and I can probably best illustrate it by stating that the growth of sales (K. W. Hours, not dollars, for the average rates charged for current have continually decreased) have increased in per cent cent six to ten times as fast as the growth in population of the principal cities of the United States during the past decade. The leaders in this industry are confident that the rate of growth in the future will be maintained and point to the almost unlimited possibilities in the power field, the development of the use of electricity in rural districts, the development of the electric vehicle especially for uses in the larger cities, the possibilities in the uses of electric power for irrigation purposes, the suitability of electricity for refrigeration purposes, for heating and so on down the line. I quote one recognized leader who in a public address predicted that the sale of current for refrigeration purposes will equal in the near future the present total sales for all purposes.

I have probably emphasized in what I have said the commercial side of the central station business, and my reason for so doing is that this feature is lost sight of in the training given by the great technical schools. To further emphasize the thought, I quote you from a notable address delivered by Mr. Samuel Insull at the 1910 Convention of the National Electric Light Association in St. Louis:

"It matters not by what name you may call it—whether you speak of it as the improvement of your load-factor, or whether you speak of it as creating a day load—the fundamental reason for the success of the business in which we are engaged is as much an appreciation of the proper method of selling our product as the opportunity to use the many brilliant inventions which have been made by the great technical minds of our time.

"I am dwelling upon this subject not with any idea of belittling the great achievement of the inventors and engineers whom it has been our good fortune to have had working in our interests in the fields of discovery and engineering, but for the purpose of impressing, more especially upon the younger men connected with our organization, the great importance of the commercial side of the business and to point out to them the advantage, alike to themselves and the business itself, of their bestowing upon the commercial side of the business as much if not a greater amount of thought than that which they bestow upon the technical operation and construction side of central-station development.

"As a manager of central-station properties it is often brought home to me that whilst it is comparatively easy to obtain first-class operating assistance, and while it is not a matter of great difficulty to obtain engineers of constructive capacity to design and build our central-station plants and systems, it is a far greater problem to obtain trained technical men who have made a thorough study of commercial conditions to take part in the commercial development of the business. I am inclined to think that, if during the next quarter of a century we are to make relatively as great progress in the development of the central-station business as has been made in the last quarter of a century, it will be necessary for the technical institutions of the country to give greater prominence to the commercial side of the central-station business and, when qualifying their students in electrical engineering and mechanical engineering, to teach them more of the true conditions governing commercial development.

"To the young engineers engaged on the operating side of the business my advice is to familiarize themselves with the commercial conditions under which the companies for which they work have to conduct their business. If they will give thought to the commercial side of the business and qualify themselves to take part in the sale of the product of the company, if they will devise new methods of selling the product, new methods for obtaining consumers of the energy produced by the central-station, they will stand a chance of achieving distinction and profit far greater than most of them can achieve in the operating and purely engineering side of the business."

This is a commercial age and it is commercialism that has given the United States a place among the nations of the world. I believe the engineers are the men who are making the United States the leading commercial country. The applications of electricity are changing the industrial conditions of our time and although some of the political economists may tell us that labor is the great source of wealth yet we all know, if we stop to think, that the development of the natural resources is the primary cause of wealth and prosperity. Electricity is and will continue to be the greatest factor in the development of our resources.

I was over in Germany last fall and in talking with one of their engineers he made a remark which impressed me very much. He said his people were a wonderfully painstaking people, were thorough students and to use his own words:—"We study and experiment and finally, after years of work, prove some theory in engineering, but you Americans come along, take one look at the results of years of work and before we know or realize the importance of this work you apply it."

GRAPHICAL SOLUTIONS OF HEATING PROBLEMS.

H. J. THORKELSON.

Associate Professor of Steam Engineering.

The adequate heating of buildings in the winter months forms one of many important engineering problems, and one whose solution is being reached partly by rational and partly by empirical methods.

As the loss of heat from a building occurs both by radiation and convection, and varies directly as the difference in temperature between the interior and exterior of the building, most methods of determining the artificial heat required take these factors into account.

Although a test may show the radiation loss through a certain 12 inch brick wall to be one-third of a B. t. u. per hr. per sq. ft. per degree difference in temperature, still the care with which brick walls are built, the character of the brick, etc., will so affect radiation that it would be unwise to depend absolutely on this experimental coefficient, and all heating calculations must consider such variations in construction in applying experimental data.

The heat loss due to convection will depend upon the number of changes per hour of the air in the building and this will also depend upon its construction, use, and methods of ventilation. Although information is available for calculating such losses, still it is necessary to make ample allowance for faulty window construction and other variables.

In this latitude the approximate average annual cost of heating a building will vary from 20 to 30 per cent of the first cost of the heating system, if steam is used, and because of this ratio it is certainly poor economy to install cheap equipment of inadequate capacity. Unfortunately, competition between contractors and poor judgment on the part of owners and their advisers result in attempts to reduce first cost of a heating system without due consideration of the resulting effect upon operating costs and the operation of the system under severest conditions.

In meeting problems of heating and ventilation of the recent University buildings, the general plan followed is to provide direct radiation in the rooms to supply the heat necessary for the usual radiation and convection losses, and when ventilating systems are installed to install such additional indirect heating surface as will be required to heat the fresh air used for ventilation, to room temperature.

The direct radiation surface required for rooms is computed by deriving a formula based on the following heat losses per degree difference of temperature per hour per unit used.

Radiation	Glass 1	B. t. u.	per	sq. ft.
	Wall .25	"	"	" "
Convection	.04	"	"	cu "

As outdoor temperatures of —20 degrees F. are frequent, it is necessary to base calculations on a 90 degree difference of temperature giving an hourly heat loss of

$$90\,(G + .25W + .04C)$$

where G represents the sq. ft. of window opening, W the sq. ft. of net exposed wall surface and C the cubical contents of the room. With a heat transmission of 300 B. t. u. per sq. ft. radiator surface per hour by a steam radiator, the above formula would indicate a radiating surface of

$$\frac{90}{300}\,(G + .25W + .04C) \text{ or}$$

$$.3\,(G + .25W + .04C)$$

and this is the formula used to determine the sq. ft. of radiating surface required.

In order to expedite calculations of this kind, one of our former students, Mr. E. F. Johns, constructed a diagram for determining areas and cubical contents graphically. Fig. 1. Areas are found by using the inclined lines from the lower left hand corner and Scale A for the two dimensions with the product shown on Scale B.

If volumes are desired, the area is first found as above on Scale B and this result is transferred to Scale C and followed in a vertical line to the dimensions of height shown on the lines radiating from the lower right hand corner the volume will

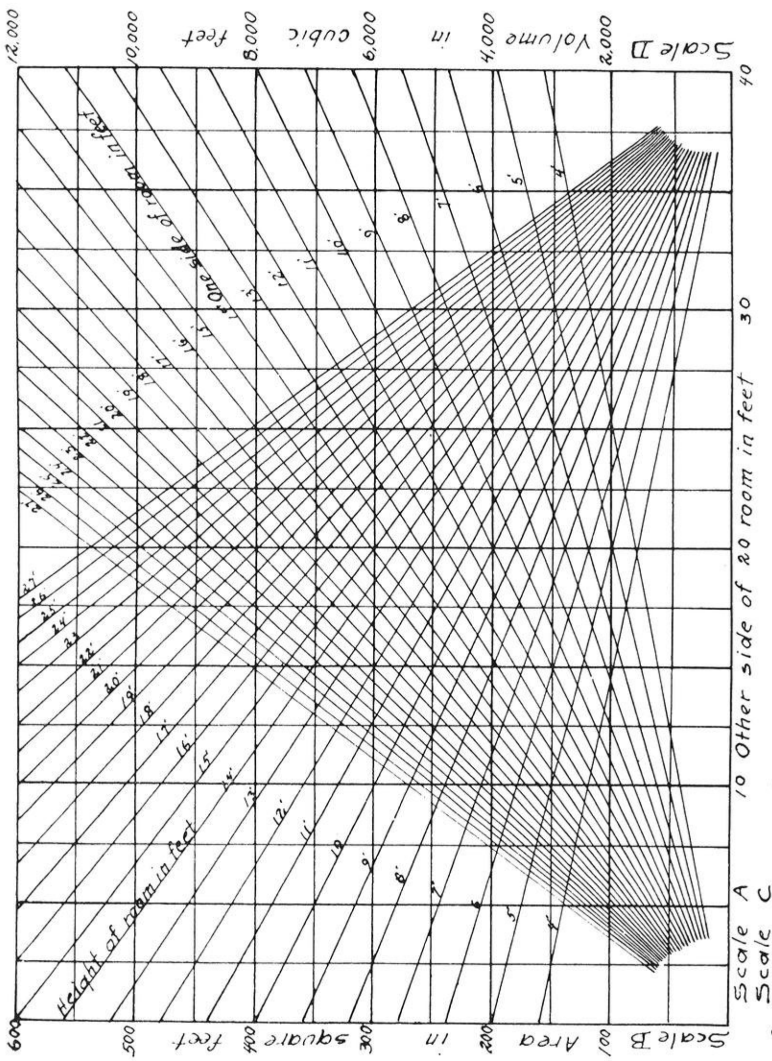
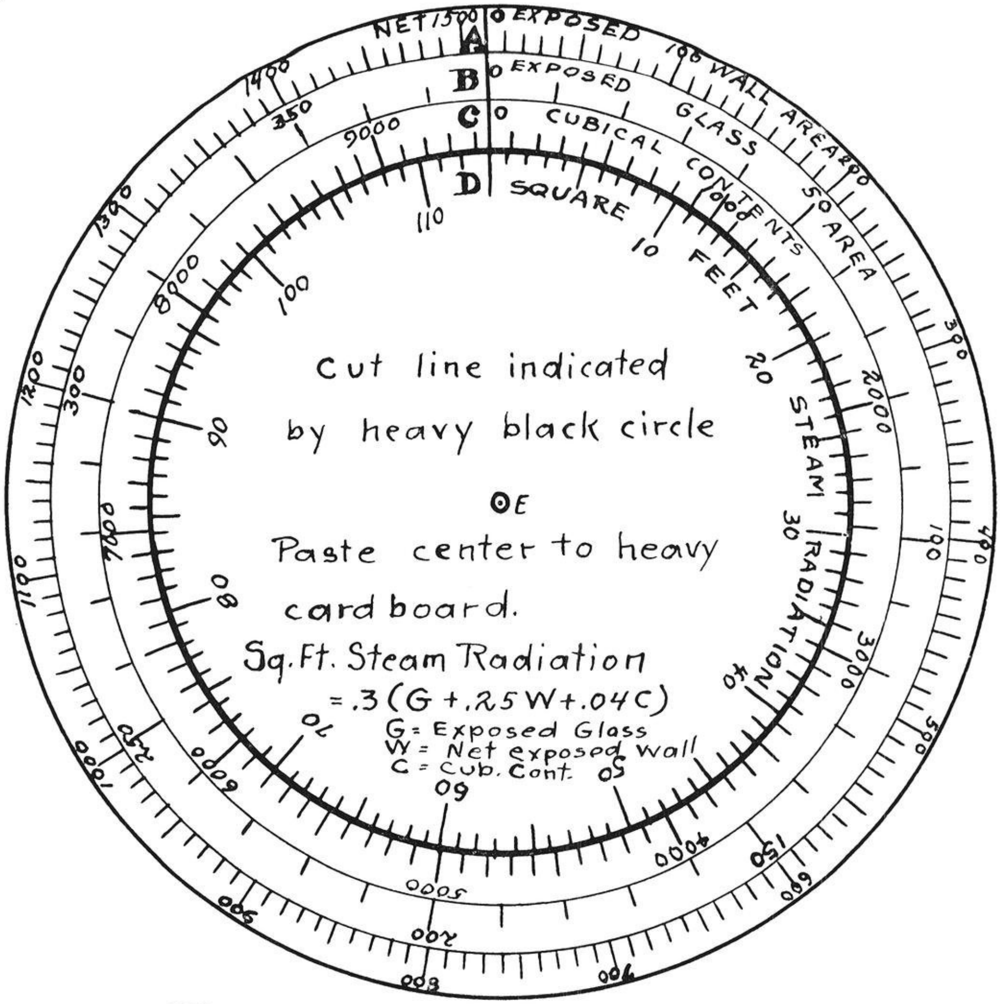

Scale D
Volume in cubic feet
2,000
4,000
6,000
8,000
10,000
12,000
One side of room in feet
Height of room in feet
Scale A
Scale C
10 Other side of 20 room in feet 30 40
800 600 400 200
Scale B
Area in square feet
100
200
300
400
500
600

FIGURE 1.

RADIATION SLIDE RULE



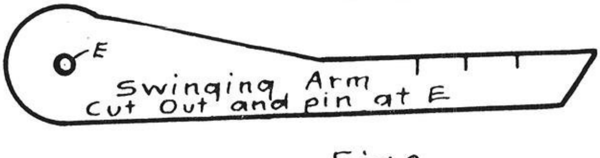


Fig 2

Supplement to The Wisconsin Engineer, November, 1912.
(See article by Prof. Thorkelson on Graphical Solutions of Heating Problems.)

be shown by Scale D. This enables easy calculations of G, W and C.

In order to permit simple calculations of the required radiating surface from the above formula, Mr. E. F. Week, U. W. '12, constructed the ingenious circular slide rule shown in Fig. 2.

Scales A, B and C are cut out in one piece forming the movable scale of the slide rule and D the fixed scale. A swinging arm is fastened to the center of the rule and in starting both scales are set at O. The swinging arm is then moved on Scale B to the figure indicating G of the formula, and held there. The movable scale is then revolved until its zero coincides with the swinging arm. This arm is then moved on Scale A to the figure representing W of the formula and held there.

The movable scale is then revolved until its zero coincides with the swinging arm. This arm is then moved on Scale C to the figure representing C of the formula. Scale D will then show the sq. ft. of steam radiation required.

If a gravity hot water system is used this result should be multiplied by 1.5 to obtain the required sq. ft. of hot water radiation. If a forced circulation is used this ratio may be reduced.

THE TESTING OF VITRIFIED PAVING BRICK.

W. P. BLOECHER, '14.

The great variation in the physical properties of vitrified paving brick of different manufactures, even when made under substantially the same conditions and of materials of a satisfactory composition, coupled with the need for absolute uniformity and strength, renders the necessity for a proper series of tests of brick specimens at once obvious. Although the manufacture of brick is indeed of ancient origin, its use in pavements is relatively recent, and still more recently, about 1895,—and only after many failures in brick pavements—do we find any systematic or scientific attempts to show by test that a given brick possesses those physical properties so requisite of a good paving brick.

The object in using vitrified brick for pavements is to provide "a durable wearing plate which will have (1) little traction resistance and (2) the greatest amount of wear resistance, and (3) afford a sanitary condition." As the first element, that of little traction resistance, is a function of the shape of the brick and its manner of laying rather than of its inherent physical properties; and element (3), looking to a sanitary condition, is of secondary importance, it follows that the paramount requisites that a brick must fulfill in order to be suitable for pavement purposes are that it be sufficiently tough and strong to furnish the greatest amount of wear resistance.

The wear of a paving brick can be divided into two general classes:

First: That due to impact, as caused, for example, by the striking of horses' hoofs, which tends to chip pieces from the brick; and

Second: That due to abrasion, as caused, for example, by the grinding action of the wheels of vehicles, which leads to the steady wear of the brick;

and to establish the ability of a brick to withstand such wear is the gist of all tests.

The tests so far devised, and used with varying success, are as follows:

1. Specific gravity.
2. Absorption test.
3. Crushing strength.
4. Transverse strength.
5. Rattler, or impact and abrasion test.

In addition, of course, the general appearance of the brick and its structure and color are always gone into, for they give valuable clues as to its value when confined to one line of brick; but the seemingly inconsistent variation of these qualities in different brands makes it no absolute criterion.

A review of these tests, taken up *ad seriatim,* shows:

I. *Specific Gravity*

The determination of the specific gravity of the brick can be made knowing the weight of the dry brick in air, its weight submerged in water and its weight, saturated, in air. By itself this information shows nothing at all definite, although it indicates in a general way the value of the brick, for the more dense a brick, the harder and stronger it usually is. As, in addition, results vary with the character of the clay used, irrespective of the true value of the brick, it is generally conceded that this test is of little or no value, and it has, accordingly, been abandoned.

II. *Absorption Test*

The absorption test seeks a determination of the amount of water any given brick will absorb. It consists of the complete immersion of the brick samples in water for varying lengths of time; the increase in the weight of the brick, or the amount of water absorbed, after such periods of immersion, representing fairly the porosity or the voids, is figured in per cent of the dry weight of the brick. While it is considered true that "the porosity of burnt clay wares is the best index to the degree of chemical combination or vitrification" of the ingredients, it is by no means a direct index to the value of the brick for pavement purposes, for the reason that practice discloses the fact that good paving brick will vary widely in the magnitude and rapidity of absorption. Hence we are forced to conclude that the porosity or degree of vitrification alone has little bearing on the value of the brick for paving purposes, although it usually serves to confirm the results of the other tests. For these reasons, this test is now seldom used.

The main consideration which in the past made the porosity test seem such an important one was the question as to the ability of the brick to withstand the internal effects of frost. Generally speaking, the magnitude of the frost action should vary about as the porosity; hence a brick of high porosity will have to withstand greater forces due to frost. At the present time, however, the process of manufacturing bricks has reached such a state of perfection that any well-made brick is able to resist the forces due to frost regardless of its porosity; accordingly, the importance of the test no longer exists.

III. *Crushing Strength*

The determination of the crushing strength was formerly gone into in considerable detail, although, as there was no standard method in use, the results differed widely. The test is not in itself at all conclusive, for, while crushing strengths as high as 10,000 lbs. per sq. in. were developed whereas an ordinary load gives but 2,000 lbs., the strains developed in the test are considerably different from those to which the brick is actually subjected. As the test reveals very little information not shown by the other tests, particularly that of the rattler, it has now been generally discarded.

IV. *Transverse Strength*

The test for the transverse strength of the brick is performed by resting the brick horizontally on two knife edges a given distance apart, and applying a load through a knife edge on the upper side midway between the supports. The results, expressed in terms of the modulus of rupture, ordinarily vary from 2,000 to 3,000 lbs. per sq. in. The test is valuable as a means of comparing the toughness of different brands of paving brick, as a confirmation of the other tests, and as a detection of the uniformity of the structural soundness of one brand; yet by itself, as with the crushing test, it furnishes no conclusive information.

V. *Rattler Test*

The impact and abrasion test, commonly known from the process involved as the "rattler test," is the most important and most widely used test to which paving brick are subjected, inasmuch as it attempts, by experimental means, to subject given specimens as nearly as possible to the abuses which they receive in actual pavement use. In its most approved form the test is made by fastening the brick specimens to slats having a channel section, which with steel heads form a cylinder; in this are inserted loosely a number of cast iron spheres, the cylinder being then revolved at a specified speed for a given number of revolutions. The apparatus is of steel, the cylinder being about 28 inches in diameter and 20 inches long, its cross-section being a polygon of 14 sides; this is set on trunnions and driven by power. The blocks are of two sizes, 3¾ inches and 1⅞ inches in diameter weighing 7.5 and .95 lbs. respectively; the tumbling action of the larger testing principally for impact and the rolling action of the smaller testing principally for abrasion. About 10 brick constitute a charge, while a complete test consists of 1,800 revolutions at the rate of 30 revolutions per minute. The brick specimens are first weighed, and the loss from chipping and wear is required to fall within a given per cent of the initial weight of the brick, usually up to 15 or 20 per cent.

This form supersedes one in which the brick alone were loosely thrown into the cylinder, their inter-action from tumbling constituting the testing forces; many of such machines are still in use.

Much experimental work has been performed on the question of testing paving brick, by able men; in most cases the rattler test is looked upon as the best criterion. The results of the experiments in this test are somewhat remarkable, for they indicate that even the slightest variations in the details of the apparatus or the method of conducting the test (such as varying the diameter of the cylinder or the speed at which it is revolved) cause corresponding variations in the results; so that the directions are given with great minuteness. In addition to those general conditions above mentioned, they provide for further details as to the design and construction of the machine; the driving mechanism; the weight, shape, and composition of the abrasive charge, and their limits of wear; the condition of the brick charge with respect to moisture, etc.; the method in detail of conducting the test and keeping the record.

In conclusion, then, it can be stated that of all the tests devised the rattler furnishes by itself the best, most uniform and dependable results; that all other tests fall short of this in some way or other, and their value lies chiefly further to confirm the results of the rattler test.

The Wisconsin Engineer.

EDITORIAL.

Each year there is a large number of tests and investigations carried out by undergraduates in the College of Engineering in connection with their theses. These tests probably do not represent the same degree of accuracy as would be obtained by very skilled observers but with capable students the results obtained are reasonably accurate.

Quite a number of such tests have recently been made under the direction of the Mechanical Engineering Department and the results obtained have been of considerable interest and value to practicing engineers. Some of the more important of these investigations have been reserved for University Bulletins. A number of these problems, however, did not seem to warrant the publication of a Bulletin though the results have considerable engineering value.

In the ordinary course of events the theses containing these results would be placed on the shelves of the Library and would be available for reference only to people in and about Madison. This is not a desirable situation, for all engineering data of value should be given publicity and thus be made available to the whole engineering profession. It has seemed logical that such data should be presented through the medium of the Wisconsin Engineer. An arrangement has therefore been made with the Mechanical Engineering Department whereby these investigations will be abstracted and reviewed by different members of the Department and published from time to time in the Wisconsin Engineer. It is hoped in this way to place valuable engineering data, the product of our own laboratories and class rooms, before our readers and the engineering profession in general. The publication of such reports will also call attention to the class of work done wholly by our students while still undergraduates at the University.

* * *

A man who has a clean college record, though the path may be strewn with cons or fails, will be the top-story man in the outer world when we compare him with the lazy, indolent man who, though never the victim of a con or its playmate, the fail, was nothing more than a scholastic parasite in his college career.

Who would employ a man in a responsible position, if he thought that that man was not capable of doing his own work—in fact never had done it and never would do it? For who learns without practice? If he is employed, he stays in a minor position until his lack of ability is manifested.

On the other hand, we engineers are forced in many instances to do what we do not know how—and what few others know—and do our best at it. If a problem confronts you which is beyond your working knowledge, do not let it drop, but consult references, try one way and then another until a satisfactory solution is reached.

We college students of engineering should never lose sight of the fact that we learn to conquer by conquering—yet our college education is merely a means of teaching us to conquer, and to be able systematically to consult references, with victory as our goal on the ever-distant, never-attained horizon.

* * *

The opening article in this number by Mr. J. B. Kommers, is the first of two papers, the second to follow in an early issue, dealing with repeated stress testing. The articles were presented by Mr. Kommers, before the Sixth Congress of the International Association for Testing Materials, held in New York, September 2–7, 1912. The first paper deals largely with the description of the test and machine, the second taking up the results of tests upon different materials.

* * *

Between the time this number goes to press and the time it is distributed in November, many important events will have taken place. The student conference will be organized for another year, we will know who is to direct the policies of our country from the presidential chair during the four years to come, and last, but, from an undergraduate viewpoint, far from least, the Chicago game will have been won,—or lost. If, through the connivance of the Fates, Bill Juneau, Joe Hoeffel and Eddie Gillette, the score be in our favor, our record will still be clear. If the Fates, excluding the other far more popular trio, reverse the decision, we will still have Minnesota upon which to vent our rage and remorse. In either case we are in a position which should call out unqualified support of the team. If we win, our claim to that elusive conference championship will have been tremendously strengthened. But we must not, cannot afford to let overconfidence get the better of us this year. If we beat Chicago, whitewash Arkansas and inundate Minnesota, we have still the Iowa game to figure on, a game that is far more dangerous from the psychological standpoint than any other contest on our schedule. If we lose, we must again show that never-say-die spirit,—the true Wisconsin spirit,—in the face of defeat. In any event we must refrain from something, bragging or knocking as the case may be.

As engineers it is often difficult for us to get out to Camp Randall during the open practice hours. We should make the effort upon every possible occasion. An hour in the stands late on a November afternoon will do more to clear up those calculus problems in the evening than that same hour spent bucking them after a hard day's work. If you cannot get out to practice, do a little yelling on the front steps and wake up the Lawyers across the campus. Let the team and the university know that you intend to help make the team win those two closing games. If you can earn, borrow, beg or—"acquire" the money, go up to Minneapolis with that team and push them along. A conference championship will mean more to you and to the University than an infinite number of nights in the pit of the Fuller. Take a long breath and a strong determination and get behind that team.

CAMPUS NOTES.

In this issue of the Wisconsin Engineer a new department will be started under name of "Campus Notes." This department is not new in a strict sense, since it was started several years ago, but for some reason was discontinued. Inasmuch as our alumni comprise half of our subscribers, it is only fair that they be given the privilege of knowing what is going on in University activities. This department will endeavor to give a review of the important things in "general college life" during the month preceding each issue. The alumni may rest assured that the men whose names appear here are men of worth in the undergraduate body, and that the events that are chronicled are the salient features of the month. This department may not be of particular interest to the student body at large, but we will make an effort to mention the things they ought to know and may have overlooked. With the assurance that, by keeping University men in touch with one another, we are fulfilling a long-felt need, we start upon this new undertaking.

* * *

On Saturday, October 5, the Cardinal played the first game of the season of 1912. Coach Juneau's men worsted the Lawrence aggregation by a score of 13–0. Samp and Hoeffel played great games, but according to one of the daily papers "Wisconsin's victory was due in a large measure to the open field work of Gillette." Gillette is a senior in the advanced M. E. course.

The cadet corps is again formed and the Freshmen are drilling. Dexter Mapel is Colonel, E. C. Noyes, Lieutenant Colonel, Walker, Taylor, and Wurdemann are majors. Noyes, Taylor and Wurdemann are engineers.

The annual Fresh-Soph rush, held on Thursday, October 3, was won by the Freshmen for the time since the substitution of the bag rush for the old lake rush. The yearlings greatly outnumbered the Sophomores, as usual, and the score of 9–6 is largely thus explained. The usual parade around the square was a little more orderly than usual, as rather strict orders had gone out in regard to what might be considered sufficient clothing.

* * *

The various Engineering Societies will soon be in full swing. Freshmen are urged to get identified with one of the societies and stick to it throughout their course. The good of these societies to a student consists in the effort he puts forth to make them a success, hence the longer he is a member the greater his ability to get benefit from this source.

The U. W. Engineer's club, is the oldest society and deals with general engineering topics. On Friday, October 4, R. L. Dodd gave a talk to the club on "Storage Batteries." The subject was well handled and the talk instructive. The officers at present are as follows:

O. R. Manegold, '13—President.

J. R. Kunz, '13—Secretary.

L. L. McLaren, '14—Treasurer.

R. L. Dodd, '13—Censor.

The Civil Engineering Society listened to talks by Wonders and Jacobs. The ability of these men, known to the student body at large, caused a fair crowd to turn out.

The present officers are:

A. H. Simon—President.

E. N. Whitney—Secretary.

L. E. Davis—Treasurer.

The student branch of the A. S. M. E. has not yet held its opening meeting. The Aero club is also a trifle late in starting. This is a new club that was organized last spring; but is rapidly becoming important.

The Mining club held a "Members Picnic" on Friday, October 4. Most of the seniors in the mining course spent the summer in the west getting acquainted with actual mine conditions.

* * *

Again Juneau has shown his ability to put out a winning team! On Saturday, October 12, the Northwestern purple was defeated by a score of 56–0. Gillette was again a conspicuous figure, his long runs adding much to our ability to score. An interesting feature to the rooters was the appearance of Ken Layman's assistant cheer leaders.

Our alumni will be pleased to know that Coach Jones, formerly Madison High School coach, will take charge of Wisconsin track work. Within the last two years he has put out some fine teams at Missouri and our track hopes are rising. Cleveland, former long distance star, has been obtained as coach for the cross-country season.

Just as we go to press comes the news of a third victory, this time against Purdue, a team which had been considered a strong contender for conference honors. The score, 41–0, gives strong promise of future victories.

DEPARTMENTAL NOTES.

Acting Dean Mack Professor of Machine Design, was in attendance at the meetings on October 15th in Chicago of the Western Railway Club and the Chicago Section of the Institute of Illuminating Engineers. At these meetings a paper on Electric Locomotive Headlights was presented by Mr. C. M. Larsen, '06, Assistant Chief Engineer of the Wisconsin Railroad Commission, on which subject Mr. Larsen has had charge of considerable experimental work for the commission. The paper was discussed, among others, by Prof. Mack, and by Mr. Walter Alexander, '97, and Mr. F. A. Vaughn, '95.

A recent and somewhat unusual acquisition of interest in the college of Engineering is a completely bound and indexed set of catalogues of sundry commercial supplies used in engineering, the first installment of which Prof. Mack has just received from the Catalogue Equipment and Supply Company of Boston, Massachusetts. This installment consists of 44 bound volumes of several hundred catalogues, and fills a three-sectional book-case. It is the intention of the catalogue agency to complete the set as soon as possible, and thereafter to keep the outfit, which they term "catalogue studies," entirely up-to-date by making quarterly renewals and additions. It is proposed, when complete, to place the set in the library for reference, for which purpose it seems admirably adapted.

Prof. O. L. Kowalke, Assistant Professor of Chemical Engineering, has been in attendance at the annual meeting of the American Gas Institute held at Atlantic City October 12th to 16th. Mr. Kowalke presented a report of the Calorimetry Committee which has been carrying on investigations on all types of calorimeters during the past three years. On this Calorimetry Committee two other Wisconsin graduates are also members: namely, Prof. C. F. Burgess, of the University of Wisconsin, and Mr. Ross Cornish, of the American Gas Company. Mr. R. B. Brown, Chief Engineer of the Milwaukee Gas Company and Mr. J. B. Klumpp, of the United Gas Improvement Company, are the other members of the Committee. Most of the laboratory investigations which furnish the basis for this report have been carried out in the Chemical Engineering Laboratories, and it is expected that this report will be the generally accepted basis for calorimeter practice throughout the country. Prof. C. C. Thomas of the Steam and Gas Engineering Department also attended the convention, presenting a paper on "The Measurement of Gas."

At the International Congress of Applied Chemistry, which was recently held in Washington and New York, three papers were contributed by the Chemical Engineering Department, as follows: "Influence of Various Impurities on the Corrosion of Iron," "Methods of Testing Iron for Corrodibility," by Prof. C. F. Burgess and Mr. Aston; "Investigation of Base Metal Thermo-couples," by Professor Kowalke. Professor Burgess was Vice-President of the section on electrochemistry and electrometallurgy.

Among other contributions from Madison chemical engineers were "Characteristics of Dry Cells and Materials used in Dry Cell Construction," by Carl Hambuechen and O. E. Ruhoff; "Influence of Cinders on the Corrosion of Iron," by W. B. Schulte.

Mr. Clement T. Wiskocil, a 1912 graduate in civil engineering, has been appointed research assistant in hydraulics. He will carry on special research work in the hydraulics laboratory, superseding Mr. L. R. Balch, who completed his work in August and returned to his home in Neilsville, Wisconsin.

Mr. C. R. Weidner, Assoc. Mem. Am. Soc. C. E., Instructor in Hydraulics, spent the past summer in charge of the stream measurement work for the Knoxville Power Company, at Chilhowee, Tennessee, which company is contemplating the development of over 400,000 horse-power in Tennessee and North Carolina, a proposition which, if carried out, will exceed any other present single system of water-power development within the border of the United States. On this same project we find a number of Wisconsin alumni, as mentioned in our Alumni columns.

The absence of Dean Turneaure during the 1st semester and the resignation of Mr. E. E. Parker have made necessary several changes in the Department of Structural Engineering.

Dean Turneaure's class work has been taken by Prof. Kinne and Mr. Gaettli. Mr. E. E. Parker resigned in June to become City Engineer of Madison. Mr. Parker had been in the department since his graduation in 1907.

The vacancy in the department has been filled by Mr. J. P. Schwada of the class of 1911. Since graduation Mr. Schwada has been with the Wisconsin Railroad Commission and also with the C. M. and St. P. R. R. in the Bridge Department.

ALUMNI NOTES.

Frank V. Sherbourne, '10, who for the past year has been with the city engineer in Oshkosh, is now employed by the American Bridge Co. at Gary.

A. R. White, '11, formerly with the Bilsby Co. of Chicago, is now research assistant in the laboratories of the Aluminum Co. of America, situated at New Kensington, Pa.

E. E. Parker, '07, instructor in structural engineering, has been appointed City Engineer of Madison.

F. H. Cenfield, '09, is connected with the efficiency bureau of the city of Chicago.

C. M. Larson, '05, is chief field engineer, Bureau of Engineering Statistics, Grand Central Terminal, New York City.

E. R. Richter, '07, is incline master mechanic for the Spanish-American Iron Co., Felton, Oriente, Cuba.

A. F. Schultz, '10, is an engineering apprentice with the Westinghouse Machine Co., Wilkinsburg, Pa.

Among the Wisconsin engineers in Western Canada are the following: R. W. Muckleston, '09, engineer, Grand Trunk Pacific R. R., Skena Crossing, B. C.; A. B. Carey, '07, superintendent of construction, Vancouver Island Power Co., Victoria, B. C.; H. N. Merriam, '98, assistant engineer, Canadian Pacific Ry., Winnipeg, Man.

A. V. Larson, '09, is with the American Ship Windlass Co., Providence, R. I.

O. A. Eskuche, '06, is erecting superintendent in the Gramm Motor Car Works, Lima, Ohio.

V. L. Phillips, '09, is a salesman and engineer for the Standard Asphalt and Rubber Co., Chicago, Ill.

Clayton R. Burt, '11, is a traverseman with the United States surveyors at Parker, Ariz.

Sumner B. Rogers, ex '08, is with the Engineering Department of the Western Electric Co. at Hawthorn, Ill.

W. G. Weber, '09, is superintendent of the Live Oak Development Co., Miami, Ariz.

John Berg, '05, C. E. '11, is with Mr. Ralph Modjeski, 1750 Monadnock Building, Chicago, Ill.

W. H. Smith, '06, is with the S. S. Johnson Co., 279 Washington St., New York City, N. Y.

A number of the alumni are in the employ of the Knoxville Power Co. at Chilhowee, Tenn. This company contemplates the development of over 400,000 horse-power, which, when completed, will exceed any other present single system of water-power development within the borders of the United States. R. S. Peotter, '05, C. E. '09, is resident engineer; R. F. Ewald, '05, is chief hydrographer; W. C. Penn, '07, is assistant engineer; and C. M. Scudder, '11, C. E. '12, O. J. Schieber, C. E. '12 and A. L. Himmelstein, '12, are transitmen.

Mr. William C. Penn, '07, was married on September 24, 1912, to Miss Leola Page Waller of Fond du Lac. Mr. and Mrs. Penn will reside at Chilhowee, Tennessee.

W. F. Lent, '10, is located in Milwaukee, Wis., with the Kuppenheimer Co.

R. C. Youngman, '09, is with the Allegheny Steel Co., Breckenridge, Pa.

F. E. Johnson, '09, has affiliated himself with the Rice Institute at Houston, Texas.

William Havers, '09, is employed in an engineering capacity by the North Shore Electric Co., Oak Park, Ill.

Mr. G. A. Rousch, who was a graduate student in Chemical Engineering in 1909–1910, has been appointed recently as Assistant Professor of Metallurgy at Lehigh University. He is also Assistant Secretary of the American Electrochemical Society.

The Cleveland Research & Testing Laboratory is a designation of a new corporation organized in Cleveland to carry on commercial investigative work. Wisconsin men will be interested in knowing that two Wisconsin men are identified with this organization, these being Dr. W. G. Wilcox and Dr. C. W. Hill. These men have spent several years in graduate work in chemistry and chemical engineering and have recently been in the employ of the Research Laboratories of the National Carbon Company. Dr. J. W. Brown, of the Massachusetts Institute of Technology, is director of this new corporation.

The University of Wisconsin

THE COLLEGE OF LETTERS AND SCIENCE offers a General Course in Liberal Arts; a Course in Commerce; a Course in Music; a Course in Journalism, Library Training Courses in connection with the Wisconsin Library School; a Course in Education; the Course for the Training of Teachers, and the Course in Chemistry.

THE COLLEGE OF MECHANICS AND ENGINEERING offers courses of four years in Mechanical Engineering, Electrical Engineering, Civil Engineering, Applied Electro-chemistry, Chemical Engineering, and Mining Engineering.

THE COLLEGE OF LAW offers a course extending over three years, which leads to the degree of Bachelor of Laws and which entitles graduates to admission to the Supreme Court of the state without examination.

THE COLLEGE OF AGRICULTURE offers (1) a course of four years in Agriculture; (2) a course of two years; (3) a short course of one or two years in Agriculture; (4) a Dairy Course; (5) a Farmers' Course; (6) a course in Home Economics, of four years.

THE COLLEGE OF MEDICINE offers a course of two years in Pre-clinical Medical Work, the equivalent of the first two years of the Standard Medical Course. After the successful completion of the two years' course in the College of Medicine, students can finish their medical studies in any medical school in two years.

THE GRADUATE SCHOOL offers courses of advanced instruction in all departments of the University.

THE UNIVERSITY EXTENSION DIVISION embraces the departments of Correspondence-Study, of Debating and Public Discussion, of Lectures and Information and general welfare. A municipal reference bureau, which is at the service of the people of the state is maintained, also a traveling Tuberculosis Exhibit and vocational institutes and conferences are held under these auspices.

SPECIAL COURSES IN THE COLLEGE OF LETTERS AND SCIENCE

THE COURSE IN COMMERCE, which extends over four years, is designed for the training of young men who desire to enter upon business careers.

THE COURSES IN PHARMACY are two in number; one extending over two years, and one over four years, and are designed to furnish a thoroughly scientific foundation for the pursuit of the profession of pharmacy.

THE COURSE FOR THE TRAINING OF TEACHERS, four years in length, is designed to prepare teachers for the secondary schools. It includes professional work in the departments of philosophy and education, and in the various subjects in the high schools, as well as observation work in the elementary and secondary schools of Madison.

A COURSE IN JOURNALISM provides two years' work in newspaper writing and practical journalism, together with courses in history, political economy, political science, English literature, and philosophy, a knowledge of which is necessary for journalism of the best type.

LIBRARY TRAINING COURSES are given in connection with the Wisconsin Library School, students taking the Library School Course during the junior and senior years of the University Course.

THE COURSE IN CHEMISTRY offers facilities for training for those who desire to become chemists. Six courses of study are given, namely, a general course, a course for industrial chemist, a course for agricultural chemist, a course for soil chemist, a course for physiological chemist and a course for food chemist.

THE SCHOOL OF MUSIC gives courses of one, two, three, and four years, and also offers opportunity for instruction in music to all students of the University.

THE SUMMER SESSION embraces the Graduate School, and the Colleges of Letters and Science, Engineering, and Law. The session opens the fourth week in June and lasts for six weeks, except in the College of Law, which continues for ten weeks. The graduate and undergraduate work in Letters and Science is designed for high school teachers who desire increased academic and professional training and for regular graduates and undergraduates. The work in Law is open to those who have done two years' college work in Letters and Science or its equivalent. The Engineering courses range from advanced work for graduates to elementary courses for artisans.

THE LIBRARIES at the service of members of the University include the Library of the University of Wisconsin, the Library of the State Historical Society, the Library of the Wisconsin Academy of Sciences, Arts, and Letters, the State Law Library, and the Madison Free Public Library, which together contain about 380,000 bound books and over 195,000 pamphlets.

THE GYMNASIUM, Athletic Field, Boating Facilities, and Athletic Teams give opportunity for indoor and outdoor athletic training, and for courses in physical training under the guidance of the athletic director.

Detailed information on any subject connected with he University may be obtained by addressing **W. D. HIESTAND, Registrar, Madison, Wisconsin.**