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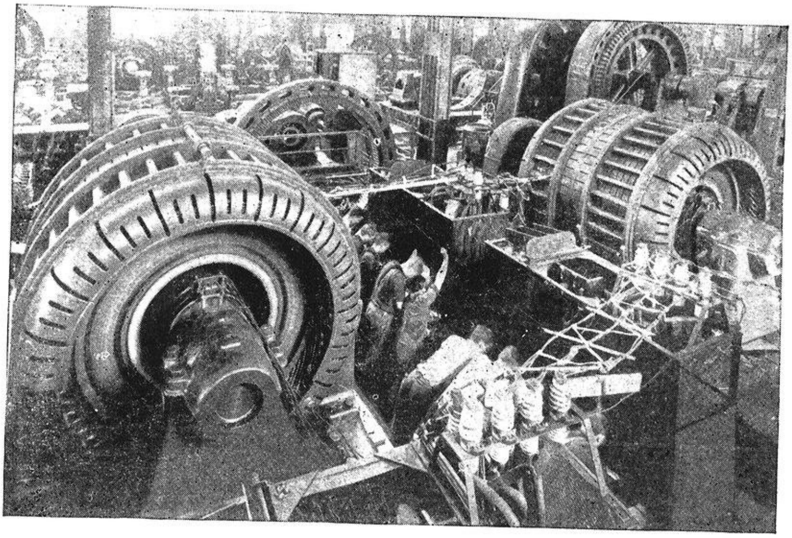

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The Wisconsin Engineer

VOL. XVII DECEMBER, 1912 NO. 3

REPEATED-STRESS TESTING.[1]

J. B. Kommers.
Instructor in Mechanics.

In making a repeated-stress test beyond the elastic limit, two methods immediately suggest themselves. One is to use a consant deflection; and the other is to use a constant load, allowing the deflection to vary according to the kind of material. If a "quality factor" is to be obtained for comparing different steels it is evident that the unit-stress to which the specimen is subjected and also the deflection which it receives should be taken into account. When the load is kept constant it is evident that both the unit-stress and the deflection would vary for different steels. A load, also, which could be used for a special alloy-steel might be altogether too large to use for a steel with a low yield-point.

In the case of a constant deflection, if the unit-stress to which the specimen is subjected can be determined, it will be possible to compare various steels no matter how much their yield-points may differ. It will now be shown that this unit-stress can be determined approximately.

Experiments were performed on steel bars 1 in. by 2 in., in cross-section, supported at the ends over a span of 42 in., and loaded at the third-points to produce constant bending-moment between the loads. Deformation measurements were made at the four corners over a gauge length of about 9 in.; and deflections were measured at the center of the beam. The dials used for these measurements read to 0.0001 in. The re-

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

sults showed that when two steel beams of like dimensions, but having radically different yield-points, were stressed beyond the elastic limits and deflected the same amount, the unit-deformations at similar points near the outer fibers were the same. The experiments showed also that the relation between unit-deformation and deflection was a straight line having the same slope both within and beyond the elastic limit.

In the Landgraf-Turner machine a deflection of 0.237 in. would be required to stress a material to 250,000 lbs. per sq. in., assuming the modulus of elasticity as 30,000,000 lbs. per sq. in., and assuming a straight line relation in the stress-deformation curve. It is evident, therefore, that a deflection of 0.375 in. would stress all ordinary steels beyond their elastic limits. From the fact, mentioned above that there is a straight-line relation between deflection and unit-deformation even beyond the elastic limit, it follows that for a deflection of 0.375 in. a specimen 0.375 in. in diameter would suffer a unit-deformation of 0.0132 in. per inch at the grips. And this would be true of all steels even though their elastic limits differed radically. The unit-stress to which a specimen is subjected could be exactly determined therefore, if a tension on compression stress-deformation curve of each material were available, by simply reading off this curve the stress corresponding to a unit-deformation of 0.0132 in. per inch.

In the absence of a stress-deformation curve the unit-stress may be approximately determined by the following method. It is evident that for a constant unit-deformation of 0.0132 in. per inch the particular unit-stress of any steel is dependent first upon the yield-point of the material. It is also evident that the amount by which the stress exceeds the yield-point will be approximately inversely proportional to the ductility. The ductility is probably best determined by the percent of reduction of area, and a value of 70% could be taken as representing the most ductile steel. If then, a material had a ductility of 20% the unit-stress to which the material would be subjected would be the yield-point plus

$$\frac{70-20}{70} \text{ or } \frac{50}{70}$$

times the difference between the ultimate and yield-point stresses.

This method of determining the unit-stress was checked by

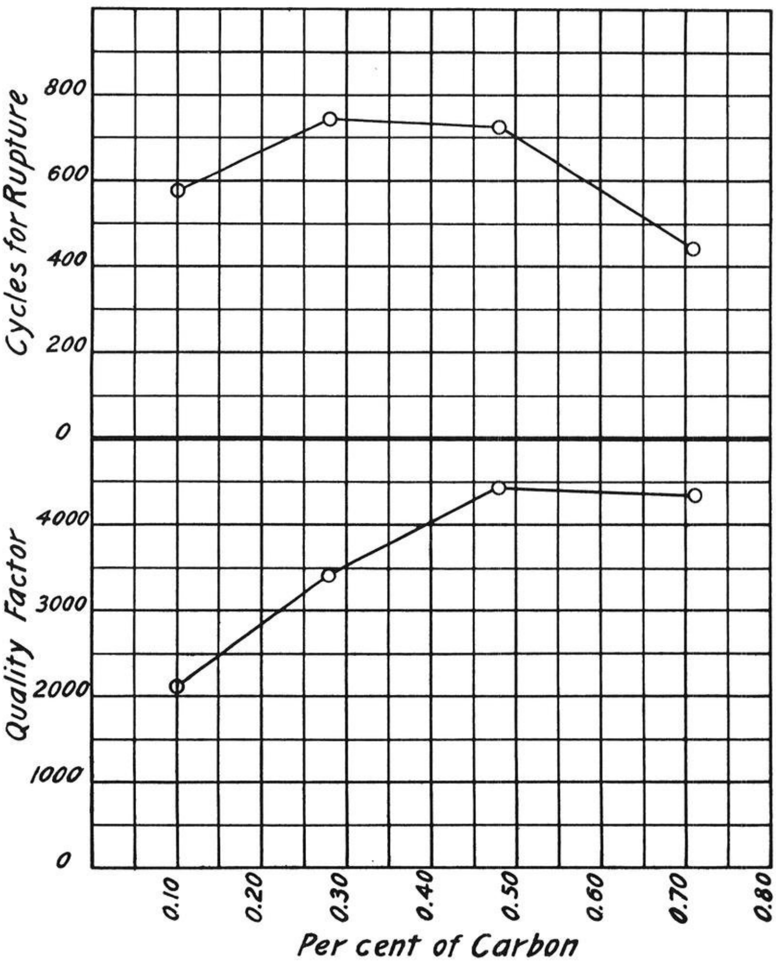

FIG 1.—*Effect of Carbon upon Cycles for Rupture and upon Quality Factor.*

experiment by obtaining the tension stress-deformation curve of two steels whose yield-points were respectively 45,000 and 90,000 lb. per sq. in. The first or more ductile material checked within 5%, and the other checked almost exactly. While the exactness of this approximate method of calculating the unit-stress depends upon the particular deflection used, it is evident that for a deflection of 0.375 in. the method gives good results.

The "quality factor" used in the following experiments was the product of the unit-stress to which the specimen was subjected (calculated as above explained) multiplied by the number of cycles required for rupture, and divided by 10,000. Dividing by 10,000 eliminated all but about four significant figures.

In determining specifications for a standard test it is evident that a deflection should be chosen which is larger rather than smaller than 0.30 in. A deflection of 3/8 in. was chosen because this seems to give uniform results and requires but a short time for a single test. For ease of observation and manipulation an average speed seemed most suitable and therefore a speed of about 300 cycles per minute was chosen. An amount of impact seemed desirable so that the specimen would rupture soon after "weakening," inasmuch as this is the significant point as far as failure is concerned. For this reason an impact of 3/4 in. was chosen. Those specimens that could be turned in a lathe and filed were treated in this way, while those that were very hard were ground to size.

RESULTS OF TESTS ON VARIOUS MATERIALS.

After having performed the preliminary experiments discussed in Part I, and having fixed upon a tentative standard test, this test was then applied to various special steels and other materials. Table I gives the results of these tests.

The first ten specimens are a series of alloy steels, most of them used in the automobile industry. These were obtained from various automobile and steel companies as shown in the table. The experience of manufacturers has shown these steels to be especially adapted to withstand hard service, and if the quality factor as determined by the proposed standard test is of any value it should show relatively high results for these steels as compared with ordinary carbon steels. Specimens 11 and 12 are ordinary cold-rolled steel and are given as samples of ordinary steel. Specimen § 11 had been annealed at a red heat, but specimen 12 was tested as received. The high quality factors for the alloy steels are notable.

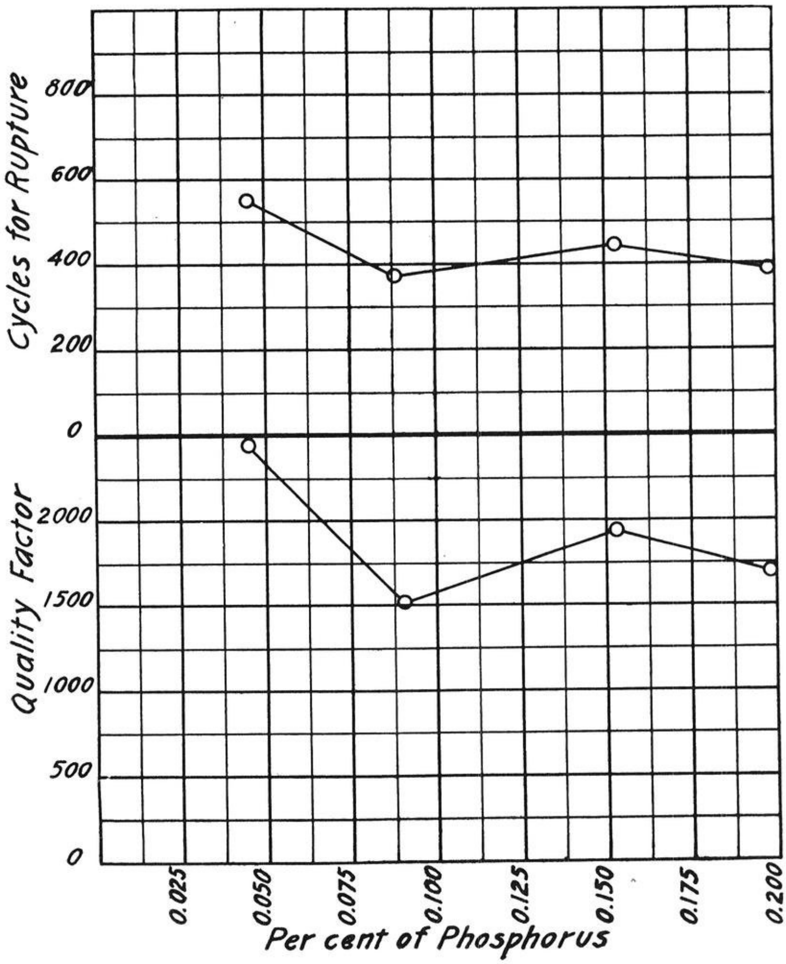

FIG 2.—*Effect of Phosphorus upon Cycles for Rupture and upon Quality Factor.*

Specimens 13 to 17, give results on steel shafting received from the Mitchell-Lewis Motor Co. Specimen 13 was cut from a shaft which had been broken in service. Specimens 14 to 17 were from similar shafting but were submitted to various heat treatments. These steels also show uniformly high results for the quality factor.

Specimens 18 to 21 are interesting in showing the result of varying the carbon content when the other ingredients are practically constant. Figs. 1 and 2 show the variations in the repeated-stress test and in the quality factor, respectively, as the carbon content varies. It will be noted that the results in the repeated-stress test are practically as high for the 0.48% carbon steel as for the 0.28% carbon steel. This result is interesting, for it would seem to show that (for steels with no heat treatment, at least) the carbon may be increased to 0.45% or 0.50% without affecting the strength in the repeated-stress test. It would be interesting to know whether this would be true also after the steels had been heat treated. Specimens 7, 8 and 9 happen to have about 0.50% carbon, and it will be noted that the quality factors for these steels are especially high. Whether these high results are partly due to the high percentage of carbon or due entirely to the presence of nickel and chromium is not known, but tests could readily be made to determine this point.

Specimens 22 to 25 give results on a series of phosphorus steels which were made up with the assistance of the Chemical Engineering Department of the University of Wisconsin. These tests were for the purpose of determining whether the repeated-stress test as performed in these experiments would point out the brittleness which phosphorus is known to produce in steels. A piece of "American Ingot Iron" was melted in a magnesite crucible in an electric furnace and saturated with phosphorus. The resulting mass was then analyzed and found to contain 5.14% of phosphorus. Alloys were then made with "American Ingot Iron" so that the phosphorus would vary from 0.05% to 0.20% in steps of about 0.05%. These alloys were then analyzed to determine the percent of phosphorus, and the results are given in Table I. Fig. 3 shows how the results in the repeated-stress test varied with the increase in phosphorus, and Fig. 4 shows how the quality factor varied with the increase in phosphorus. The writer believes that the variation would be much greater in ordinary steels which contain larger amounts of carbon.

Specimens 26 to 31 give results on a series of nickel-chromium steels made from electrolytic iron, Swedish iron and "American Ingot Iron." These steels were furnished by the Chemical Engineering Department of the University of Wisconsin.

Specimens 34 and 35 demonstrate again that the repeated-stress test will point out brittleness. The brittle cast brass gives a result which is less than 16% of that obtained on the tougher rolled brass.

It seems to be the opinion of some engineers that a repeated-stress test as performed in these experiments is largely dependent upon the ductility, and that therefore other qualities of the specimen are not fairly represented in the test. That this is not a fair criticism is well shown in the series of tests represented by specimens 18 to 21. Taking the percent of reduction of area as representing the ductility, it is seen that specimen 19 has slightly less ductility than specimen 18 and yet the former has a much greater strength in the repeated-stress test. Also specimen 20 has a ductility considerable less than specimen 19, and yet there is very little difference in the repeated-stress test. The fact that ductility is not the only factor which determines the results in the repeated-stress test is also shown by specimens 14, 15 and 17. It is again shown by specimens 5 and 6.

The writer believes that one of the factors to be noted and reported in a repeated-stress test is the character of the fracture. In looking over the results in the table it will be noticed that practically all those specimens which gave high results in the repeated-stress test had "fine" or "very fine" texture at the place of fracture. It will be noticed also that specimens like wrought-iron and cast brass, which gave very poor results, showed coarse fractures.

The writer believes also that the uniformity of manufacture of any particular kind of steel is well brought out by the repeated-stress test. A homogeneous product, for instance, should give results in the repeated-stress test that vary but little from each other; and results on the same steel (or at opposite ends of the same specimen) that show a great variation may rightly be looked upon as indicating that the steel is not as uniform as it should be.

Results of Tests.

No.	Kind of Material	Heat Treatment
1	Steel	Not Known........................
2	Steel Shaft	Heated to 1500°F. Quenched. Annealed 1500° F............................
3	"	Heated to 1500°F. Quenched. Annealed 1500° F............................
4	"	Heated to 1500°F. Quenched. Annealed 1500° F............................
5	Steel	None................................
6	"	Not Known..........................
7	"	Heated to 650° F. Quenched in oil. Drawn at 8 0° F. for 30 min..........
8	"	Heated to 1500° F. Quenched in oil. Drawn at 800° F. for 30 min..........
9	"	Heated to 1950° F. Queuched in oil. Drawn at 800° F. for 30 min..........
10	"	Heated to 900 C. Cooled in air, Heated to 750° C. quenched in soda. Heated to 900° C. quenced in oil. Drawn back at 500° C..........................
11	Cold Rolled Steel	Annealed at a Red Heat................
12	"	Not Annealed........................
13	Broken Shaft	Not Known...........................
14	Steel Shaft	Annealed.............................
15	"	Heated to 850° C. Quenched in oil......
16	"	Heated to 850° C. Quenched in Water...
17	"	Heated to 850° C. Quenched in Water. Drawn at 300° C....................
18	Carbon Steel	None.................................
19	"	" ....
20	"	" ....
21	"	" ....
22	Phos. Steel	Annealed at a Red Heat................
23	"	" " " " " ....
24	"	" " " " " ....
25	"	" " " " " ....
26	Nickel Steel	Annealed at a Red Heat................
27	"	" " " " " ....
28	"	" " " " " ....
29	"	" " " " " ....
30	"	" " " " " ....
31	"	" " " " " ....
32	Steel	None.................................
33	Wrought Iron	None.................................
35	Rolled Brass	None.................................
36	Cast Brass	Nonc.................................

Results of Tests.

No.	Yield Point	Ultimate Strength	% of Elongatiou	% of Reduction of Area
1	109.200	122.700	20.5	66.8
2	101.200	107.100	6.5	19.8
3	65.300	91.400	34.	69.6
4	102.700	121.100	24.	65.
5	81.800	88.700	17.5	50.7
6	232.500	287.000	None	None
7	208.400	214.000	10.	50.1
8	172.000	176.300	?	49.3
9	124.800	149.300	?	48.3
10	173.800	179.600	10.75	56.1
11	39.500	61.300	34.2	62.8
12	91.000	100.200	?	40.5
13	42.700	87.300	29.	40.2
14	53.020	73.700	28.7	52.3
15	80.806	116.300	12.5	39.3
16	123.400	180.000	7.	31.3
17	100.000	145.300	10.	46.4
18	36.200	49.800	41.	66.8
19	43.900	66.400	35.	63.3
20	40.100	79.100	23.5	42.3
21	58.600	120.200	15.5	24.5
22	42·200	58.200	26.5	59.2
23	40.600	58.000	34.5	72.7
24	43.750	64.400	35.5	70.7
25	42.100	65.000	33.	69.2
26	?	?	?	?
27	61.700	93.400	20.	53.8
28	73.400	119.800	11.	23.2
29	61.800	84.500	31.	71.3
30	53.700	80.900	14.5	51.7
31	63.400	98.250	11.	62.3
32	40.700	66.900	39.	60.
33	36.200	50.700	26.	40.6
35	51.200	56.200	25.	27.3
36	16.290	28.300	13.	15.5

Results of Tests.

No.	% C	% P	% S	% Ni	% Cr	% Va	% Mn	% Si
1	.24	.008	.021	3.52	1.67	....	.33	.28
2	.24+0.35	......	......	3.5	....	....	....	....
3	.25+0.35	......	......	3.5	....	....	....	....
4	Chrome Nickle Steel							
5	.20	......	......	......	.90	.18	.35+0.40	....
6	.45	......	......	......	1.10+01.25	.18	.80+0.40	....
7	.46	.009	.013	......	1.22	.16	.90	.18
8	.50	.009	.009	2.02	.98	....	.46	.15
9	.50	.015	......	......	.67	....	.83	.41
10	.30	......	......	......	.90	.17	.72	....
11	....	......	......	......	....	....	....	....
12	....	......	......	......	....	....	....	....
13	low carb.	......	......	3.5	....	....	....	....
14	"	......	......	3.5	....	....	....	....
15	"	......	......	3.5	....	....	....	....
16	"	......	......	3.5	....	....	....	....
17	"	......	......	3.5	....	....	....	....
18	.10	.019	.035	......	....	....	.44	....
19	.28	.016	.039	......	....	....	.47	....
20	.48	.029	.04	......	....	....	.44	....
21	.71	.03	.027	......	....	....	.39	....
22	....	.045	......	......	....	....	....	....
23	....	.088	......	......	....	....	....	....
24	....	.153	......	......	....	....	....	....
25	....	.198	......	......	....	....	....	....
26	.30	......	......	1.5	.75	....	....	....
27	.30	......	......	1.5	.75	1 Fe Va	....	....
28	.30	......	......	1.5	.75	....	....	....
29	.30	......	......	1.5	.75	1 Fe Va	....	....
30	.30	......	......	1.5	.75	....	....	....
31	.30	......	......	1.5	.75	1 Fe Va	....	....
32	.22	.007	.026	......	....	....	.47	.12
33	....	......	......	......	....	....	....	....
85	....	......	......	......	....	....	....	....
36	....	......	......	......	....	....	....	....

Results of Tests.

No.	Repeated Stress Test	Average Repeated Test	Quality Factor	Fracture Repeated Test
1	380, 328	354	3890	Quite Fine grain
2	354, 372	363	3830	Granular
3	532, 535	534	3490	Slightly Granular
4	314, 317	315	3280	Very Fine grain
5	264, 239	252	2110	Coarse, Granular
6	339, 243	291	8350	Very Fine grain
7	323, 363	344	7220	" " "
8	375, 329	352	6100	" " "
9	347, 393	345	4570	Quite Granular
10	298, 395, 356, 445	374	6530	Fine grain. Granular
11	459, 480, 463, 479, 441, 493	461	1920	Some what Granular
12	214, 281	248	2355	Finely Granular
13	757, 952, 847, 797	838	5170	Rough Granular
14	519, 545, 458, 467	495	2880	Slightly Granular
15	547, 582, 553, 516	549	5290	Fine grain
16	453, 363	408	6330	Very fine Grain
17	382, 376	379	4370	" " "
18	577, 581	579	2130	Slightly Granular
19	746, 739	742	3410	Fine. Slightly Granular
20	706, 746	726	4430	" " "
21	411, 474	442	4350	Granular
22	550	550	2450	Fine Grain
23	373, 375	374	1517	Coarse Granular
24	420, 466	443	1940	Fine Grain
25	407, 372	390	1650	Coarse Grain
26	532, 537	535	?	Quite fine. Slightly granular
27	495, 412	453	3130	" " " "
28	365, 366	366	3820	Quite Coarse. Granular
29	491, 386	439	2720	Very Fine grain
30	572, 624	598	3650	Quite Fine
31	422, 403	413	2780	Very Fine grain
32	457, 474, 514	481	2130	Fine,y Granular
33	130, 110, 204, 150	148	625	Coarse, Rough. Ragged
35	896, 698	797	4320	Finely Granular
36	113, 142	127	326	Rough. Coarse Granular

Results of Tests.

No.	Fracture Tensile Test	Remarks
1	Very Fine. Cup & Cone	Pierce Arrow Motor Co.
2	Coarse. Crystaline	Dayton Motor Car Co.
3	Slightly Granular. Cup & Conc	" " " "
4	Very Fine grain. Cup & Cone	" " " "
5	Slightly Granular. Cup & Cone	
6	Very Fine grain	Vandium Sales Co. of America
7	" " "	" " " " "
8	" " "	Halcomb Steel Co.
9	Quite Fine. Granular	" " "
10	Very Fine grain. Cup & Cone	" " "
11	Quite Fine. Slightly Granular	United Steel Co.
12	Finely Granular	
13	Rough Granular	
14	Very Fime. Cup & Cone	Mitchell Lewis Motor Co.
15	Very Fine grain. Cup & Cone	" " " "
16	" " " " " "	" " " "
17	" " " " " "	" " " "
18	" " " " " "	" " " "
19	Slightly Granular	Carnegie Steel Co.
20	Finely Granular	" " "
21	Coarse Crystaline	" " "
22	Fine grain. Slightly Granular	" " "
23	Coarse Crystaline	Tensile Specimen not analyzed
24	Granular	" " " "
25	Coarse Granular	
26	....	Electrolytic Iron.
27	Quite Fine. Slightly Granular	" "
28	Quite Coarse Granular	Swedish Iron.
29	Very Fine grain	" "
30	Finely Granular	American Ingot Iron.
31	Fine grain. Slightly Granular	" " "
32	Slightly Granular	Olds Motor Works.
33	Ragged Fibrous	
35	Fine Grain Slightly Granular	
36	Rough. Coarse. Granular	

In choosing the machine which is to be used in a standard repeated-stress test it is undoubtedly of great importance that it be one which will allow of exact adjustment, so that the amount of deflection may be kept the same within very small limits. Even small changes in the deflection of the specimen cause great changes in the cycles required for rupture; in fact, this factor seems to be more important than any other. The Landgraf-Turner machine is faulty in this respect for the reason that there is no easy way of adjusting the hammer dies accurately. It is therefore almost impossible to get the machine adjusted the same way after new hammer dies have been put in or some equivalent change made.

In a standard test, also, all specimens should be of the same size and should preferably be first turned up in a lathe in order that straightness will be assured. The specimen may then be ground to size, as has been previously suggested. The gripping devices should be such that there will be no possibility of the specimen slipping in any way.

The writer is at present designing a machine which he thinks will fulfill the conditions which the experiments show should be embodied in a repeated-stress testing machine. With this machine also, he hopes to make tests to determine whether the manner of gripping the specimen influences the results appreciably.

It is hoped that this investigation will help in arriving at some standard commercial method of determining the "service quality" of materials which are to be subjected to repeated stresses. Most engineers would probably admit that the "endurance stress" as determined by Wöhler and other investigators is of great interest and importance; and yet it is not established that even this long and expensive test would give results which could be relied upon in comparing different materials. Professor Arnold of Sheffield University, England, has shown, for instance, that the Wöhler test does not point out the brittleness which phosphorus is known to produce in steel. For commercial purposes, certainly, some short test is desirable, if it is shown that such a test will give reliable results.

A BORING RIG FOR THE MACHINE SHOPS.

PROF. A. L. GODDARD.
Superintendent of the Machine Shops.

The Cummer engine, which for over twenty-five years has furnished power for the machine shops, and which for most of this time has been the special care of John Conohan, our veteran instructor in engineering (particularly regarding those mysterious mechanical forces which kept the brass ball of the crank pin oiler in position), recently required reboring. Since there was no boring rig on hand suitable for this purpose, Mr. Sladky, instructor in the machine shop, designed and with the assistance of several students, built a boring rig which possesses some features worth describing.

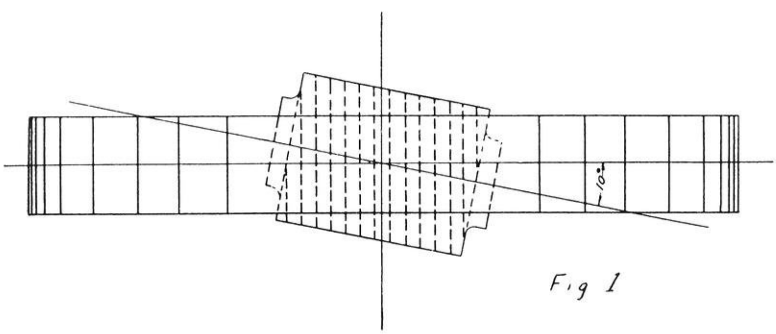

FIG. 1.

The bar has a travel of thirty inches. The distance between ends of the cylinder is thirty-six inches, there being five inches of counterbar on each end. It was deemed advisable to make a boring rig adaptable to any work for which a portable outfit of this nature might be desired.

A train of compound spur gearing is generally cumbersome and the last gear of the train must always be of sufficient strength and rigidity to pull the cut without straining, or chattering will result. A single worm and gear will furnish the desired speed reduction, but a worm and gear of the ordinary type and of the proportions required is an item of considerable expense. Oftentimes, as in this case, a spur gear heavy enough to serve as the drive gear can be had at practically no expense. Among the heritages of other days was found a spur gear of 49 teeth and 3 diametral pitch. A double thread worm of 3 13/16 inch pitch diameter and of 2 1/8 inch lead (equal to

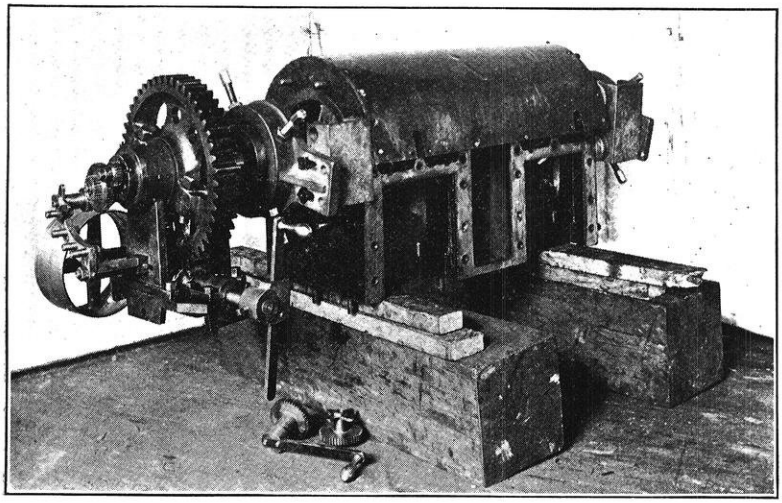

FIG. 2.

twice the circular pitch of the gear), would have about 10° pitch angle. Now, if the axis of the worm be placed at an angle with its usual position equal to the pitch angle, we get a worm gear of a type corresponding to the Seller's worm and rack, which has been used so successfully for planer drive. This is shown in Fig. 1.

This arrangement of the worm and gear provides for the engagement of new points of contact on both the worm and gear with less rubbing or sliding between the engaging surfaces. Of course the sides of the worm should be $14\frac{1}{2}°$ to mesh with an involute gear.

Fig. 2 shows the rig in position and Fig. 3 shows the bar by itself. It will be noted that the star feed wheels can be removed and a crank and pinion substituted for use in traversing the head rapidly by hand. The pins for engaging the star feed are four in number. Any of these pins may be removed so that one, two, three or four teeth of the star wheel may be fed per revolution of the bar. Change compound gears are

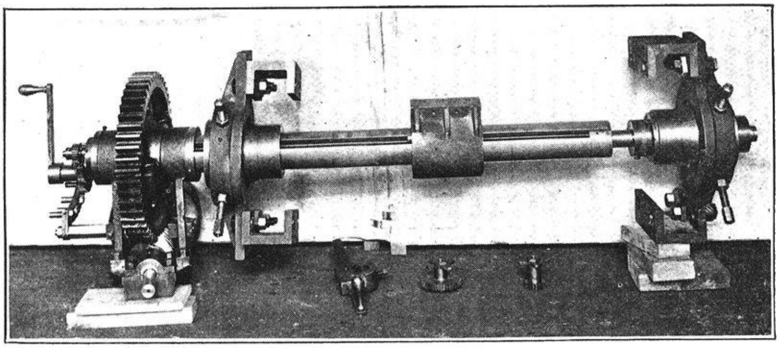

FIG. 3.

also provided to secure a greater range of feeds. The bar is driven by a one-half horse power motor belted directly to the drive pulley on the worm shaft. A crank can also be applied to the worm shaft for convenience in setting the cutters. The bar itself is 3¾ inches in diameter and has a ½ inch key way for the feather. The brackets and spiders provide means for easily attaching and centering the rig to the work.

As shown in the photographs the worm runs in an oil bath. The end thrust on the bar is taken by two set collars against the bearing at the further end of the bar. That end of the bar was turned down to 1¾ inches to permit of its passing through the stuffing box, if occasion required. The feed screw is 9/16 inch and 14 pitch. The worm was cut in a universal milling machine with a 29° milling cutter. As indicated above, it was double thread to give a convenient speed reduction.

THE ELECTRIC ARC HEADLIGHT FOR LOCOMOTIVES.

JOHN G. D. MACK.
Professor of Machine Design.

During the earlier period of railroading in this country no attempt was made to run trains except during daylight hours, unless in case of emergency or delay. On account of the rapidly increasing traffic and the transportation of mail, it became necessary to establish night runs, which required some method for illumination of the track. One of the first devices appears to have been a fire basket, or a fire built on a platform in front of the locomotive. A more satisfactory illuminant became necessary as night runs became longer and more frequent, which resulted in the development of a headlight fitted with a reflector, which Kirkman states was first used on the Boston and Worcester Railroad in 1840. It is probable that lard or whale oil was used in the lamps of the earlier headlights, as mineral oil made from petroleum did not come into use until some years later. At this time, however, there was in use an oil distilled from coal, known as "coal oil," a term which still persists as a popular name for kerosene. The term "kerosene" was originally a name for a particular brand of "coal oil."

The common oil headlight of the present day is probably no better as an illuminator of the track than was its early ancestor, in fact it is not as satisfactory on the average, for in the earlier days of railroading, each engineer had his own engine and therefore felt responsible that all parts should be kept clean and the bright portions highly polished. This condition is impossible to maintain with present heavy duty locomotive requirements, under which the locomotive usually must be gotten out of the roundhouse with only such repairs as will enable it to pass the Federal or company regulations and get over the road. The oil headlight is said to be one of the few devices used in railroading which has received no improvement; if there has been a change it has been one of deterioration. The tendency of engineering as well as other affairs to run in cycles is illustrated by the return, in some degree, of the practice of having a certain locomotive assigned to a given engineer, who thus feels a pride and responsibility in the maintenance of his engine.

On the British and Continental railways the headlight is given small consideration, in some cases not being used. This is due to the fact that on these railways the public is absolutely excluded from the right of way except when aboard a train, or at carefully guarded crossings. The idea of the track being used as a promenade is unknown.

From the standpoint of the traveling public, the trespasser who endangers his life by walking the tracks, and those who of necessity are required to use highway crossings, the foreign practice relating to the protection of the right of way is greatly superior to ours.

In the year 1911, 5,284 persons were killed on the railway tracks in the United States who had no business to be there. This number excludes highway crossing accidents, accidents to employes and to the traveling public. The number of trespassers killed was 51 per cent of the total number of persons killed on railways in this country during the year named. During the ten year period 1902-11 inclusive, the number of passengers killed on the railways of the United States was 4,340, and the number of trespassers killed was 51,083. There was not a single year during this period when the number of trespassers killed did not exceed the number of passengers killed during the entire ten year period.

In the State of Wisconsin there are over 9,000 highway grade crossings, while within the city limits of Madison there are sixty-three such crossings, twenty-five of which are protected by some means, there being but two which are not at grade. However great may be the desire and necessity for better guarding of the right of way in this country, it will be many years, possibly many decades, before continental conditions are reached or approached, due to several reasons, among which are the following:

The great area traversed by the railways, much of it in thinly settled sections of the country, renders absolute protection in all parts a matter of almost prohibitive expense.

The generally poor condition of the highways, especially in wet seasons, making them almost impassable for walking, requires those who walk to take the more direct and level track in preference to the muddy, dusty, circuitous or hilly highway, to prove which let anyone consult his own experiences in traveling afoot.

The average American citizen would probably resent an official command to get off the track, especially if it were the shortest and best footway to his destination, as he would resent much of the minute foreign police supervision of the citizen's acts, some of which doubtless would not be so effective in prolonging his life as if he were forced to walk on the highway.

In addition to the available human track obstructions just noted are the unavoidable obstacles, such as a washout, a car on a side track too close to the main line, criminal attempts to wreck trains, etc.

If a condition of track absolutely free from obstructions could be maintained, the headlight question would be of no consequence, but until that state of railway operation arrives, the headlight will be a subject for vigorous discussion.

At the present time locomotive headlights may be grouped in four classes according to the source of illuminant in the order of development, as follows:

1. Oil.
2. Electric arc.
3. Acetylene gas.
4. Metal filament electric incandescent.

The general design of the case is substantially the same in all, the principal difference in design apart from the illuminant being in the reflector, and in some cases the substitution of a lens for a front cover glass. The common type of reflector is of copper with a burnished silver plated reflecting surface, which usually becomes tarnished in a short time, due largely to the sulphur in the coal. It is difficult to restore the silver to a good reflecting surface, particuarly with the polishing materials available in the roundhouse. Some reflectors now on the market are made of glass, silvered on the back. The silver is thus protected against discoloring influences, while the exposed glass surface may readily be maintained in good condition, thus making a most efficient and durable reflector.

As the speed of trains increased a brighter illumination of the track was demanded in order to avoid accidents. Under normal conditions of track, a heavy train at sixty miles per hour may be brought to a stop in about 2,000 feet, this figure being very approximate, on account of the many variables which are involved in the problem. In any event the stopping distance of a train, even at moderate speed, is so great that the oil headlight is of no value in showing obstructions ahead in time to prevent accidents. Its value therefore is only that of a signal light of an approaching train and as a spreading light which gives the engineer some indication of his position by showing land marks on or close to the right of way. In some cases the oil headlights are in such poor condition that they will perform neither of these functions.

A type of oil headlight has recently been developed which has a silvered glass reflector and front lens giving better illumination along the track than the old design, but the beam is of small diameter and outside its range the illumination is not as good as with the standard type.

The acetylene gives a much better illumination than the oil headlight, but the writer has not had the opportunity to observe one having a good reflecting surface which it is believed would add materially to the efficiency of this type. Even at its best, however, the acetylene light will probably not meet the demands of those who desire the powerful illumination ahead of the train which they believe will add to the safety of operation.

Incandescent lamps of the tungsten type which are used in automobile lamps give strong illumination but are just now beginning to be designed commercially for high power locomotive headlights and the writer has not had opportunity to make a test of this type. Powerful illumination of the character just noted is met at the present time only by the electric arc headlight.

The arc light had become a fair commercial success by about 1880, and naturally it was proposed to use it on locomotives, which was done so far as the writer can learn about 1885, on the Pennsylvania, and before 1890 it was tried on various other roads the C. H. & D., I. D. & W., C. & E. I. and Vandalia, so that it is not a new device. The generator was driven by a reciprocating or oscillating engine and there were engine, generator and lamp troubles.

In present day designs a small turbo-generator set is used. the lamp is of simple construction, the operation of the three elements being satisfactory and quite free from the earlier troubles. In the lamp, carbon is used above for the positive terminal and copper below for the negative, automatic feed thus being required only for the carbon.

In some designs an incandescent lamp is fitted in the reflector; this may be cut in as the arc is cut out by means of a double throw switch in the cab, this change being made if thought necessary when meeting another train, or on entering a yard or terminal.

During the past ten years a number of states, through legislative enactment, have made laws specifying in various terms the requirements for locomotive headlights. Many of these laws have been such that the conditions imposed could be met only by the electric arc.

The Wisconsin Legislature during the 1911 session passed the following locomotive headlight law:

"Locomotive Headlights. Section 1809v. 1. It shall be the duty of every corporation operating any steam railroad of more than fifty miles of track within this state, to equip on or before July 1, 1912, every locomotive, power vehicle, power car, and other equipment used as the equivalent of or in place of locomotives, except such as are used exclusively for switching service or in railroad yards and not elsewhere, with a headlight of sufficient candle-power, measured with a reflector, to throw a light in clear weather that will enable the operator of the same to plainly discern an object the size of a man, at a distance of not less than eight hundred feet, and thereafter to maintain and use such headlights upon every such locomotive, vehicle, car or other equipment, when the same is operated at nighttime."

The law contains an additional paragraph, giving the penalty for its non-compliance.

During the past decade a number of headlight tests have been made by railroad officials and others interested in various phases of the subject. In order to have an independent basis for comparison, the Railroad Commission of Wisconsin ordered an extensive series of tests made by its engineering staff in the spring of the present year (1912). The committee having direction of the tests was selected from the Commission's engineering staff and consisted of the writer, who was at that time in charge of the mechanical department, as chairman, Mr. M. H. Hovey, safety service expert, and Mr. J. N. Cadby, inspector of gas and electric service.

An extensive series of tests was planned and performed during the spring and summer, with the co-operation of the C. & N. W. and C., M. & St. P. Railway officials, who furnished locomotives, headlights and provided clear track for the tests. Engineers, firemen, and other train men accustomed to the observation of signals and running conditions from both these roads and several others in the state were present at the various road tests, serving as observers with members of the staff of the Railroad Commission.

In some of the tests the observations of thirty observers were taken in order to determine average conditions. These tests were made with two types of oil, two sizes of acetylene and two makes of electric arc headlights. In testing the standard oil headlight, two were used, one being new with a highly polished reflector, and the other an older one with a tarnished reflector. The second type of oil headlight was one of recent development, having a silvered glass reflector and a front lens, both a 16" and 18" size being tested.

The distance tests consisted of the determination of the distance in which a man could be "picked up" when walking toward the standing locomotive, as well as when the man was stationary and the locomotive approaching him at various speeds. In order to determine average and extreme conditions, the observed men were dressed in white, black or neutral colors.

In addition to the "pick up" tests, observations were made on the influence of the headlights on signals, the visibility of semaphore arms, the effect on signal lights of various kinds as to reversal of color, the production of false reflections known as "phantom lights," and the observation of signal lights in the glare of a powerful facing light. Several extensive series of photometric measurements on the headlights were conducted by Mr. Cadby.

Beyond this brief summary, no report of these tests will be made, as they are given by Mr. C. M. Larson, Assistant Chief Engineer of the Railroad Commission in a paper presented by him before the Western Railway Club, and published in Volume 25 of the proceedings, which also contains a discussion of the subject by railroad officials and others. In Mr. Larson's paper the observations made in these tests are reported in sixty-two large tables, and the plans of the tests and methods of conducting them are described in detail. References are also made to headlight tests performed by others.

As this discussion deals particularly with the electric arc headlight, the arguments for and against this light will be given, as derived from laboratory and road tests, opinions, and experiences related by railroad men interested in train operation, practically every one of which arguments will find a disputant.

Statement of the case for the electric arc headlight:

(1) Good illumination of the right of way for a sufficient distance ahead to prevent or reduce damage from an obstruction.

(2) Warning of an approaching train.

(3) Light sufficient to show position of semaphore blade.

(4) Practically daylight conditions increasing the safety of operation.

Statement of the case against the electric arc headlight:

(a) An engineer looking from the cab into the field of an electric arc headlight, and at intervals of three-quarters of an hour meeting a similar headlight, loses in two hours' time the power to distinguish colored lights.

(b) Classification lights (on the head end of the locomotive) are practically obliterated if the same locomotive carries an electric arc headlight. In one of the Wisconsin tests, out of 182 observations at 600 feet on a locomotive carrying an arc headlight, not a single classification light was observed.

(c) The electric arc does not ordinarily show obstacles on the track at a sufficient distance to prevent the probability of an accident.

(d) The electric arc may indicate a false or phantom light when the light behind the roundel is extinguished and in some cases a green or other colored phantom was observed when a light was burning behind a red roundel.

(e) When an observer is facing an arc headlight, practically everything beyond is blanked.

(f) It is impossible to estimate the distance from the observer of an electric arc headlight causing confusion at grade crossings.

(g) The electric light is confusing in yards and terminals to those not behind it.

(h) It is injurious to the eyes.

(i) In time of sleet, snow, fog or rain the reflection from these elements prevents observation ahead.

(j) Fusees disappear in the rays of the electric arc.

(k) The substitute incandescent controlled by a switch in the cab is unsatisfactory, as it is not likely to be used at the right time for those not on the engine, and it gives another duty to the already overburdened engineer.

(l) Dependence cannot be placed on reading the semaphore blade positions by the electric arc. The rules of some railroads forbid the use of blade readings from sunset to sunrise.

(m) The reading of disc signals under illumination of the electric arc would be very hazardous.

The above are probably not all the charges which could be made against the electric arc headlight, but it is a strong arraignment as each charge is supported by recorded observations or expert opinion. If the case is not examined from other angles it would appear to be criminal practice to employ such a headlight on a locomotive.

The writer has endeavored to make a compilation of accidents chargeable directly to the electric arc headlight but with no great degree of success, and would be glad to receive specific instances from readers of this article.

Two cases are reported as occurring the same night on one road in Wisconsin during one of the floods last summer, in both of which the electric arc headlight showed a track washout at sufficient distance ahead to prevent injury to life.

One official on a road using this headlight said that he could not give an instance of a wreck caused by the arc headlight but could give a long list of accidents prevented by its use.

The "phantom lights," which all investigators have found, appear to be rather peculiarly the product of laboratory investigation as dangerous phenomena, for they have been seen by locomotive engineers and regarded as fairly harmless as long as arc headlights have been used. Public attention was not directed to them until they were carefully studied in the laboratory, or under laboratory conditions in road tests.

If locomotive engineers did not so regard the phantoms, train operation at night with the arc headlight would be rather intermittent. Possibly no locomotive engineer has analyzed his solving of phantoms to any greater extent than any one has studied the mental processes involved in crossing a street in the middle of a block crowded with rapidly moving traffic.

In regard to brilliancy of the arc headlight it may be noted that the eye has grown accustomed to artificial light of many times the intensity of that which sufficed a decade or more ago. We are not only accustomed to this increased light intensity but continually demand a brighter and brighter light.

Special training, as in the case of the blacksmith, permits him to determine with fair accuracy the heat of a piece of steel in a fire in which the ordinary observer can see nothing but a bright glow, and which partly paralyzes the latter's vision for many seconds.

One of the most conclusive charges brought against the electric arc headlight is (b) the obliteration of classification lights.

It is to be noted however that the classification light may be seen if the arc is switched off or if this is not done it may be observed after the bright beam has passed. In addition, the whistle signal is used for the same indication as the classification light and replied to by the engineer on the side track. Thus always giving protection and double protection when the classification lights can be seen.

There doubtless are conditions under which the arc headlight is unsatisfactory, but many locomotive engineers who have run behind it, some of them for years under various conditions, give strong testimony as to the value of this form of track illumination as a safety device and one questions whether there is a more competent authority. It is certain no one has a greater personal interest in avoiding collision with obstructions ahead of the train than the man on the locomotive, for in case of such collision he gets the worst of it.

As the area traversed by a railway becomes more highly developed, the necessity for a powerful headlight decreases, due to the elimination of grade crossings and the adoption of more careful protective measures. The increased density of rail traffic and the increasing number of parallel tracks under these conditions intensifies the valid objections to this form of headlight. Without attempting argument in further detail, the following point may be noted.

There are over 20,000 electric arc headlights in operation on single and double track roads, so that it would appear that if even a part of the above case against this light were in full effect, wrecks due to it would be of nightly occurrence and every electric arc headlight would be taken off in a week.

THE ENGINEERING LIBRARY.

FRED E. VOLK, '08.

In these days the engineer does not depend on a few text books and his own experience, but draws very largely on the experience of others through the literature of his profession. The problem of securing information is so important that the larger engineering firms maintain well equipped libraries in charge of trained librarians, several assistants being employed in some cases. To the young man just beginning his professional career, technical literature is especially valuable, for having little experience of his own he must depend largely upon that of others. He ought therefore to know how to find quickly the best material on the subject in hand, and for this reason it is just as important that the engineering student should have practice in the use of a library, as that he should do field work in surveying, testing in the dynamo laboratory or any other form of laboratory practice. For though a library may not always be available, a person can generally secure the desired information if he knows where and how to find it.

This library practice can best be carried on in connection with the regular courses, the student being given general references to questions arising in connection with his class-room work and being required to find material on the subjects for himself. Much of this work has always been done here but it was long handicapped by the fact that the books wanted were not conveniently located for use by engineering students. To overcome this and encourage their wider use, all of the engineering books and periodicals belonging to the University Library were removed to the Engineering Building in February, 1911, and the Library of the College of Engineering established as a branch of the main library.

The library so formed contains about 12,000 volumes of books and bound periodicals, besides numerous pamphlets. It is growing rapidly, nearly 700 volumes having been added during the past year. Books are bought on the recommendation of the members of the faculty and an effort is made to secure all the best engineering books as soon as issued. The current numbers of about 250 technical periodicals are available in the reading room, and the files of bound periodicals contain complete sets of all important technical magazines and society transactions. In addition to these, there is a good col-

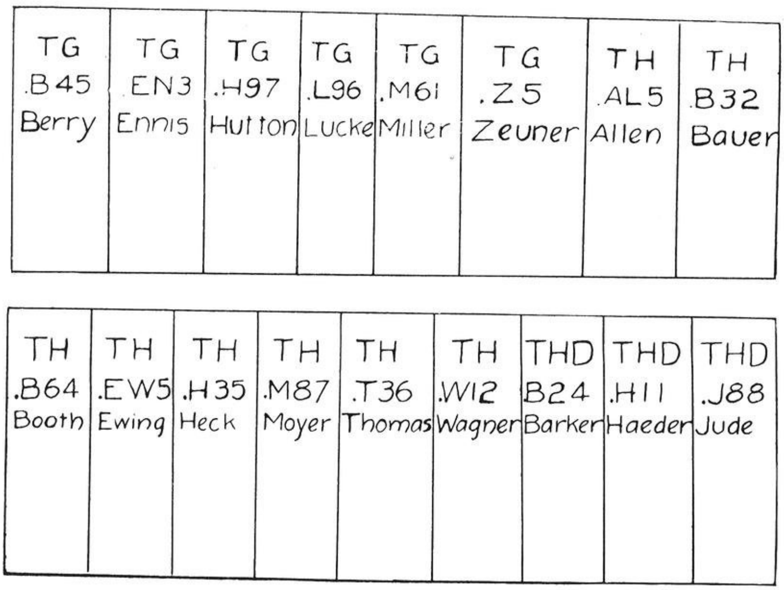

FIG. 1.

lection of encyclopedias, dictionaries and indexes, and a carefully selected collection of standard works on mathematics, physics, and chemistry, for reference.

The entire resources of the library are available for free use within the library itself, and readers are encouraged to go to the stacks whenever they wish, as it is desired to make the use of the books as free as possible. Students may also borrow books for home use by making a deposit of two dollars to cover fines and damages. This deposit, less charges, is refunded at any time desired.

To make the books readily accessible it is of course necessary to have some systematic method of classifying and arranging them, so that the books on a given subject will be found together on the shelves. A modification of the Library of Congress Classification is used and the books are marked with the Cutter call numbers. The first line of letters on the label denotes the class in which the book belongs and the second line the author's name. The arrangement on the shelves is by classes in the alphabetical order of the call numbers, with the authors in alphabetical order under each class. Figure 1, which is a representation of a portion of the books on steam

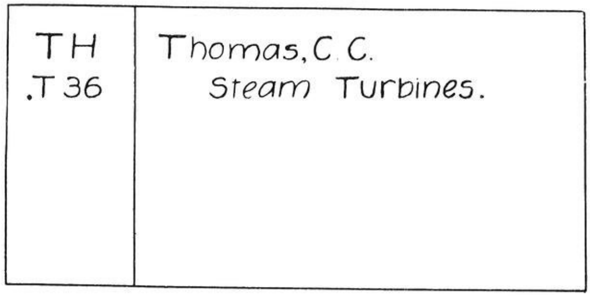

FIG. 2.

engineering, illustrates the above-described arrangement. Here the books on thermo-dynamics are designated by the call number TG, those on steam engines and turbines by TH, and the ones on valve gears by THD.

To facilitate the finding of material, a good card index is provided, in which for each book or set of books there is an author card and as many subject cards as are necessary to bring out the various subjects treated. These cards are arranged in a single alphabet as a dictionary catalogue. Books may therefore be found from the author's name when known or from the subject treated. Thus, in looking for the book on steam turbines by C. C. Thomas, we look in the card index under the author's name, or the heading "Steam Turbines." In either case we would find a card like Fig. 2. Having located in the catalogue the card for any book it is an easy matter to find the book itself from the call number which is given in the upper left hand corner of the card. In the case cited, the TH directs us to the books on steam engines and turbines.

and the .T36 (the period is used before the T to differentiate the author number from the class number) is easily found from the alphabetical order of the authors under the class. The number of students thus finding books for themselves has been constantly increasing, until now about half of the readers are doing so. Allowing this freedom involves extra labor in keeping the books in order, but is much more satisfactory from the reader's standpoint than closed stacks. It is a saving of time to go directly to the shelves, a person often finds that some other book on the same shelf is better suited to his needs than the one he is seeking, and it is always a satisfaction to have at hand all of the books on a given subject. Besides, when looking over the shelves a person often finds some book which he does not want at the moment, but which he will return to later.

As soon as the volumes of periodicals are completed, they are bound and placed in the periodical files on the second floor of the stacks, where the arrangement is in alphabetical order by titles. Each volume has an index and the library has collective indexes of individual periodicals whenever obtainable, but the chief means of locating material in the periodicals are the general indexes such as the Engineering Index, Engineering Abstracts, Science Abstracts, etc., of which the library has complete files. When a student who is not familiar with the methods of finding material comes seeking information from the periodicals, he is directed to these general indexes and their arrangement and use explained and then demonstrated by locating material on the given subject, the aim always being to teach the student how to help himself.

Today the engineer is interested in many things outside the purely technical phases of his work, so it sometimes happens that questions arise which can best be answered by reference to the works on history, economics, science, etc., or the public documents at the main library. In such cases the reader is referred to these sources of information. Guide cards in the catalogue also refer the reader to the main library whenever additional material on a subject may be found there. Similar references to the Engineering library in the University library catalogue seek to overcome as far as possible the disadvantages of dividing the library.

It is impossible to say just how much of an increase in the use of the Engineering books has been produced by the establishment of the Engineering library, but that it has been considerable is certain. It is a significant fact that the records of those members of the faculty whose accounts cover the two years show a 50% increase in the number of charges during the first year after the change. A large number of students make daily use of the library and from the facility with which the majority of them find the things they want it is safe to say that the library is not only fulfilling its chief function of furnishing information, but that it is doing much to familiarize students with engineering literature and the means of finding information.

* * *

The author of the above article, Mr. F. E. Volk, Librarian of the Engineering Library, is a graduate of Ripon College, '06, and of the electrical engineering course of the College of Engineering, University of Wisconsin, class of 1908.

Following his graduation from the University, he taught one year in the Marquette High School and spent the following year, '09-'10, in the apprentice course of the General Electric Company. During the first semester of the year '10-'11 Mr. Volk made a study of library methods in the University Library preparatory to taking charge of the Engineering Library in February, 1911. —John G. D. Mack.

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EDITORIAL.

Professor Dennis' lecture on "The Relation between History and Engineering" suggests an idea which may be well worth developing. Why not a course in the History of Engineering? As graduate engineers, we go out into the world knowing very little about the youth and growth of our chosen profession. We know of the men who, by devoting their lives to the quest of engineering knowledge, have opened vast fields of opportunity to the world, only what we may have acquired by hearing their names linked with a certain law, machine or type of structure. How many of us know all those men whose names grace the exterior of our own building? How many of us can name the particular line of research which has made each famous? A one-fifth course required of all Seniors, and given, perhaps, by one of our History Professors in the College of Letters and Science noted for the interest of their lectures, would help to destroy our ignorance of the earlier days of our profession. No particular text need be followed; the work could rather be carried on by lectures, each taking up the development of some phase of engineering or the work of some famous engineer. Supplementary reading and topics would supply the desired amount of outside work. Grades in the course might perhaps be better based upon regularity of attendance and excellence of topics rather than upon a final examination, a difficulty in so general a course. Such a course might easily be made one of the most attractive and valuable offered in the college. Surely no man can consider himself well-grounded in a subject when he knows little or nothing of the growth and development of that subject. As a valuable cultural and practical addition to our curriculum it would round out and give a greater completion to the graduate's grasp of his profession.

* * *

Christmas vacation is almost here. It is longer than ever this year by a week and everyone will have a good chance to get rested up and to catch up all the loose ends that have been dragging of late. Then comes the crucial part of the semester,—the home stretch leading to the finals. We shall all be able to do better work and more work during those weeks. There will be fewer balmy afternoons to tempt us out. It is up to each man to confirm the good impressions he may have created in classes, and to destroy any others he may have inspired. A month's consistent work will do wonders, even at the end of an indolent semester.

We often wonder whether most of the students appreciate the true value and convenience of the Engineering Library. Only those students who remember the building before the addition of the new wing can properly realize and gauge the difference between present and former conditions. As a convenient place to study between classes, as a source of supplementary information, and as a means of keeping abreast with the advance of the profession, its value cannot be overestimated. One of its greatest advantages is the freedom which is granted and the lack of forms and "red tape." Yet it is by no means unsystematic. Mr. Fred E. Volk, the librarian, in this number tells of the aims and methods of the library. Anyone who uses it can testify as to how well it fulfills these aims.

* * *

It is a long look ahead to St. Patrick's day and the possibility of the Engineers' Minstrels. Among some of the students the idea has arisen that the Minstrels are given every other year. Past history shows a sort of a dot, dot, dash system, the result of circumstance rather than of design. Shows were given in 1903, 1905, 1906, 1909, 1910 and 1912. It is to a great extent up to the Senior Engineers. It is rather a big task to hope to surpass last spring's effort. More, however, may be done with the development of the St. Patrick idea, which seems to have taken a permanent hold. The 1913 Engineers have started out with originality in the form of their smoker. With a little more unity and organization they should be able to carry through a celebration which would surpass all previous ones, a celebration which would be more than a parade advertising the Minstrels. They have an opportunity to make that one day peculiarly and interestingly an Engineers' day. For the present, about all that can be done is to discuss the question casually. Toward the close of the semester the sentiment should have crystallized and definite action can be taken. It is worth thinking over. When a song like "St. Patrick was an Engineer" can in one night catch the ear of the whole school, it is a sure sign,—if you believe in signs,—that it will lend itself to more and more popular variations of the theme if we only take it up and carry on the idea with enthusiasm.

* * *

As good sportsmen we don't like to be yelling too loud when our team is winning, for well we know that good spirit is shown by being behind a losing team. We feel, however, that great commendation is due the team, the coach and the "forces" that have brought to Wisconsin the Western championship. To every man on the team is due honor for the part he did toward making the season a success. Though every man cannot star, it is only by bucking up against consistent teammates that stars are produced. To the coach is due the credit for a generalship and creation of unity that made success. Last, but by no means unimportant, is the credit due to those self-sacrificing students, who unknown and unhonored kept "bucking up" the delinquents. But for the efforts of many of these in keeping certain "indispensables" up in their work, our team would have been weakened by ineligibles. So to all the factors that made this season a decided and long-to-be-remembered success we are ready to give the highest reward—a Varsity Locomotive.

CAMPUS NOTES.

Most of our alumni do not need to be told of the results of the Chicago game when we avenged ourselves for last year's defeat by a 30—12 score. Many of them were back in person to witness the victory and many more followed it from afar through the columns of the next day's newspapers. However, no department which pretends to record the more important of our undergraduate affairs could omit mention of such a game, even if assured that all the readers were previously informed. The alumni took advantage of the "Homecoming" features in connection with the game and poured in from long distances. The Milwaukee and Chicago Alumni Associations were especially in evidence with their badges, banners and parades. The celebration of our victory was a little more conservative than those of past years, in the "spiritual" way.

In our last home game of the season, the Razorbacks from Arkansas went down to defeat by the score of 64 to 7. The low score is partly accounted for by the absence of Gillette, Ofstie, Van Riper and several other regulars from the line-up.

One week later, nearly a thousand students made the trip to Minneapolis to settle last year's tie with the Gophers. When the dust had cleared away we found the Cardinal again on the long end of the score, 14—0. The game was a struggle from start to finish. A rather noteworthy feature of the game was that the eleven Wisconsin men who lined up at the kick-off were the same who played in the last scrimmage. Not a substitution was made during the entire game.

The last game, also away from home, was with Iowa, and resulted in a 28—10 victory. Wisconsin jumped into the lead early in the first quarter on a 50-yard run by Gillette and was never headed. This game marked the close of the most successful football season in a decade, if not in the history of the sport at Wisconsin.

The Badgers scored a total of 246 points to 29 scored against them. They were never behind in a game during the season.

and in no single quarter did their opponents score more points than did the new conference champions.

While we are lauding the football team, we must not forget our other conference champions. At Evanston, Illinois, November 23, the Wisconsin team won the cross country run against the other conference schools, and Ames, Nebraska, and Missouri. Captain White was the individual star, winning the race in record time for the course under unfavorable weather conditions.

The reflection of a sentiment toward the University of Michigan, favoring a return of the Wolverines to the conference fold, was shown by the circulation of petitions throughout the Wisconsin undergraduate body expressing a desire for this return. Over 2,500 signatures were secured the first day. A resumption of the old rivalry for athletic supremacy, impossible under present conditions, is highly to be desired from any point of view.

* * *

The Prom situation this Fall was one of the most unusual that has happened within the last few years of class politics. The question at stake was not at all an issue of personal qualifications of the candidates, but was a question of changing the fundamentals of the Junior Prom as an institution. White, captain of the cross country team, ran for chairman on a platform advocating a two-dollar prom, no house parties, and other revolutionary features. Ivan Bickelhaupt ran on a ticket which promised most of the features of old time functions; while "Doc" Tormey advocated a middle course that would make the Prom more democratic but still keep within the traditions. The feeling was especially intense, for all factions had a strong following. The ballot resulted in the election of Tormey, with White second and Bickelhaupt a close third. Whether or not this situation will appear in following elections is a matter that is still causing some feeling.

* * *

At the class elections held at the same time as the "Prom" election the following officers were chosen:

Seniors	Juniors
President—E. S. Gillette	Ray Cuff
Vice-President—Harriet Prince	Katherine Cronin
Secretary—L. G. Castle	Kenneth Bragg
Treasurer—J. G. Beattie	Al Johnson
Sergeant-at-Arms—Frank Youngman	——— Butler

Sophomores	Freshmen
President—H. B. Clayton	Al Kessenich
Vice-President—Marie Clauer	Anita Pleuss
Secretary—M. Cohn	Gordon Clapp
Treasurer—Bohstedt	Dow Harvey
Sergeant-at-Arms—R. Keeler	Arthur Wickham

The Senior and Sophomore tickets were uncontested.

* * *

The new Student Conference, formed this fall, consists solely of representatives of the different classes of each college, with no ex officio representation except for the President of the Freshman class, the only Freshman member. The representation from the College of Engineering is as follows: Seniors—E. A. Anderson, E. S. Gillette, Herman Larson, Ralph Moody, C. P. Stivers, E. N. Whitney; Juniors—R. L. Replinger, J. W. Young, A. E. Sackerson, F. D. Bickel; Sophomores—H. Hersh, J. U. Heuser.

Besides the usual more or less routine matters to be taken up, the question of the desirability of further centralization of authority will be threshed out.

* * *

It is interesting to note the new step which the Senior class in the College of Engineering is taking in the Senior-Engineer smoker and mixer which is scheduled for Thursday evening, December 5th. The details and general arrangement are now under consideration by the committee, consisting of Malcolm McFarland, Richard Corbett, K. W. Erickson, Converse Wurdeman and J. K. Livingston.

* * *

At the fall election of Tau Beta Pi the following men were chosen: R. Boissard, W. K. Fitch, S. S. Gregory, F. Halladay, A. C. Kelm, H. Larson, F. W. Lorig, F. C. McIntosh, E. K. Morgan, E. C. Noyes, and S. D. Wonders. No high Junior was elected.

DEPARTMENTAL NOTES.

The annual smoker and student-faculty mixer given by the Civil Engineering Society at the Union on Friday evening, October 25, for the civil engineers, met with the same success as has characterized this event in the past several years. It was largely attended by both faculty members and civil engineering students; the atmosphere of frankness and good sentiment which prevailed, while not entirely new, was very noticeable.

After an hour of good fellowship and chats, during which a goodly assortment of "eats, drinks and smokes" were served, the faculty speakers of the evening, Prof. Doolittle, Prof. Christie, Acting Dean Mack, Mr. Morris and Prof. Pence were introduced by President Simon, each of whom made a few pertinent and well-received remarks.

* * *

The first of this year's series of lectures for engineering students by outside lecturers was given in the auditorium of the Engineering building on Wednesday morning, November 20th, by Prof. A. L. P. Dennis of the History Department of the College of Letters and Science, who chose for his theme "The Relations of History and Engineering."

As its title implies, the lecture was non-technical in character; this did not, however, detract from its value or the interest with which it was received. Prof. Dennis after calling attention to the value of the evidence left by engineers of past generations to the historian as a source of historical information, such as the ancient cathedrals, the Roman roads, etc., brought out strikingly the important part which has been played by the engineer in the development of civilization. He showed how the achievements of engineering, such as the diverse forms of machinery, methods of transportation, etc., brought about a condition of specialization in production, resulting in industrial communities and cities, and making possible our present system of society. That the engineer was a heavy contributor to civilization, and that engineering labor is correspondingly of a most productive variety, is the inevitable conclusion which we must draw from the statements presented by Prof. Dennis.

* * *

The week of November 10th to 17th brought with it the annual inspection trips of the Senior students in civil, mechanical and electrical engineering. The civil engineers, thirty-five strong, under the guidance of Professors Kinne, Corp and Van Hagan, went to Milwaukee, where they made close inspections of the Grand Avenue viaduct, the C. M. & St. P. Ry. interlocking plant and car shops, the municipal incinerating plant, the North Point pumping station, the pumping station for the flushing tunnel, the West Allis Works of the Allis-Chalmers Co., the Prescott Steam Pump Co., various lift bridges, buildings under construction, and the water-meter testing laboratories in the City Hall.

The electrical and mechanical engineering students were, as usual, divided into two parties. One under Professors Thomas and Black visited Milwaukee, Chicago, Gary, Buffington and the new dam under construction at Keokuk, Iowa. The second party under Professors Christie and Disque, visited Gary, Buffalo, where the Niagara Falls power plants were inspected, and Pittsburg, where the various branches of the steel industry were inspected. Some of the members of this second party also included a visit to Keokuk.

* * *

Mr. L. R. Balch, '05, C. E. '09, who was engaged in advanced research work in the Hydraulics Laboratory last year, after a number of years work with the United States Reclamation Service, has taken up a position at Madison in the consulting offices of Mr. Daniel W. Mead, professor of Hydraulic and Sanitary Engineering.

* * *

Professor L. S. Smith writes from Munich, Germany, at which place he is making a special study of pavement construction, under a German educator, that he finds the pavements there are uniformly good, and superior to those both in London and in Paris.

At the meeting of the National Electro-Platers Association, to be held in Chicago, December 14th, the Department of Chemical Engineering is represented by the following announcement:

Paper by Prof. C. F. Burgess, "The Application of Chemistry in Electro-Plating."

Paper by Prof. O. W. Watts, "The Microscopic Structure of Electro-deposition."

ALUMNI NOTES.

Geo. E. Long, Chemical Engineer '08, has recently accepted a position as Electro-Chemist with M. Guggenheim's Sons, New York City, where he will be engaged in experimental work on electrochemical and metallurgical problems. Mr. Long has for several years been in the employ of the Aluminum Company of America as a Chemical Engineer.

Mr. W. A. Jassen left the University in 1907 to take up work with the Bettendorf Axel Company of Bettendorf, Iowa. He completed his requirements and received his degree of B. S. in Chemical Engineering in 1911. Mr. Jassen has been particularly successful and has been promoted to the position of Assistant Superintendent. In this position he has charge of one of the largest furnaces in the country for the manufacture of steel, for steel casting.

Mr. Carl S. Reed of the 1905 Mechanical Engineering class recently resigned as Western representative, at Chicago, of the American Locomotive Company to become Eastern Sales Manager of the Bucyrus Company in New York City.

H. C. Ward, '05, is in the Rochester Sales office of the General Electric Company.

S. W. Stanley is now a second Lieutenant in the U. S. Engineering Corps stationed at Fortress Monroe.

H. B. Sanford has the position of Assistant Professor of Electrical Engineering at the Imperial Polytechnic Institute in Shanghai, China.

W. E. Lent, '10, is located in Milwaukee with the Cutler Hammer Company.

L. E. Glauter is with the People's Telephone and Telegraph Company in New York City.

C. J. Belsky has affiliated himself with the Wisconsin Railroad Commission.

J. L. Johnson, '09, is now Secretary and Treasurer of the Lindsay range Corporation at Rockford, Ill.

Frank Kennedy, '08, who is a second lieutenant in the U. S. Engineering Corps, has been transferred from Atlanta, Ga., to Panama. He will be at the head of the school of aviation there.

Alex. F. Gilman, '10, is now instrument man in the engineering corps of the Chicago and Northwestern Railroad at Boone, Ia.

D. V. Swaty, '98, is now the Boston representative of the Great Lakes Dredge and Dock Company.

R. C. Falconer, '95, is principal Assistant Engineer of the Erie Railroad Line east of Salamanca.

V. P. Falconer, '05, is Engineer, Maintenance of Way, of the New York State Railroads.

H. P. Palmatier '12, is an Electrical Engineer with the Escanaba Traction Company, Escanaba, Michigan.

The graduates in Civil Engineering for 1912 are now located as follows:

R. E. Branstad, McClintic Marshall Co., Rankin, Pa.

A. M. Chuchian, Illinois Central Railroad, Freeport, Ill.

A. W. Ely, Chicago, Milwaukee and St. Paul R. R., Milbank, South Dakota.

J. R. Jamieson, Chicago, Milwaukee and St. Paul R. R., Milbank, South Dakota.

E. R. Hoffman, Gordon and Walker Co., Ellensburg, Wash.

C. H. Kirch, T. M. E. R. & L. Co., Milwaukee, Wis.

S. A. Krell, Chicago, Milwaukee and St. Paul R. R., Chicago, Ill.

C. A. R. Distelhorst, U. S. Government Engineering Corps, Rock Island, Ill.

W. E. Jessup, Los Angeles Aqueduct Co., Los Angeles, Cal.

H. J. Wiedenbeck, La Clede Gas Co., St. Louis, Missouri.

L. J. Markwardt, Forest Products Laboratory, Madison, Wis.

G. L. Mears, Little Construction Co., Fond du Lac, Wis.

T. W. Reilly and T. M. Reynolds, Highway Commission, Madison, Wis.

L. A. Smith, City Engineering Corps, Madison, Wis.

H. W. Vroman, Instructor in the College of Agriculture, University of Wisconsin.

J. H. Wasson. Railroad and Tax Commission, Madison, Wis.

Liang Yu, Chicago, Milwaukee and St. Paul R. R., Bridge Department, Chicago, Ill.

M. Lora has returned to Cuba.

H. R. Kroening is in the contracting business in Milwaukee, Wis.

D. P. Falconer, '05, is now Engineer, Maintenance of Way Department, of the New York State Railways, Rochester, N. Y.

F. E. Bates, '09, and R. M. Yager, '09, are with the Bridge Department of the city of Chicago.

L. M. Larson, '09, is affiliated with Brill and Gardner, Consulting Engineers, Chicago, Ill.

J. W. Dohm, '11, is now Assistant Engineer of the Oliver Mining Co., Hibbing, Minn.

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