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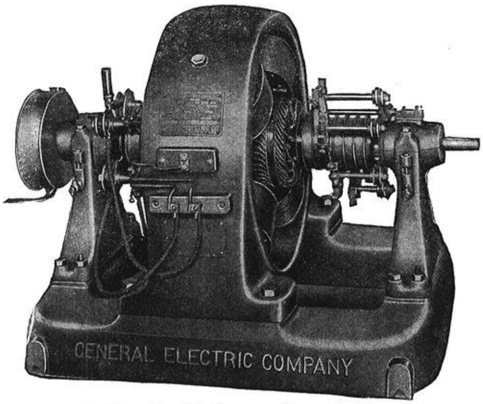
The Wisconsin Engineer

OCTOBER, 1913

Vol. 18 No. 1



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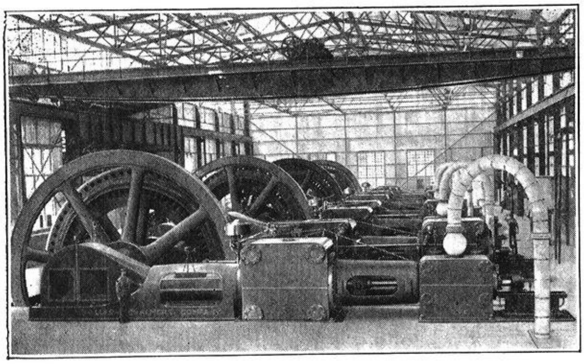

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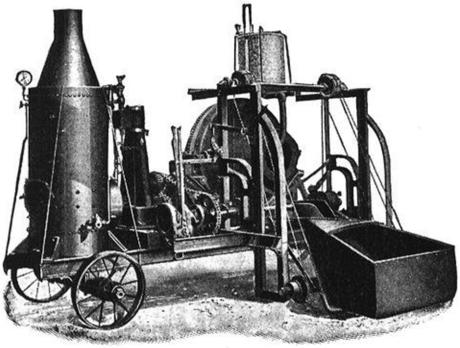

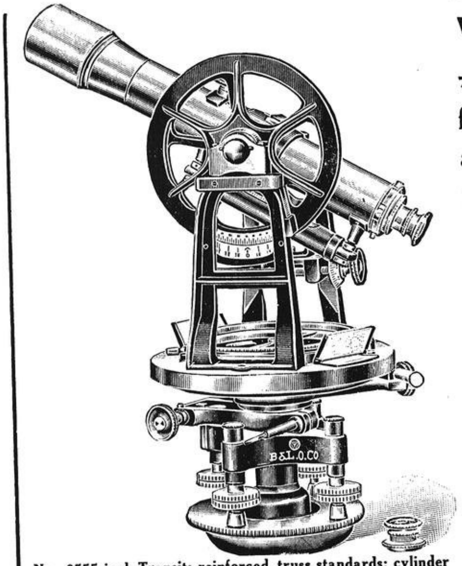

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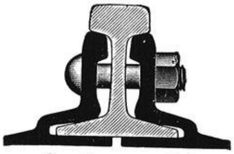

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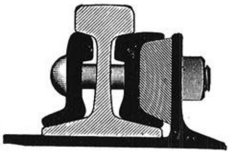

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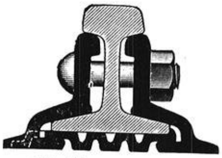

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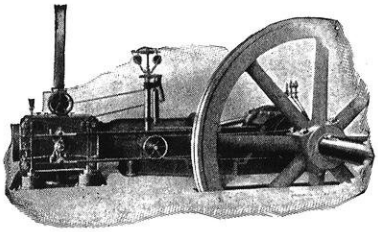

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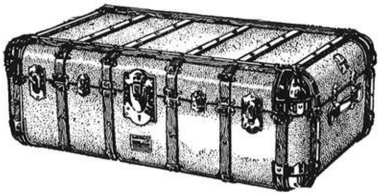


The Wisconsin Engineer

VOL. XVIII OCTOBER, 1913 NO. 1

IMPORTANCE OF A GOOD DISTRIBUTING SYSTEM FOR A CENTRAL STATION.

By M. D. Cooper.
Electrical Engineer, Nat'l Electrical Lamp Ass'n, Cleveland, Ohio.

The most common electrical distributing system in use at the present time is the constant potential system. This system implies the maintenance of a certain voltage at all points on the distributing system. Of course, an absolutely uniform voltage can not be maintained for there are bound to be certain losses in transmission.

In the transmission of electricity for power purposes a greater amount of voltage drop is ordinarily allowed than in the case of transmission of electricity for incandescent lighting. Power service is not so greatly effected by the voltage drop as is lighting service. Alternating current motors maintain practically a constant speed regardless of reasonable fluctuations of the line voltage, and direct current motors will operate satisfactorily where constant speed is not a primary requirement even though the voltage does fluctuate a considerable amount.

With a given load, alternating current motors consume practically the same amount of power over considerable ranges of voltage. This is true in a lesser degree of direct current motors. The numerous accessory devices which are now used on central station circuits, particularly those of the heating classes, such as flat irons, toasters, etc., also incandescent lamps, suffer a variation in wattage consumption as the voltage varies. A loss in line voltage on a central station circuit is therefore more costly than might appear at first sight; not only is the energy lost which is consumed on the line but there is also a decrease in the wattage consumption of load. These variations may not seem very important to engineers who are accustomed to thinking of power in blocks of 1000 kilowatts, yet considered from the commercial side, they are immensely important to every central station.

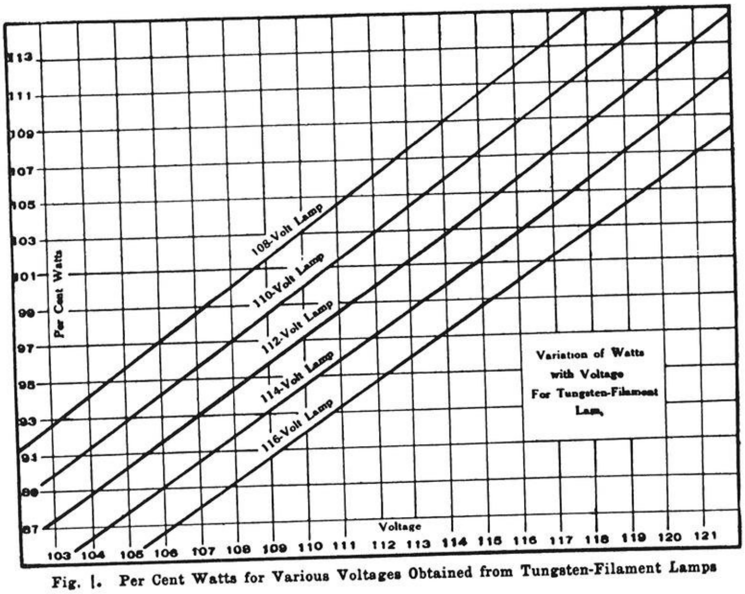


Fig. 1. Per Cent Watts for Various Voltages Obtained from Tungsten-Filament Lamps

Fig. 1 gives a curve showing how much the wattage of an incandescent lamp (Mazda) varies as the voltage supplied changes. It will be noted that a decrease of four volts would cause a loss in wattage consumption of six per cent. Under a straight meter rate this would correspond to a loss in revenue of six per cent. Cases can readily be imagined where a six per cent difference in revenue would mean the difference between operating the central station at a loss and operating it at a profit, hence, the statement that the question of line voltage is a very important one for every central station.

Aside from the loss in revenue which accompanies excessive voltage drop there is also a decrease in the amount of light given by an incandescent lamp, and there is also a chance for the operation of accessory devices to become unsatisfactory.

An incandescent lamp fulfills its rated performance with respect to wattage, candle-power, and life only when burned exactly at its rated voltage. If the voltage supplied is less than the lamp voltage its wattage consumption is decreased in a certain proportion and the candle-power in a much greater proportion, thus decreasing the efficiency of light production. If the voltage supplied is greater than the lamp voltage, the wattage, the candle-power and the efficiency are increased, but the life of the lamp may be unduly shortened. The total cost of light consists of two elements; the cost of energy and the cost of renewals. Since the economy of light production depends upon a proper balance between these two components of the total cost, it is highly important that the balance be preserved by operating the lamps under the voltage conditions which are universally agreed to be the most suitable for yielding simultaneously the proper quantity and a good quality of light, the proper revenue to the central station and the proper economy of light production.

As far as the quality of lighting service and the revenue obtained therefrom are concerned, if undervoltage burning exists, it makes no difference whether it is caused by interior drop, by the selection of an improper lamp or by lack of detailed knowledge of the exact voltage conditions existing on the system—the result is the same, less light, poorer quality of light, less revenue to the central station, dissatisfied customers and an opening for competing illuminants.

The effect of a considerable drop in voltage on the operation of the various auxiliary electric appliances is somewhat similar to the effect on an incandescent electric lamp. In other words, the manufacturers of these appliances have established definite voltage ranges within which their operation will give satisfaction. The impression has existed that incandescent lamps require much closer voltage regulation than any other class of load, but it is found that various electric appliances (other than those motor driven) require nearly as close voltage selection and voltage regulation as is necessary for the successful operation of lamps. Appliances of the heater class, such as flat-irons, curling-iron heaters, warming-pads, etc., are rated by their manufacturers in steps of from five to ten volts, showing that the voltage limits are satisfactory operation are from two and one-half to five volts either side of the rating. Appliances of the cooking class, such as toasters, percolators, grid-irons, broilers, etc., which demand somewhat closer temperature regulation, are rated in smaller steps of from three to seven volts, showing that the voltage limits for satisfactory operation are from one and one-half to three and one-half volts either side of the rating. If the voltage supplied to the apparatus is lower than that at which it was intended to operate, the time required for producing the heat necessary for economical and successful accomplishment of the work in hand is too great. The result is, in many cases, a return to the earlier heating methods in use before electricity became economically and satisfactorily available. These close voltage limits in the ratings of appliances have been adopted by manufacturers because they recognize that the economical and satisfactory operation of a majority of these appliances depends upon the time required to attain a certain heat and this in turn upon the voltage at which current is supplied.

The organization of which the author is connected has during the past year made a considerable number of voltage investigations upon central station circuits. A resume of the data obtained from these investigations may be of interest. In 133 central stations, located in towns of from 1000 to 15,000 population the average line drop was found to be 5.2 per cent of the plant voltage. The figures for the maximum line drop encountered in each place averaged 9.9 per cent. The difference between the maximum and minimum voltage on the circuits as a per cent of the average voltage gives an average figure for the 133 stations the lamps were burning at a voltage 3.4 volts less than the rated voltage. The following able gives a summary of the errors in the switchboard voltmeters:—

Error of Voltmeter	No. Reading High		No. Reading Low
Accurate		36	
1 Volt	16		10
1.5 Volts	2		..
2 Volts	20		14
2.5 Volts	2		4
3 Volts	16		17
3.5 Volts	3		3
4 Volts	13		5
4.5 Volts	1		2
5 Velts	11		6
5.5 Volts	..		1
6 Volts	3		1
7 Volts	1		1
10 Volts	1		..
10.5 Volts	1		..
11 Volts	1		..
	91	36	64

It will be noted that a relatively small proportion of the meters were reading correctly and that nearly half of them read too high. These high reading voltmeters tend toward keeping the line voltage lower than it should be.

Referring to the curves it will be noticed that 3.4 volts of undervoltage burning corresponds to a loss in revenue to the central station of 5.5 per cent. The customers also lose 12 per cent in candle-power. It is thus seen that the question of voltage conditions upon the circuits of central stations is one which merits the attention of every engineer, since upon proper voltage conditions depend not only the satisfaction of the customers with electric service, but also the successful operation of the central station both from the engineering and the financial standpoints.

THE EFFECT OF SALTS UPON THE STRENGTH OF CONCRETE CURED AT LOW AND NORMAL TEMPERATURES.

H. E. PULVER, B. S., C. E.

This article is a report of tests made during the winter and spring of 1912 by S. E. Johnson and the writer, instructors in Mechanics at the University of Wisconsin. A report of these tests has been submitted by Mr. Johnson to the Michigan Agricultural College for the degree of Civil Engineer.

The object of the tests conducted was to determine the effect of sodium chloride and calcium chloride, separately and together, upon a 1:2:4 concrete cured at low and normal temperatures. Normal temperatures mean ordinary room temperatures, say from 60° F to 75° F, while the low temperatures indicate those below freezing.

The concrete used was a 1:2:4 mix by volume, this mix being adopted as typical of that which would be used in practice in most instances.

In performing the tests common salt ($NaCl$) and calcium chloride ($CaCl_2$) were used dissolved in the mixing water, the percentage of the salts being varied over what seemed to be a practicable range. For the salts used alone the percentages of $NaCl$ in the mixing water were 6, 9, 12 and 15 by weight while those of the $CaCl_2$ were 2, 4, 6, 8 and 10. When the salts were mixed the range was from 6 to 15 per cent for the $NaCl$ and from 2 to 8 per cent for the $CaCl_2$.

The specimens were four inch cubes. Those cured at low temperatures were broken at ages of 14 and 60 days, while those cured at normal temperatures were broken at ages of 14, 60 and 360 days. Four specimens were broken at each age for each batch of concrete. For the specimens cured at low temperatures, an effort was made to get the curing conditions as near as possible like the most rigorous ordinarily found in commercial work.

The cement used was Atlas Portland and, in order that there might be no variation in the quality, a sufficient quantity for the entire work was mixed thoroughly at the beginning and stored in air tight cans until used. The results of tests on this cement, which were made in accordance with the rules of the A. S. T. E., follow in Table I.

TABLE I.

Fineness	Not Made
Consistency of Volume:—	
Cold Water Pat	Passed
Air Pat	Passed
Steam Pat	Passed
Normal Consistency	22%
Time of Set:—	
Intial Set	2 hrs. 20 min.
Final Set	6 hrs. 15 min.

Tensile Strength

Age in Days	Unit Stress in lbs. per sq. in.	
	Neat Ave. of four	1-3 Mortar Ave. of four
1	277	
7	640	177
28	804	283
60	970	406

The sand used was a good quality of bank sand from Janesville, Wisconsin, and all used was taken from the same bin. The weight per cubic foot was 108 pounds. The stone was a soft crushed limestone from quarries near Madison, Wisconsin. This stone would all pass through a sieve of an inch and a quarter mesh and weighed 90 pounds per cubic foot.

The NaCl used was a common grainer salt; the $CaCl_2$ was an inexpensive, coarse grained, granular salt taken from a barrel obtained for use in the laboratory.

A mixture of water and NaCl was made, using 25 per cent by weight of the salt, and stored in a covered can until used. Also a mixture containing 20 per cent of $CaCl_2$ was prepared and stored. When making the specimens, portions of the above liquids were mixed with water to give the proper percentage of salt desired.

Since the total quantity of concrete in any one batch was less than a half cubic foot, it was considered best to weigh all materials used. The cement and aggregate were first thoroughly mixed together by hand and then the liquid was added in a sufficient quantity to give a "just wet" mixture which would flow and form a smooth surface in the molds. The wet mixture was turned until it appeared to be of a uniform consistency. About 10 per cent by weight of water was required to produce a mixture of the proper consistency, though this percentage varied slightly for different batches. The specimens were surfaced by trowelling until fairly smooth.

TABLE II.

TESTS OF 1:2:4 CONCRETE CURED AT NORMAL TEMPERATURES

VARYING PERCENTAGE OF SALT IN MIXING WATER

Date Made 1912	Temperature When Mixed		Salt Percent		Unit Compressive Stress lbs. per sq. in.		
	Room	Batch	$CaCl_2$	NaCl	14 Days	60 Days	360 Days
Mar. 9	63	52	0	0	1910	3010	3580
*Feb. 3	63	58	0	0	1240	1330	
Mar. 9	63	52	0	6	1684	2620	2895
Feb.10	65	65	0	9	1525	2385	3055
Feb.12	68	68	0	12	1270	2060	2485
Feb. 3	63	58	0	15	1335	2220	2740
Feb.13	69	59	2	0	1920	3220	3740
Feb.14	67	60	4	0	2105	3510	3880
Feb.15	69	60	6	0	1725	3280	3670
Feb.15	69	61	8	0	1510	3070	3155
Feb.16	68	61	10	0	1655	3025	3330
Feb.16	70	59	2	6	1600	2650	3150
Feb.17	71	63	2	9	1695	2590	3100
Feb.17	71	64	2	12	1420	2440	2805
Feb.20	63	60	2	15	1320	2350	2725
Feb.22	66	56	4	6	1585	2550	2960
Feb.22	68	58	4	9	1550	2390	2965
Mar. 2	63	58	4	12	1710	2935	3580
Mar. 4	65	55	4	15	1245	1880	2410
Feb.26	68	60	6	6	1310	2475	2575
Mar. 4	65	54	6	9	1305	2370	3025
Mar. 6	62	54	6	12	1345	2420	
Mar. 6	62	52	6	15	1380	2415	
Feb.26	68	60	8	6	1120	2075	2490
Mar. 8	62	58	8	9	1135	2085	2445
Mar. 8	62	60	8	12	1110	1995	2525
Mar. 7	63	59	8	15	1550	2605	2940

All temperatures are given in degrees Fahrenheit.

* Cured in inside air and not placed in running water.

Materials at room temperatures were used in making specimens which were to be cured under normal conditions. In making specimens to be cured at low temperatures, the cement was at room temperature, the aggregate was brought in from the outside where the temperature was below freezing and the water was taken directly from the city mains. The temperature of this water was usually about 55° F, and that of the sand and stone, brought in from the outside, about 20° F. For a record of the temperatures observed, when the different batches were made, see Tables II and III.

TABLE III.

TESTS OF 1:2:4 CONCRETE CURED AT LOW TEMPERATURES

VARYING PERCENTAGE OF SALT IN MIXING WATER

Date Made 1912	Temperature When Mixed			Salt Percent		Unit Compressive Stress lbs. per sq. in.	
	Room	Outdoors	Batch	$CaCl_2$	NaCl	14 Days	60 Days
Jan. 20	64	13	42	0	0	213	427
Jan. 30	61	13	51	0	6	482	685
Jan. 30	61	13	51	0	9	680	942
Jan. 30	61	13	51	0	12	813	1192
Jan. 20	64	13	42	0	15	614	1060
Feb. 5	69	17	41	2	0	420	466
Feb. 5	69	17	44	4	0	444	564
*Feb. 5	69	18	55	6	0	349	367
*Feb. 8	72	1	46	8	0	286	334
*Feb. 8	67	1	46	10	0	234	348
Feb. 12	68	15	52	2	6	817	992
Feb. 12	68	15	52	2	9	848	1185
Feb. 9	66	7	41	2	12	690	1045
Feb. 9	68	7	38	2	15	583	807
Feb. 13	58	21	52	4	6	785	914
Feb. 13	58	20	51	4	9	755	926
Feb. 20	63	15	45	4	12	766	1215
Feb. 20	63	15	45	4	15	713	1200
Feb. 21	54	20	43	6	6	680	988
Feb. 21	53	20	38	6	9	480	850
Feb. 27	63	21	52	6	12	505	615
Feb. 27	63	21	52	6	15	527	863
#Feb. 27	63	21	51	8	6	390	590
Feb. 28	67	30	50	8	9	487	654
Feb. 28	65	30	52	8	12	402	589
#Feb. 29	65	14	44	8	15	535	658

All temperatures are given in degrees Fahrenheit.

* Badly disintegrated. Edges were spalled and the surfaces appeared soft.

\# Edges were spalled a little on the sixty day specimens.

The specimens cured at normal temperatures were allowed to remain in the air for twenty-four hours after making, next placed in running water for thirteen days, and then stored in air until broken. The temperature varied from 60° F to 75° F during the curing period. The cubes cured at low temperatures were, immediately after making, stored in cold air, either outdoors or in a refrigerator, where the temperature was below freezing throughout the curing, excepting two days when the temperature rose to a maximum of 35° F. All low temperature specimens were stored in the laboratory, at normal room temperature, for one day before breaking.

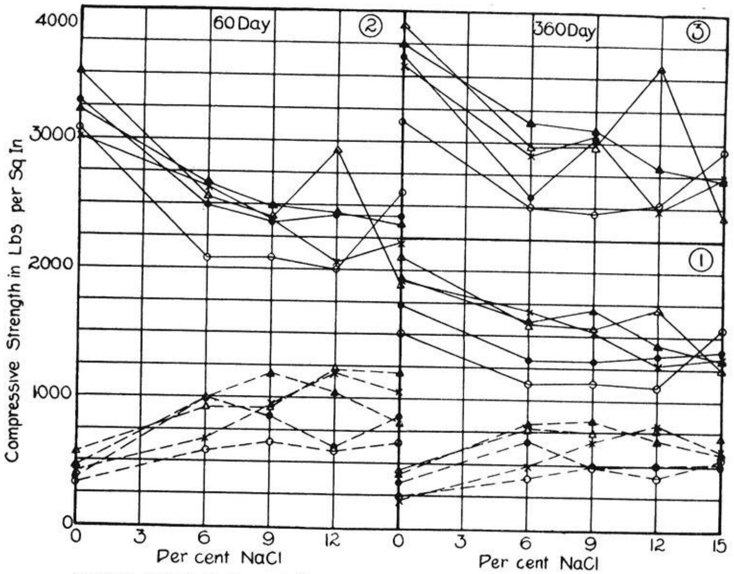
All of the testing was done in a 100,000 pound capacity Riehlé Universal testing machine. The cubes rested on a spherical bearing block, and care was taken that they were centrally placed on the block. Three or four thicknesses of blotting paper were used, both above and below, in bedding the cubes.

The results of the tests on the cubes are given in Tables II and III and Curve Sheets 1 to 9 inclusive. Curve Sheets 1, 2 and 3 show graphically the results from the specimens broken at 14, 60 and 360 days respectively. Percentages of NaCl in the mixing water are plotted as abscissae and unit compressive strengths as ordinates. The results obtained by using but one salt in the mixing water are shown on Curve Sheets 4 and 5. On Curve Sheets 6, 7, 8 and 9, unit breaking loads are plotted as ordinates and percentages of NaCl as abscissae, and each of these sheets represents a set of curves drawn for a certain percentage of $CaCl_2$.

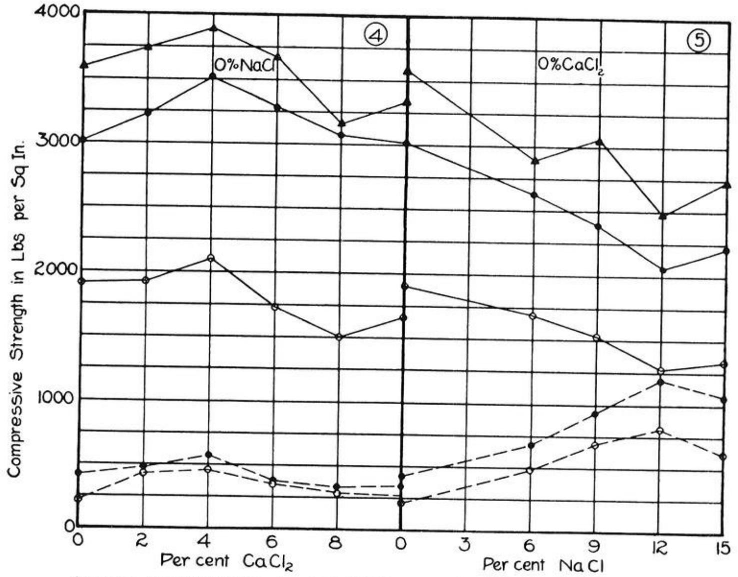
Conclusions.

The curves show, that as the percentage of NaCl is increased, there is a nearly straight line decrease in the strength of the concrete cured under normal conditions. See Curve Sheet 5.

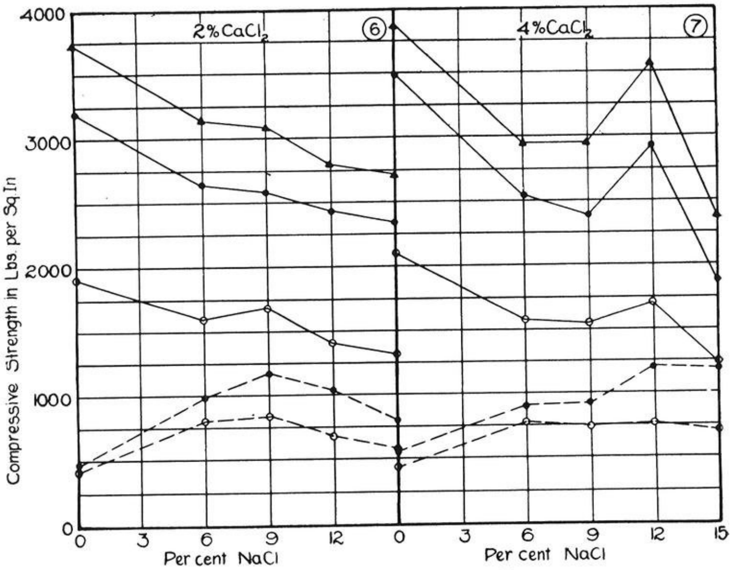
The effect of NaCl alone, when added to concrete cured at low temperatures, is probably to reduce the freezing temperature and hence retard the freezing of the concrete, thus permitting of its setting and hardening. The curves show an increase in strength for the addition of NaCl up to twelve per cent, after which there is a decrease. It may be that, beyond twelve per cent, the weakening of the concrete due to the excess of NaCl more than offsets



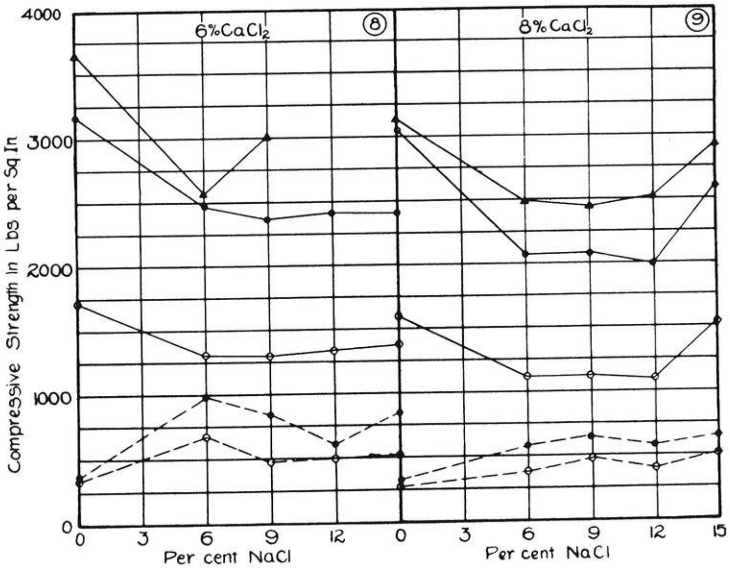
Legend Cured at Normal Temperature —, Cured at Low Temperatures – –
0% $CaCl_2$ = x. 2% $CaCl_2$ = ▲ 4% $CaCl_2$ = △ 6% $CaCl_2$ = ●. 8% $CaCl_2$ = o



Legend: Age 360 Days = ▲, Age 60 Days = ●, Age 14 Days = o
Cured at Normal Temperatures —. Cured at Low Temperatures – –



Legend: Age 360 Days = ▲, Age 60 Days = ●, Age 14 Days = ○
Cured at Normal Temperatures — Cured at Low Temperatures — —.



Legend: Age 360 Days = ▲ Age 60 Days = ●, Age 14 Days = ○
Cured at Normal Temperatures —, Cured at Low Temperatures — —

the strengthening due to the reduction of the freezing temperature.

When $CaCl_2$ alone is added to the concrete, cured either at normal or low temperatures, the effect is to increase the strength up to about four per cent $CaCl_2$, at which point the maximum strength seems to be obtained. This increase in the strength of the concrete may be due to the acceleration of the setting of the cement by the $CaCl_2$. Serious disintegration was observed on the surfaces of the cubes cured at low temperatures and six, 8 and 10 per cent of the $CaCl_2$. This disintegration did not appear on any of the cubes cured at normal temperatures or where $NaCl$ was also used.

With concrete cured at low temperatures, the best effect seems to be obtained by using both $NaCl$ and $CaCl_2$ in the mixing water. From the curves it is seen that a two per cent $CaCl_2$ and nine per cent $NaCl$ mixture appears to give the most satisfactory results. For concrete cured at low temperatures, this mixture gives about as much strength as any of the mixtures tried, and, for the concrete cured normally, there is not a very great reduction in strength due to the addition of the salts in those percentages.

These tests were made with but one brand of cement. It is probable that there would be some variation in the results with other brands, but it is not thought that this variation would be great enough to affect the general conclusions.

It is also possible that some brands of common salt might contain a sufficiently high percentage of calcium sulphate to affect the results to some extent.

THE GAYLEY DRY BLAST PROCESS.

OLIVER W. STOREY, Ch. E.

In the WISCONSIN ENGINEER for March, 1913, an article appeared under the title of "Air Conditioning." In this article, under the head of "Air Conditioning in the Steel Industry," figures showing the saving to a plant using this device, are given. In the particular test quoted a saving of twenty per cent in coke consumption and an increase of twenty-five per cent in the output of the furnace was obtained. Such a saving is of tremendous importance in the steel industry when we consider that the production of pig iron has reached the rate of 30,000,000 tons per year in the United States.

A blast furnace is so constructed that the air necessary for the carrying out of the reactions, is introduced by tuyeres just above the molten slag in the hearth and into the smelting zone where a temperature of about 2600 degrees F. exists. This blast of air is introduced at a temperature of 800 to 1200 degrees F. being heated in the hot blast stoves, at a pressure of from fifteen to thirty lb. per sq. in. Since it requires about four to five tons of air per ton of iron produced a 500-ton furnace would require nearly one and three-fourths tons, or about 40,000 to 50,000 cu. ft. of air per minute. These figures give an idea of the immense quantities of air consumed in a blast furnace.

When we speak of air we include the moisture which is always found. This moisture content is a variable quantity, being lowest in the winter and highest in the summer, also varying in different localities and from day to day, and from hour to hour. The amount of moisture will run from one-third gal. to two gal. of water per 10,000 cu. ft. of blast. This would mean that with a furnace using 50,000 cu. ft. of air per minute a total of one and one-half to ten gal. of water would be introduced into it.

What is the effect of this water vapor?

The air is blown into the hottest zone of the furnace. When the water vapor strikes the white hot carbon a chemical reaction ensues, the water being broken down by the hot carbon as follows:—

$$H_2O+C=2H+CO.$$

This reaction is not exothermic, that is, heat is not given off as when a piece of wood burns, but is endothermic, heat being required to carry out the reaction, as in the melting of ice.

This heat must be supplied by the surrounding materials and consequently the introduction of water vapor tends to chill the smelting zone and slag. The hydrogen and carbon monoxide partly burn in the upper and cooler zones of the furnace and partly return the heat lost in the lower part but this does compensate for the heat lost in the smelting zone where it is most needed.

Since the moisture content of air varies from hour to hour so the amount of moisture blown into a furnace will vary within wide limits. This variation means that the temperature of the smelting zone will vary a great deal. Such differences in temperature means a poor control of the reactions taking place in the blast furnace smelting zone. The reactions taking place in this zone determine the nature of the pig iron within certain limits. With poor control of these important reactions it will be difficult to control the pig iron.

Take a specific example. A certain blast furnace running high-silicon foundry-iron found it almost impossible to make a satisfactory percentage of that quality pig iron during the summer even with high fuel. Why? A high temperature is necessary for the following reaction:—

$$SiO_2+2C=Si+2CO.$$

The large amount of moisture in the air during the summer months caused such a large absorption of heat for the dissociation of the water that the proper temperature even with a high consumption of coke, could not be maintained.

A second furnace, running on basic iron, produced twenty per cent more in February than in August on a much lower fuel consumption. The running of the furnace was smooth during the winter months while the summer months were marked by "messes," tuyeres closed by slips, and other irregularities, constituting serious additional business losses.

The control of the pig iron analysis is important in any plant and especially where a certain grade of iron is desired. A certain percentage of the pig iron produced will be of the correct analysis while the remainder or "off iron" will vary. If no immediate use is had for this "off iron" it must often be sold at decreased prices and often at a loss. The production of "off iron" often amounts to fifty per cent and higher in the summer months and is due to failure to control the smelting zone reactions.

The relation of the moisture in the atmosphere to the running of the furnace has been known and observed for many years. As long ago as 1800 the desirability of removing moisture from the atmosphere for use in blast furnaces had been referred to in an English publication. It had been the leading subject of the first address of the first president of the iron and steel institute of England.

Truran refers to the influence of moisture on the quality of iron in his "Manufacture of Iron" written in 1862. He makes reference to the increased consumption of fuel in the summer.

Different methods for the extraction of moisture from the air were proposed from time to time. These methods made use of the affinity of desiccated calcium chloride for water but none were a commercial success. The presence of moisture was regarded as a necessary evil which could not be overcome.

Though all agreed that the removal of the moisture from the air would be desirable, the elimination of this water was pronounced by high scientific authority and technical experts to be economically unattainable. In spite of this overwhelming array of opinions, Mr. Gayley went ahead and showed them how it could be done!

But it was not the result of one day's work, or one week's, or one year's, but of six years of patient experiment! As a result of this long series of trials Mr. Gayley gave an improvement to the world which was the most important in iron and steel metallurgy since the introduction of the hot blast.

A short sketch of Mr. Gayley's life will not be amiss.

He was born at Lock Haven, Pa., on October 11, 1855. He began his professional life as chemist for the Crane Iron Company, Catasauqua, Pa., 1877–80. He then became superintendent of the Missouri Furnace Co., St. Louis, and later was the manager of blast furnaces, E. & G .Brooke Co., Birdsboro, Pa., 1880–85. In 1885 he became manager of the blast furnaces at the Edgar Thompson Works, and he later became a managing director of the Carnegie Steel Co. In 1907, he was made first vice-president of the U. S. Steel Corporation, remaining in this position until 1909.

While at the Carnegie Steel Company he carried on the experiments which led to the development of the Gayley Dry Blast.

This achievement has been so notable that Mr. Gayley was awarded the Perkin medal in January of this year. The Perkin medal is awarded annually to a chemist residing in America "for achievements of high value in applied chemistry."

Only a brief outline of the experimental work done by Mr. Gayley will be given. His own account is given in his speech of acceptance of the Perkin Medal. It is indeed a very modest account of the many difficulties which he overcame.

No previous data was available on the drying of large quantities of swiftly moving air. The problem is best stated in his own words,

"I mention that we had to work out the necessary data for a practical demonstration, and the suggestion might arise, why did we not avail ourselves of the experience of refrigeration firms? Indeed, we tried. The proposition was put up to several important makers of refrigerating machinery but without substantial benefit. To refrigerate the air for cold storage rooms was a specification they readily understood but the treatment of a hurricane of air was an entirely different problem to them. We were, therefore, compelled to work out data ourselves and make our own card of estimate."

This problem meant the removal of over 200 gallons of water every hour from air being pumped at the rate of over 40,000 cu. ft. per minute. Theoretical inventors had worked out schemes of precipitating the moisture out by lowering the dew point. This works in a quiet atmosphere, but as soon as there is a wind dew will not precipitate out but is driven away as a fog. The latter conditions would hold in any apparatus attempting to precipitate the moisture in a blast of air.

Mr. Gayley cooled his air to a temperature far below the freezing point and produced a veritable snowstorm. In his own words, "this was delightful on a hot July day." But this did not produce the desired results since the snow would later become water vapor again if not extracted from the air. He could not successfully remove the snow from the air.

Success crowned his efforts when he brought the temperature of the brine in the circulating pipes nearer to the freezing point of water and the frost became fixed on the pipes instead of creating a snow storm.

In 1900 he had plans worked out for a plant capable of treating 40,000 cu. ft. per minute. He then applied for an appropriation of $100,000 to make this installation and "here my most difficult work began—to persuade my associates that moisture in the air could appreciably, even in a small degree, affect the working of a blast furnace."

It was not until 1903 that Mr. Gayley secured his first appropriation and early in June, 1904, the plant was put in operation at the Isabella furnaces at Pittsburg and proved a success.

The results obtained in manipulating the furnace with dried air were often astounding. The importance of blast drying was recognized and many installations have been made.

Not only has the coke consumption been decreased and tonnage increased but the regularity of furnace working and control over product are results which help toward the success of air drying. Some furnaces have decreased their fuel consumption by twenty-five per cent and at the same time increased their tonnage twenty per cent. This is unusual, the usual figures being from ten to fifteen per cent.

But if the heat required for heating and dissociating the moisture of the blast is a small fraction of the total heat requirement of the blast furnace process why does the removal of this heat requirement effect such big economies?

In the operation of the blast furnace there is a certain "critical temperature." The blast furnace working depends upon the supply of heat above this temperature. Therefore the measure of economy is produced by the total available heat above this critical tmperature and not by the total available heat of the blast furnace. That is, a small addition of heat above the critical temperature produces a marked effect in the working of the furnace.

The specific case of the high silicon iron mentioned earlier can be readily explained on the basis of the above reasoning. To produce a high silicon iron requires a high temperature above a critical range. The moisture during the summer time was sufficient to cool the smelting zone to a point where this reaction could only partially take place. By drying the air enough heat was saved to raise this temperature sufficiently to a point where it could take place entirely. A few degrees at the critical point are of great influence.

To illustrate the effectiveness of air drying a writer makes the observation that as soon as the dried blast was started, the tuyeres began to glow like stars and the furnace began to work hotter. No more convincing evidence is needed to show the hotter working of the furnace than the immediate brightening of the tuyeres.

Though the success of drying the air blast has been established, it does not necessarily mean that it could be used and operated successfully financially at every furnace. The apparatus required for such an installation is extensive and costly and the saving in the blast furnace operation must offset the costs attending such an equipment. In moist atmospheres the installation of an air drying plant is financially warranted, but in dry climates as in some parts of Great Britain and Germany the use of this process is not meeting with encouragement.

While the Gayley process has been proven to be a wonderful success this has not deterred other inventors from working along similar lines.

Two recent German patents have been issued, one using calcium chloride in stick form and the other either sodium or potassium hydroxides as the drying medium. The materials are regenerated by heating with the waste gases from the furnaces. These are simply old ideas worked out along new lines.

This invention again illustrates that the hitherto regarded "impossible" has been accomplished though very learned men of science first stamped Mr. Gayley's claims as preposterous. It teaches us again that it is always prudent not to say that "such and such a thing cannot be done" for usually "where there's a will, there's a way" so amply illustrated by this invention.

LIBERAL EDUCATION AND THE ENGINEER.

ARTHUR T. NORTH, '85, University of Illinois, Assoc. M. Am. Soc. C. E.

Social and commercial intercourse between human beings is one of the essentials of civilized existence and any influence which facilitates such intercourse is of vast importance. One function of education is to fit human beings to associate with each other in a manner beneficial to the individual and society at large. Considering the many factors which are a part of the social fabric, it is apparent that all education, regardless of its specific trend, should be as liberal and broad as possible. Intercourse between human beings involves two functions, one being the power to express facts or ideas intelligently and the other is to have the ability to understand such expressions.

The past twenty-five years have witnessed an unparalleled increase of engineering knowledge, two phases of which will evidence this fact; the application of electricity to its legion of uses and the development of the combination of steel and concrete as a form of construction. New processes of manufacturing is evidenced by the production of structural steel, displacing the wrought iron products of twenty-five years ago. The vast increase in wealth makes possible undertakings which were not dreamed of at that time, hence we find that wealth and modern materials and knowledge are co-ordinate factors in the problems confronting the engineer to-day. The requirements of these problems are unlimited and of the most complex nature.

Specialization seems to be necessary but we find that the executive force directing all great projects is one who is a specialist with a liberal education acquired through broad experience and individual effort. It is doubtful whether our faculties of today realize the problems which will confront their graduates, as the principle effort seems to be the dissemination of book knowledge and small effort seems to be made to cultivate the ability to transmit such knowledge to others. Engineering knowledge is fundamentally an adjunct of commerce for it is the basis of all projects of production and construction undertaken by human beings. These projects are directed by the engineer or architect the expenditure of large amounts of capital—that these expenditures be directed intelligently is then a matter of economic importance.

Speaking more particularly of specifications written by architects throughout this country we find the large majority to be crude in expression, ungrammatical, amateurish and often, in parts, conveying no concrete idea whatever—and many of these specifications are known to be written by, or bear the imprint of, men known to have had a technical training. The same condition prevails with specifications prepared by engineers. There are two causes for this deplorable condition; one is the lack of knowledge and the other is the inability to write understandable English. The result is that intelligent contractors add a monetary premium to the amount of the contract, to cover all possible interpretations of an ambiguous specification. An added cost, possibly litigation, is the owners portion as a result of employing an engineer or architect who is incompetent.

The power of expression is an absolute necessity for one who would rise above the ordinary condition and this power is based on the ability to use the English language. If the curriculum does not provide for this knowledge, and by its fruits it evidently does not, then it must be acquired individually. It is as essential for the engineer to be able to transcribe a portion of Tennyson, Keats or Clough into a plain concise statement as it is to be able to determine any factor of a formula. Co-ordinate abilities to express and understand are essential to success.

Another important element of the engineer's training along liberal lines is to take advantage of personal experience and that of others. Professor George Fillmore Swain * recently used this expression: ''In these days, when higher education is a fad, there is an increasing tendency, in my opinion very pernicious, to regard book knowledge as the equivalent of experience. We are more and more inclined to regard those as able to speak with authority, whose knowledge is derived simply from books, who perhaps have spent their lives in a professional chair, with no actual experience in the subject they teach or write about.''

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* President, American Society of Civil Engineers, professor of Civil Engineering, Harvard University. Annual address before the Society at Ottawa, Canada, July 18, 1913.

This is a note of warning that must be observed by those who aim for success. Experience is the great teacher and those who labor possess knowledge not given in books. For example, some persons who operate a wheel-barrow might lay out a system of run ways which could be used with less expenditure of energy (which cost money) than a person who never indulged in that form of recreation and books do not touch on matters of this kind. These practical items, as a whole, are important and have their place in the economical administration of affairs.

If possible, work for a period in personal contact with a man who earns a salary of $15,000 to $20,000 per annum. Observe his methods of separating the essential from the non-essential and learn the true value of things. One in charge of large operations has no time to waste on non-essentials. Academic training is necessary but a large portion of it is useless as applied to every day problems. Let us illustrate by two formulae for the same purpose. In building construction wooden columns range in length from 8′ 0″ to 12′ 0″ and sustain comparatively small loads with stresses from 1600# per square inch reduced downward—a simple, every-day proposition.

One formula reads: $S = C\ (1 - P/80d)$ . . . . (1) in which

S = Allowed unit stress.
C = Compressive strength of timber with the grain.
l = length in inches.
d = least side or diameter in inches.

The other formula reads: $S = P/A[1 + (ec/r^2 + 3/10)\ \mathit{sec.}\ l/Kr \sqrt{FP \backslash AE}\ ]$ . . . . (2) in which

S = Allowed unit stress.
A = Sectional area of column.
c = Distance of extreme fibre from neutral axis.
e = Eccentricity of load.
E = Modulus of elasticity.
F = Factor of safety.
K = Constant depending upon fixity of ends.
P = Load.
r = Radius of gyration.
sec. = Secant.

Remember that formula 2 is to be applied to every day building construction and not to a Quebec Bridge. It is purely an "academic" formula which will consider "fixity of ends," the cumbersome "radius of gyration" etc., for this purpose. In buildings, the ends of columns are universally square bearing and housed in metal caps and sustained laterally by girders and beams. Thousands of columns work continuously in Chicago under formula 1 and they would undoubtedly work as safely under formula 2. No brain which would occupy itself daily gyrating through formula 2 would ever earn $15,000 to $20,000 per annum directing works. All things have their fitness, there is wheat and there is chaff, proportion and value—also common sense and if we possess the latter, let us use it.

An engineer,* in a recent conversation, likened the brain of an experienced engineer unto a beaker containing a saturated solution. By adding various reagents to the solution we get various precipitations. The experiences of an engineer, sometimes sad and sometimes gay; the observations; scraps of disconnected information, gathered everywhere; random thoughts and dreams; continuous study and work; all thrown, without classification, into the breaker and dissolved until the solution is saturated—at this condition one has judgment. The presentation of a problem is analagous to the introduction of a reagent and the successful solving of the problem is accomplished through the medium of the precipitations, otherwise known as knowledge.

Then let us fraternize with our fellow human beings, the high and the low, in so far as may be meet; observe, study and work in the field of our particular specialty and do likewise in other fields as opportunity affords; make frequent excursions into the realm of English literature thus equipped—

> "In gallant trim the gilded vessel goes;
> Youth on the prow and Pleasure at the helm,"

—and bring back cargoes of value and happiness; make all labor a pleasure that it may be effective; be specific, broad and liberal—find ourselves and then we may hope for success.

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* Mr. V. D. Allen, inspector of buildings, Cleveland, Ohio.

GROWTH OF LOCOMOTIVE DEVELOPMENT.

By Dr. Leonard Keene Hirshberg, A. B., M. A., M. D., Johns Hopkins.

Precedent plays as much a part in locomotive design, that the building of these huge, iron behemoths of modern transportation may be said truly to be more evolutionary than kangaroo-like. There are fifty-seven different varieties of reasoning why locomotives change so slightly in nature and organization. Marine engines have expanded in so many directions that relatively speaking the locomotive seems almost to have stood still. Designs for the latter are dictated mainly by the chief mechanical or locomotive engineers of a few great railway companies, who have for the most part arrived at an age of professional position where there is little left to be hoped for from them, unless they enter a new field. There are really no private locomotive firms. If there were, a new impetus would be given the inventions and designs for locomotives.

Marine engineering is open practically to everybody with a mechanical bent, and as elsewhere this competition is the mother of invention. The inevitable and frequent failures make for progress. There is no marine engineering trust, nor do the big steamship companies pretend to design or furnish their own engines. The very existence of a steamship line or marine architect, unlike the railroad, depends upon keeping far ahead of the nearest rival. Only the most fit survive, and those who for example ignore the steam turbine or lean heavily upon some design of oil-engine valve-gear which embodies the long familiar eccentrics and slotted link of the Stephenson reversing-gear, serve only as conservative ballast to the engineering world.

True enough some progress has been made in locomotive building. Size, speed, and capacity have grown apace. Even a thoughtful attempt to meet new conditions and extend the earning capacity of the locomotive has been made. But the ambition merely of improving fuel economy and hauling capacity are not everything.

The search for fuel economy has indeed lead to higher boiler pressures, which in turn strengthened the case for compounding.

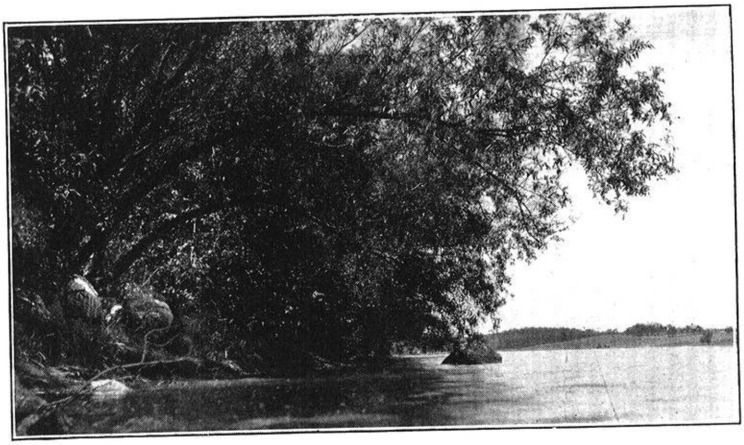
ever remains to be done even with these. Large locomotives have done away with the single driving wheel, even six wheels coupled is now common practice for passenger and ten coupled is far from rare, for heavy freight service. The twenty-six inch stroke is no longer the limit, while the locomotive boiler now often has a flat-topped firebox and a flat-topped steam space about it. Double engines under one boiler are growing in number, while automatic stokers are the rule.

The boiler has been the limiting factor in hauling power, so anything that reduces the demands on it, is obviously as good as making it of larger capacity. Superheating not only reduces the coal bills, but also raises the hauling capacity. The four cylinder locomotive with its better balance of reciprocating parts increases the possibilities of high running speeds. In the main the running speeds are limited by track conditions and industrial considerations, rather than the mechanical imperfections of the locomotive. On the other hand the ordinary steam locomotive has proved itself deficient in accelerating power under heavy service. The large tank engine is a poor way of relief.

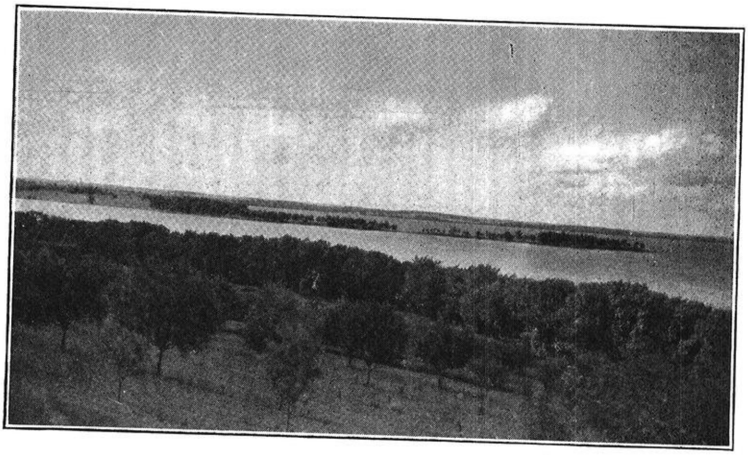
Radical changes are absolutely necessary in spite of the engineering delusion that the steam locomotive has arrived at its final, substantially perfect form. This nonsense has been dispelled from the thoughts of the marine engineer, who thought the same of the vertical triple and quardruple engines, before the steam turbine and the oil-engine came into being. Gas and electric lighting, antiseptic and aseptic surgery have all passed through the same misty, moisty bog of the reactionaries. What is needed then in the case of locomotives, is an extreme change of organism. Maybe the shape will go, perhaps the boiler, perhaps the coal. There may appear a combustion engine burning gas or oil, or a turbo-electric locomotive of heavier, yet different build. Who knows? At any rate, an independent, radical, competive inventor must make his bow to the engineering audience.

CAMPUS ARTICLE

The campus of the University of Wisconsin, ranking first in beauty of all college campuses of the West and middle West, presents a view that is enchanting in its picturesqueness. No matter from what angle viewed, our campus is naturally beautiful. Old Mendota on its entire northern edge lends an enticing charm with scenes along its shore-line such as the one pictured below. (1) These are delightfully numerous to the canoist who lazily lingers in the shadows and to his brother who seeks pleasure in walking under the leafiness of "lovers' lane" and University drive.

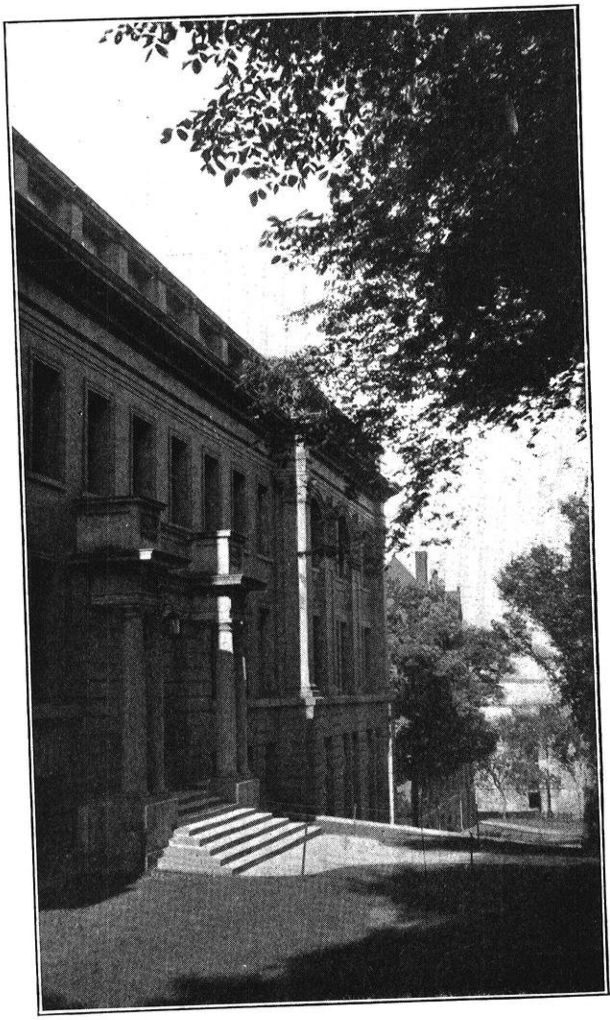


To every one is Picnic Point visible. Even the Agric is allowed the satisfaction that comes to the Hill student or to any of the denizens on the north half of the campus from gazing out of a class-room window at its alluring tranquility. Perhaps the best view of the peninsula is obtained from the top of the toboggan-slide where one sees it from the greatest elevation on the campus. The landscape (2) is thus made to include not only the Orchard and University drive but also the northern shore-line of the lake, a small bit of which helps define the slender neck of land terminated by Picnic Point.



An aid to the general charm of the campus is the location of the buildings. Two avenues of stately structures flank the broad expanse of green ascending the hill to Main Hall. When one considers that the engineering building (3) is located just half way up the incline on the north side, engineers of all classes may

congratulate themselves. For who has not stood in its sunny portals (4) and watched the inter-class-hour procession that for fifteen minutes enlivens the north walk as it does nowhere else around the "U." All go by, from the chemist leaving his dusty retreats in the old Chem Engineering building to the blazee co-ed who flits and sometimes slips merrily by from an hour's ses-

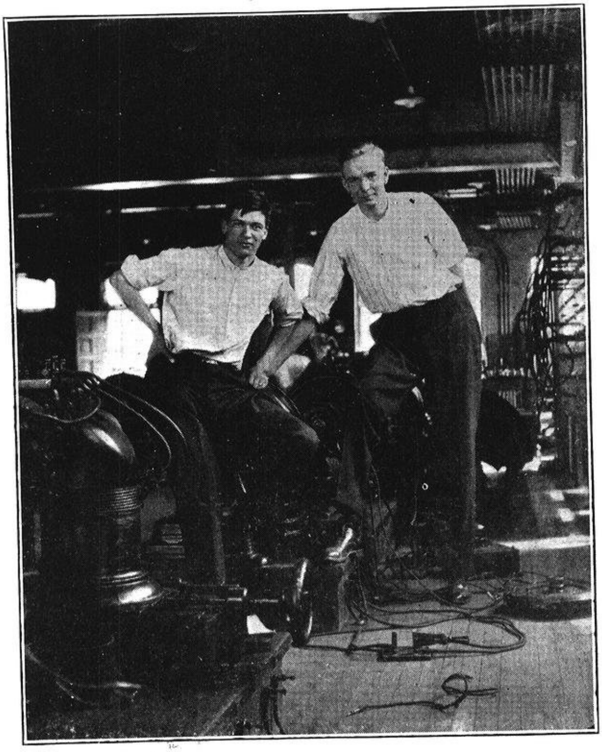


sion with some antiquary on the Hill from whom she has absorbed, seemed to absorb, Greek or Romance language. The engineer may view them all, and he generally does. Sheltered, as has been stated, by the southern exposure, few students in this particular college fail to avail themeselves of the recreation and nicotian relaxation afforded around the engineering entrance. There are other sequestered nooks and "hang outs" here and there about the campus each of which claims a larger or smaller coterie of devotees, but none has the monopoly of convenience, the fitness for the purpose that is associated in the mind of every Engineer Grad with the portals of the building where he got his start.

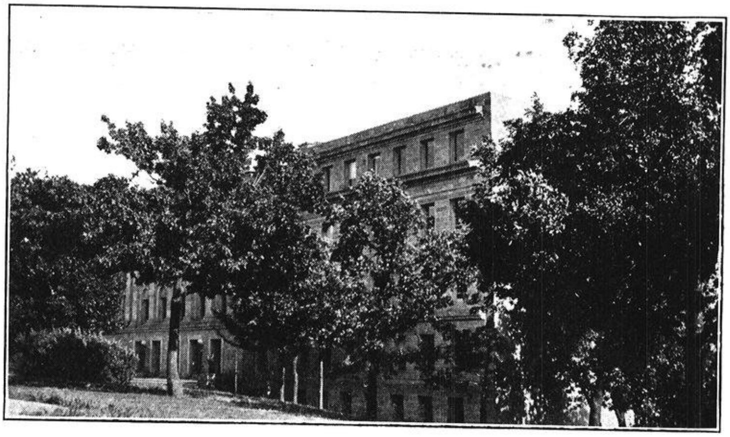
"Got his start," do I say? "Is there work, then, hard work connected with the lives of those who dwell in the Quartiere Latinne of American Venice?" "Yea, verily," comes the answer. Those stately fronts with column and balluster, those ivy-covered ruins of early "varsity" days, all belie their exterior and contain within, cold dreary class-rooms, where toil is master and merriment never enters, what a contrast there is between that lazy group that lounges under trees, smoking and talking, free from care, and this assembly of "Attic Angels" in the hydraulics lab! (5) What a contrast, too, one finds when he thinks of that "fusser" drifting along with fair Margueritte in a canoe, as he gazes at the accompaning snap-shot from the Elec-

trical lab where "Clark" and "Spider" tamper with the "subtle fluid," electricity, and delve in the somber complexities of generator operations. (6) There is a contrast indeed, but the labors of the one are mixed with the pleasures of the other, who, more lucky than he, happened to be "off duty" when the snap-shots were taken.

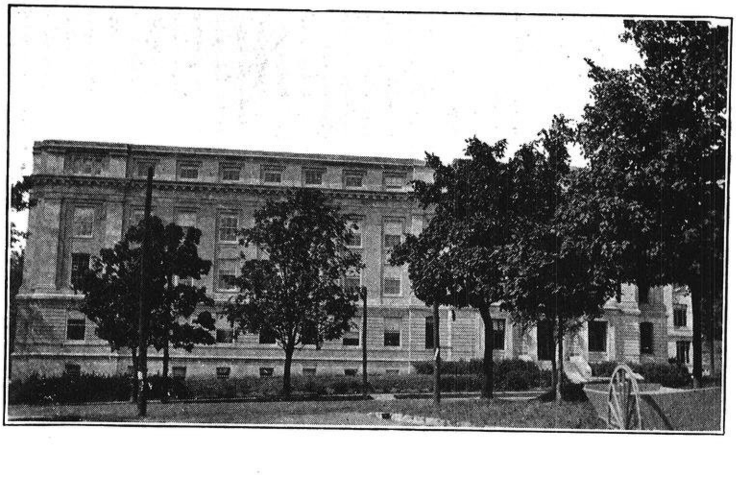
The lastest addition to the south side of the hill approach is the new Biology building. (7) Though not entirely completed since it presents a rather unsightly temporary wall on one end, it nevertheless strengthens the southern half of the upper campus. Behind it and further back among the Agricultural college grounds, new buildings have almost ceased to attract attention so frequently are they erected. The addition to the Chemistry



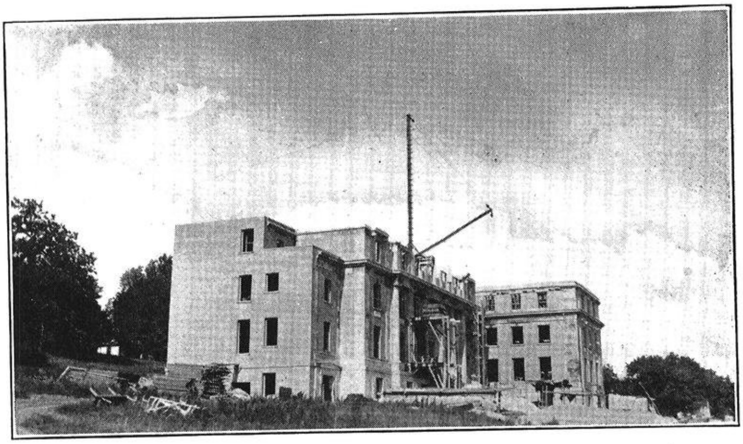
building (8) is deserving, however, of notice, since the engineer must always "do his time" in this department. From the standpoint of facilities this new annex is unrivalled. Its huge main laboratory affording every opportunity for convenient experimentation to seven hundred fifty students at one time, is a great advance over conditions usually encountered.

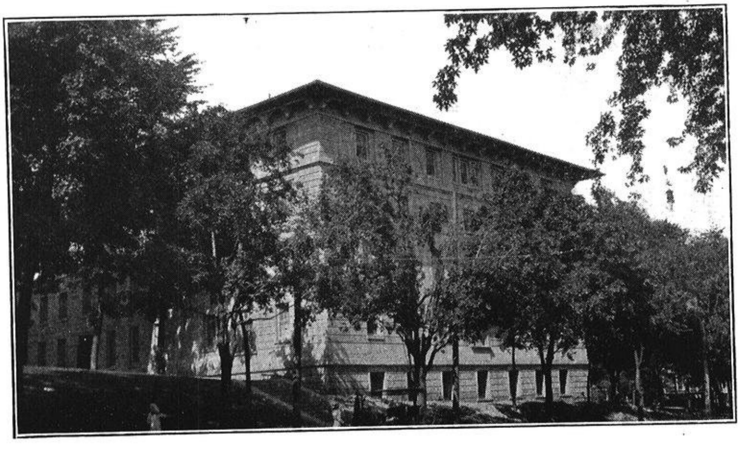


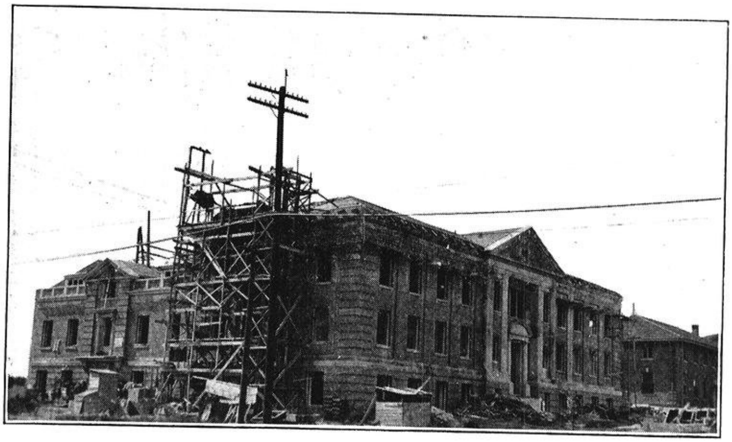
Other new buildings are those for Home Economics (9) a boon to the Agric department, Barnard Hall (10) the girls' new dorm. and the University high school. (11) The University is planning more.



Let them come. There is still room on the campus, there are plenty of places where the introduction of a new edifice of the style Wisconsin has adopted would not be amiss. The only difficulty is the general change that comes with the filling in of old familiar places. It works sad alterations to those who come back after even a few years from their graduation day. Their campus is indeed gone just as our campus will be gone when in a half score years we return to view again our alma mater. For it is the associations, that cluster around the present home of our instruction just as it now exists, that endear the campus to us,







and when in the future day the march of development erases our old landmarks it will destroy the material bodies round which the memory clings and leave us memories alone, memories of the campus as we used to know it. (12)

The Wisconsin Engineer.

John W. Young, General Manager.

C. M. Osterheld, Editor.

The remainder of the positions have been tentatively arranged but will not be announced until the next issue. Tryouts are now being held for some of the minor offices, and anyone interested in the work is requested to speak to one of the above men.

ALUMNI REPRESENTATIVES

J. G. Wray, '93, Chief Engineer Chicago Telephone Co., Chicago, Ill.
A. C. Scott, '02, Professor of Electrical Engineering, University of Texas, Austin, Texas.
A. J. Quigley, '03, Sales Manager, Agutter-Griswold Co., Seattle, Wash.
R. T. Herdegen, '06, A. O. Smith Co., Milwaukee, Wis.
Frank E. Fisher, '06, Electrical Engineer, Diehl Mfg. Co., Elizabethport, N. J.
R. H. Ford, '06, '09, Electrical Engineer, General Electric Co., Lynn Mass.
J. E. Kaulfuss, '08, Instructor of Civil Engineering, University of Maine, Orono, Maine.
M. D. Cooper, '08, Electrical Engineer, National Electric Lamp Association, Cleveland, Ohio.
Hale H. Hunner, '09, Civil Engineer, Oliver Iron Mining Co., Hibbing, Minn.
F. E. Bates, '09, '10, Civil Engineer, Drafting Dept., Kansas City Terminal Ry. Co., Kansas City, Mo.
F. C. Ruhloff, '12, Mechanical Engineer, The Bucyrus Co., So. Milwaukee, Wis.

EDITORIALS.

One often hears the remark that it pays to go into engineering because of the abundant opportunities for rapid accumulation of money. This is the false idea that a majority of the men entertain when they undertake any specialized course. They choose a profession which offers the largest pecuniary inducements; whereas they should be entering the field because they feel a natural adaptation to it, or, because of peculiar fitness they will be of greater service in that vocation then in any other. There is great danger of analizing the wheat of a calling by the appearance of the husks and not by the quality of the kernel; and a prospective candidate for any profession could do well to examine closely to see whether there is not more than a legitimate amount of husks.

The alumni and upperclassmen recall many of the things that disillusioned them in their rosy estimate of the worth of the profession they have entered. We do not wish to discourage you, Beginners, in the pursuit of your chosen work, but we want to warn you of the necessity of having a reason for choosing it. If you have gone over the ground carefully and know that you will like it and that your biggest opportunities lie there, stick to it by all means and accept our welcome. If, however, you are only going into this occupation because some friend has told you that great financial gain will result—get out of it!

The big end in education is to fit us to make a LIFE. The little end is to help us make a living. If, Freshmen, you have come to an engineering college with these thoughts in mind we welcome you gladly and hope that all success may be yours.

But remember, you will be expected as Wisconsin men to be broad engineers; so plan your course accordingly. Take the subjects that make for efficiency and service, in order that, in after life the world may look upon you and say, ''THERE GOES A MAN''

Alumni, we hope you will find that this year's volume of the Engineer is up to your expectation. You are the men that make the Engineer a paper that Wisconsin men will have reason to be proud of—for most of the technical articles deal with the work of graduates. In the past, your success in practice has given our school an enviable reputation. Will you not add to this by making our technical magazine the best in the country? If you see flaws in our work that you have a remedy for, won't you give us a ''tip?'' As Moses had his followers hold up his hands so that the Red Sea would not drown them so we ask you to sustain us so that we may not be overwhelmed by a flood of mistakes. As we start out on a new volume we cannot help but feel that you are with us, and we extend you the hearty greetings of the Engineer.

At the beginning of the college year two classes of students are readily distinguishable in the campus population,—the old student returning to renew his work and the new student who is here to begin his college course. The old student knows about what to expect and falls in line with ease and as a matter of course. He needs little direction and wastes little time in finding his place. A few are a bit too sure of themselves and need a word of caution. The new student is navigating unfamiliar waters and requires time to get his bearings. If diligent he will soon become used to his surroundings and find himself well started on his college journey. If he is careless and postpones the beginning of regular, serious study he is apt to find himself adrift and flowing down stream and a big effort will be necessary for him to recover lost ground. Industry and common sense need to be applied to the situation.

The Engineering faculty, through the Wisconsin Engineer extends a warm welcome to both old and new students and hopes that the work of the coming year will be both enjoyable and profitable.

F. E. TURNEAURE.

DEPARTMENTAL NOTES.

CHEMICAL ENGINEERING

Prof. Burgess has given up active connection with the University in order to go into commercial work. Prof. Kowalke will fill the position formerly held by Prof. Burgess. Though the latter will no longer conduct recitations he will still maintain an advisory interest in the research work of the department.

HYDRAULIC ENGINEERING.

The following men have been elected to fellowships and scholarships, to do work in the Hydraulic Engineering department:

Mr. Harlan C. Woods, Nebraska 1909, Inst. in Civil Eng. U. of Colo., Fellow.

Mr. E. D. Gilman, Wisconsin 1912, Fellow.

Mr. Clifford A. Betts, Yale 1911, Wisconsin C. E. 1913, Scholar.

Mr. Max. F. Rather, Wisconsin 1913, Scholar.

Note, Mr. Woods has resigned to take charge of the Civil Eng. work in Roberts College, Constantinople, Turkey.

Geo. Jacob Davis Jr., Dean of the Engineering School, University of Alabama, spent the summer in Madison preparing bulletins on "*Weirs with Varying Channels of Approach*". The experimental work for this bulletin was done as a thesis when Dean Davis was in charge of the Hydraulic laboratory here, in 1905, 06, 07.

The following men from other colleges, attracted by the splendid opportunities offered by our Laboratory for instruction, were enrolled in courses during the summer:

Prof. Richard S. Kirby, in charge of the Engineering school, College of Pennsylvania, Gettysburg, Pa.

Frank L. Brown, Instructor in Civil Engineering, University of Kansas.

John A. Herrington, Superintendent of the Shops, Texas A. & M. College.

Harry N. Lendall, in charge of the Engineering school Rutgers College, New Brunswick, N. J.

John W. Young, General Manager of the Wisconsin Engineer, was enrolled in one of the Hydraulic courses this summer.

MECHANICS DEPARTMENT.

Mr. J. B. Kommers has been promoted from instructor to Assistant Professor of Mechanics.

Professor Withey has been conducting research work on the aggregates of Wisconsin. Much of the detail work is being done by student assistants.

Mr. H. E. Pulver, whose article appears in this issue has been working all summer to get some data on cement. The cement is peculiar in that it cannot be subjected to water. It is hoped that sufficient data will be obtained to make a valuable article for the Engineer.

STEAM AND GAS ENGINEERING.

With the exception of Prof. C. C. Thomas, and Mr. W. C. Rowse all of the faculty will be back for 1913-1914.

Associate Prof. Thorkelson has been advanced to full Professorship, and will have charge of the department. Assistant Prof. A. G. Christie will be Associate Professor, and will be head of the laboratory. Mr. J. R. Du Priest, of Cornell, will take Mr. Rowse' place.

Prof. and Mrs. Thorkelson and Prof. Christie have been abroad all summer, first attending the meetings of the International Society of Mechanical Engineers in Germany, and then touring around the continent.

EUROPEAN ENGINEERING SCHOOLS

F. E. TURNEAURE, Dean, College of Engineering, University of Wisconsin.

During the year 1895—6, and again during the past winter, the writer had the opportunity of visiting a number of the technical schools of Germany, France, and Great Britain. At the request of the editors of the Wisconsin Engineer there will be described in this article some of the peculiar features of these schools which may be of interest to Wisconsin students.

The German school system, from top to bottom, is so thoroughly organized and so widely known that we naturally turn to Germany when we begin to inquire about any phase of European school systems. So far as engineering schools are concerned, it may be said that the German system has been adopted in several other European countries, notably Austria, Switzerland, Norway and Sweden. In France and England, however, the development of these schools can hardly be said to have followed along the same lines.

The technical school system of Germany is very complete, including schools of all grades, from the continuation school, in which the amount of instruction is limited to eight or nine hours per week, up to the professional engineering school, or technical high school, which is of the same general grade as the University, and which corresponds most nearly to the standard engineering school of this country. Between the continuation school and the technical high school there are large numbers of trade and secondary technical schools, with courses ranging from one to three years in length, and covering a very wide variety of instruction. These secondary technical and trade schools are, from the standpoint of the German industries quite as important as the technical high school. The technical school of secondary grade and the continuation school, have, unfortunately, received very little encouragement in this country up to the present time. This condition will, however, rapidly change in the near future, as many of our states and cities are beginning to make suitable provision for this grade of technical education. For the purpose of this article, we will confine our further attention to the technical high school, or the engineering school proper.

In Germany, and, to a considerable extent, in other European countries, the technical high school is quite separate and distinct from the University, having separate organization and separate maintenance. Generally, these schools are maintained by appropriations from the state, but in Great Britain private endowments and city appropriations have materially aided. Student fees are very small, but under the German system, they are often sufficient to add materially to a professor's salary.

In Germany, there are, all together, nine institutions of the rank of the technical high school. These are located at Charlottenburg (Berlin), Munich, Dresden, Stuttgart, Karlsruhe, Hanover, Brunswick, and Aix la Chapelle. The Swiss school at Zurich and the great school at Vienna are fine institutions, and, for all practical purposes, may be classed as German Schools. In the matter of rank all of these schools are on substantially the same basis.

The entrance requirements are of the same grade as the entrance requirements to the universities, but more latitude is allowed in the preparatory course of study. Thus, for university preparation students must attend the classical preparatory school, in which both Latin and Greek are required. For the technical school, students are accepted from preparatory schools in which neither Latin nor Greek is taught, modern language, science and drawing taking their place.

The preparatory course of study in Germany carries the student somewhat farther than the high school course here, so that the students when they enter the technical school have already completed one or two foreign languages, mathematics up to analytical geometry, and more of history and general studies than is the case in this country. Students are, therefore, much better prepared and more mature than the average freshman in our own schools.

The courses of study correspond very closely to the standard courses of this country, nearly every school having courses in Civil, Mechanical and Electrical Engineering, and very commonly in chemistry and architecture, although all of these branches are not taught in all schools. Mining engineering is provided for in these countries in separate mining schools, some of which are very famous.

The course of study is laid out usually to cover four years, although in some schools a fifth year program is provided. The studies of the course are very similar to those prescribed in American schools, but, owing to the more advanced preparation of the students, the work begins a little higher up and is carried somewhat further. Language is not included, the only general subjects commonly given being economics and, sometimes, a short course in law. German technical schools of all grades appear to teach more of technical detail than would in this country be considered worth while; that is, so many details of practice are taught in the school which we would leave to be acquired in practical work.

To give an accurate idea of one of the courses of study, the following is a brief outline of the civil engineering course at Munich.

First Year.—Higher mathematics, descriptive geometry, experimental physics, experimental chemistry, technical mechanics, principles of construction.

Second Year.— Higher mathematics (including differential equations), strength of materials, graphical statics, building construction, materials of construction, mineralogy, economics, map drawing.

Third Year.—Surveying, foundations, highways, theory of bridges, bridge design, highway construction, water supply and sewerage, building construction, machine design, materials of construction, geology.

Fourth Year.—Land surveying, railway and highway construction, railway yards and railroad operation, bridge design, reinforced concrete, tunnels, hydraulic construction, water supply and sewerage, machine design, estimates and costs.

While the studies are essentially the same as in American schools, the methods of teaching are quite different. There is practically no recitation work, but all theoretical instruction is given by means of lectures, at which the students take careful notes and prepare for examinations from these notes and such reference books as they may wish to consult. To an Americar teacher this seems like a very inefficient method of teaching, especially in the case of mathematics and theoretical studies. It is one which would certainly be a failure in this country, but the greater maturity of the students, and the fact that everyone is accustomed to this method seem to be sufficient reasons why it is reasonably successful. In other respects also, the methods differ greatly from ours. There are no quizzes, and, in fact, generally no semester or term examinations. As a rule, students who desire diplomas pass their examinations therefor in two parts, one at the close of the first two year period and the final at the end of four years, providing he is reasonably diligent and is ready to try the examination. There is, however, no compulsion about it, and students may, as a rule, attend lectures as long as they please without taking examinations. Very often students do not care for the diploma of the school, but instead take state examinations for state positions.

It seems rather odd to see students laboriously copying down long mathematical formulas, as I have seen, for example, in a two hour lecture on hydraulic motors, where the teacher was actually giving his lecture from notes which he had used for several years. I have also seen teachers lecturing in mathematics from a printed book, the students carefully taking down full notes of the lecture. In studies involving design, students are taught to a considerable extent in drafting rooms in the same manner as here. As regards laboratory facilities, European schools until recently have been poorly equipped as compared to American schools, but now there are many fine engineering laboratories to be seen there. At Munich, where the writer visited last winter, a fine new laboratory building had just been completed and the equipment was being installed. Fine laboratories exist also in many of the other schools.

In the operation of these laboratories the student gets much less practice in doing things for himself than is the case here. In physics and chemistry the laboratory work is more like our own, but in the engineering laboratories the work is carried on more in the form of large scale experiments conducted by large groups of students, excepting in the case of advanced students and instructors themselves, who may be carrying on research work. There is much less of regular laboratory instruction given to the regular student than is the case here.

The relations between student and teacher are much less intimate than in American schools. This is partly the result of the lecture system, but is also due to the ordinary and natural relations which exist between student and teacher in all of the schools. The student gets very little opportunity of questioning his teacher, but must get his help as best he can from books and from other students and, to a certain extent, from assistants in the drafting room. On the whole, however, the system seems to fit the characteristics of the German student, and the results are undoubtedly quite satisfactory.

To the writer it was particularly interesting to note any considerable change which might have occurred in German schools during the past seventeen years, since he had a opportunity to visit them in some detail in 1895 and again last year. In the German schools the principal change which has taken place is in the development of better laboratories. At the time of our previous visit there were practically no engineering laboratories for student use in the German schools, but at just about that time a number of reports were being published by German travelers who had been impressed with the laboratory facilities of American schools. In the courses of study comparatively little change has taken place. A few studies, such as reinforced concrete, have been added, and increased attention is being given to the gas engine and to some special lines in electricity. The length of the regular course remains the same, and there seems to be very little tendency to increase it. However, graduate study is increasing and quite a number of doctors degrees are now given every year to advanced students in technical schools.

The attendance in the German schools is very large. The rapid growth in numbers has been somewhat similar to that in this country, but occurred at a somewhat earlier date. In 1893 the total attendance in the German and Swiss schools was about 7600, but in ten years it had risen to 18700. Since 1903 the increase has been very much less rapid, and in some schools there has been a decrease. The industrial growth of Germany during the past twenty-five years has given rise to a great demand for technically trained men, and it is interesting to see how the very large numbers of engineering students from technical schools of all ranks are absorbed in the German industries. The writer was told by the Director at Munich that most of the students who complete the work there find little difficulty in securing a position. A good many go to foreign countries, particularly South America.

Foreign technical schools do not have machine shops, but it is a common practice to require at least one year of shop experience of mechanical and electrical engineering students before a diploma is given. This matter of shop experience has been very frequently discussed in English and German Societies, and it is yet quite undecided as to whether this shop experience is more valuable when taken before or after the technical course.

British technical schools have undergone a very much greater change during the past fifteen years than the German schools. At the time of our previous visit there were not more than a half dozen institutions in Great Britain where a student could get a technical education equivalent to a four year course in an American school. At the present time, however, there are at least a dozen well equipped engineering schools of a grade substantially the same as the standard American school. The development of these schools has in this time been very rapid, and the money available seems to be very ample for all needs. The nature of the course and requirements for admission and graduation are more nearly like the American school than the German school. Laboratories are well equipped and conducted much after our own fashion, but the lecture system for theoretical work is quite generally employed.

The number of students in English schools is very much smaller than in Germany. In fact, the facilities offered in English schools seem to be out of proportion to the number of students. In two or three of the cities which the writer visited, the attendance in each place was about 100 to 150 engineering students, all told.

One of the causes of the marked difference between the number of students attending British and German schools is undoubtedly the fact that in England the principal industries came first and the schools afterwards, while the reverse may be said to be the case in Germany. German industries have been created largely by technically trained men, and these men naturally know how to use the product of the schools. In England it is comparatively difficult for technical graduates to find employment, and in many cases they are obliged to go through precisely the same apprentice system as the uneducated employee. The custom is often still followed, even in civil engineering, of the college graduate paying a fee to his employer to allow him to enter his office as a student or apprentice in order to learn the practical side of the work. These conditions are not such as to encourage large numbers of young men to study engineering in school, and many of those who graduate emigrate to Canada or some of the English colonies to find employment.

French technical schools are not as well known abroad as the schools of Germany, and, indeed, are not nearly as numerous or as largely attended. It is interesting to know, however, that France was the first to establish a school of civil engineering, the famous School of Roads and Bridges at Paris being founded early in the nineteenth century. This school was established and is still maintained to furnish civil engineers for government positions on river and harbor work and on the state highways and railways. It is conducted in a manner somewhat similar to our West Point school for military engineers, in that the students are selected by examination, and as soon as they enter the school they receive a small compensation. During vacation periods and after graduation they are employed by the government.

There are other engineering schools in Paris and elsewhere in France which train young men for the various kinds of engineering practice, but it may be said that French industries are such as to demand very much smaller numbers of technically trained men than those of Germany. Schools of high rank are few in number, and neither in attendance nor in the work of the members of the faculty have they acquired the reputation of the German schools.

The writer is often asked the question if it is worth while for the student who has graduated from an American school to spend a year in Germany. In answer to this, he believes that, so far as actual instruction is concerned, the American school is much better adapted to the American student and American conditions than is the German school, and that even for graduate study there is not much to be gained directly in a foreign school. Foreign travel is, of course, interesting and profitable in many ways, but it is believed that such travel and study will be more profitable to a young man after he has spent some years in practice and is in a position to understand and appreciate foreign practice along his particular line. On the whole, we believe it to be true that the German school is best adapted to the German student and German conditions and the American school to the American student and American conditions.

ALUMNI NOTES.

Robert L. Stiles is with the John Deere Plow Co. of Moline.

C. D. Vaughn is drafting for the McClintic Marshall Construction Co. at Pittsburg.

Lester L. Stoddard is a student engineer with the General Electric Co. at Lynn, Mass.

George A. Scarcliff is with the Brazilian Iron & Steel Co., at Ouro Preto, Brazil.

E. P. Abbott, '08, is a field engineer with the Willamette Iron & Steel Works, in Fresno, California.

Roy L. Dodd is with the Milwaukee Electric Railway & Light Co.

Ralph E. Moody is with the Milwaukee Electric Railway & Light Co.

Robert H. Johnson is with the General Electric Co.

Jesse E. Miller is Superintendent of the Electric Light & Power plant at Brodhead, Wis.

J. K. Livingston is in the Commercial Engineer's office of the American Telephone & Telegraph Co. in New York City.

John R. Manegold is also in the above office.

John W. Griswold, and Floyd M. Rosenkranz are with the Denver Gas & Electric Co.

Jesse L. Brenneman and G. Roland Kuhns are taking the apprentice course in the General Electric plant at Schenectady.

Walter F. Nickel is with L. G. Arnold at Chippewa Falls, Wis.

Andrew Seifert is in the U. S. Army Engineers Service at Rock Island.

S. D. Wonders is with the Armstrong Cork Co., at Pittsburg.

E. Phelps Langworthy is doing some steel refining at Buchanan, Mich.

Roscoe F. Ballard is with the Riter-Conley Co. at Pittsburg.

Richard A. Corbett is with the International Harvester Co. in Milwaukee.

Alfred C. Kelm is a power plant engineer with the Municipal power plant at Idaho Falls, Idaho.

Carl R. Findeisen is with the traffic department of the Chicago Telephone Co.

The alumni are urged to send news of their whereabouts so that we may be able to keep our alumni department right up to date. A great many changes usually take place in the summer time, and we expect to have a raft of announcements for the next issue.

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the word in the old sense, as a place where the degree of A. B. or A. M. may be secured. There is sore need of high schools whose aim is to prepare students to take engineering courses.

The above editorial is reprinted exactly as it appeared in the September 3 issue of Engineering & Contracting. We wish to thank the above publication for their courtesy. During the past summer the Manager has been in communication with some of the biggest engineers in the country, and this question has been discussed at length. The men, almost without exception, acknowledge that the average engineering graduate is ignorant of practical business. Their advice is to stay with the engineering course, but to combine with it as many of the above mentioned "business studies" as possible. We cannot second that advice too strongly, and we recommend every underclassman to have a good talk with his adviser, or some of his instructors, and find out just how much can be done toward arranging his own course to this end.

Watch for them

The following are just a few of the men who will write for **The Wisconsin Engineer** in the coming winter.

F. E. Turneaure,
L. K. Hirshberg,
W. Chisholm,
D. E. Foster,
L. V. Ludy,
O. W. Storey,
F. E. Fisher,
H. Martin,
H. J. Thorkelson,
V. Karapetoff,
M. D. Cooper,
E. R. Maurer,
J. W. Shuster,
A. C. Scott,
C. I. Corp,
E. Bennett,
H. E. Pulver,
A. T. North,

We have some of the most prominent men in the country writing for us next year, and the articles they are preparing are almost all from brand new material on subjects that are interesting the Engineering world at the present time. No matter who you are, Professor, Instructor, Practicing Engineer, or Student you can't fail to find a wealth of valuable reading in these articles. Just drop us a postal, and have the Engineer come regularly every month.

FRESHMEN:—**The Wisconsin Engineer** is recommended by every man on the Engineering faculty, ask them about it.

The Wisconsin Engineer

Our motto—"To give all we can for what we get."

AN ANNOUNCEMENT.

In keeping with our policy of "Giving all we can for what we get," we are going to establish an "Advertisers News Department." In this section, which will be conducted by Mr. Young, we will endeavor to publish newsy items regarding our advertisers that will be of general interest, not only to our readers but to our advertisers also. We trust that you will co-operate with us in sending in new bulletins, unusual contracts or developments, and pictures of special work. We publish the fifteenth of the month, and through a special arrangement with our printer all material received up to the seventh will be on time for that issue.