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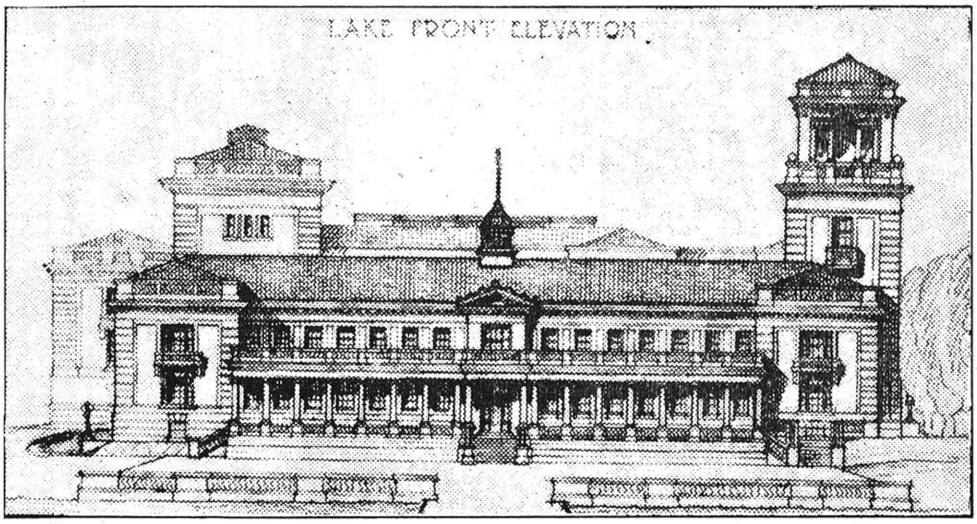

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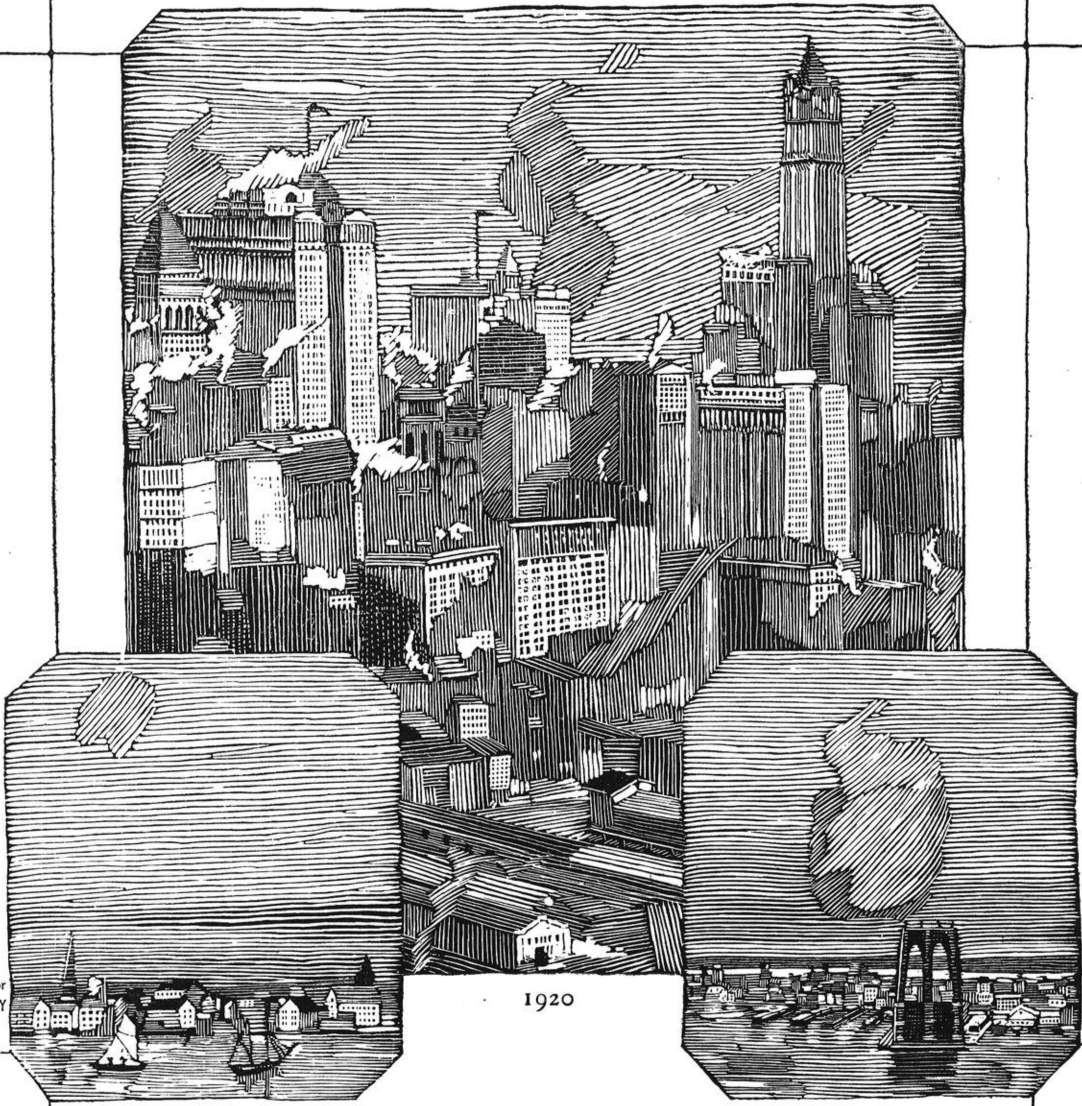

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The Wisconsin Engineer

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UNIVERSITY OF WISCONSIN

VOL. XXVI, NO. 2 | MADISON, WIS. | NOVEMBER, 1921.

DECIMAL POINT DETERMINATION IN SLIDE RULE OPERATION

JAMES THERON ROOD,

Professor of Electrical Engineering

Of the tremendous army of engineers using the slide rule to a greater or less degree, very few are able to readily and accurately locate the decimal point in the series of figures obtained in even the simplest of slide rule operations. Where the calculation is simple, involving simple multiplication or division only, the position of the point is usually obtained by guess work or else by some approximation method, worked either mentally or on the fingers. If the computation is a multiple term multiplication, division or combination of both, such as an extended, complex fraction, these methods generally fail and the computer is left in uneasy doubt as to whether or not he has rightly guessed where the point should be. Further, the time required for these approximation methods is often so great that the actual time taken in determining the correct row of digits in the answer may be the least part of the operation.

> TRY THIS ON YOUR SLIDE RULE
>
> **If the total minutes lost daily through use of inefficient methods of placing decimal points were multiplied by 800, the approximate number of rules in this school, how many man-hours per day would be found wasted? Second: Because of inaccuracies due to the same inefficient methods, how many grade points are lost per school year? In this article Prof. Rood points out the absurdity of using these slipshod methods and offers to students and other readers a method which has been proved thoroughly practical.**

That this is poor engineering as well as poor efficiency must at once be admitted. That it tremendously limits the use as well as the usefulness of the slide rule in engineering offices is well known to every expert practicing engineer. There are, indeed, many offices where the use of the slide rule is strictly prohibited, since too much danger to life and limb as well as to invested dollars may arise from a misplaced decimal point.

Such inaccuracy and uncertainty is absolutely unnecessary, even in the most complicated arithmetical operations. There is no good reason why the slide rule should not be used in any engineering calculations unless very close precision is demanded, greater than that which can be had with a slide rule. Even this objection can be questioned in most cases. An accuracy of better than one-tenth of one per cent should habitually be had with the ten-inch rule and one of the order of a twenty-fifth of one per cent with the twenty-inch rule, even without the use of the cylindrical lens on the cursor. Further, a very considerable number of engineering computations are based primarily upon values resulting from observations that have themselves been obtained with common types of measuring instruments, the readings of which are very seldom reliable to a tenth of one per cent and very often not reliable to better than one-fifth of one per cent. One of the absurdities encountered time and again in computation work is that of seeing calculations based upon such uncertain data carried out to the third or fifth decimal point by laborious hand or calculating machine operation.

A simple, quick method is available for determining the location of the decimal point with absolute exactness in even the most complicated computations. This method can be readily understood and applied, can be used with every type of slide rule operation and with it available there is no excuse for the restricted and half hearted use of the slide rule that exists at present among engineers.

I. Multiplication. Fundamental Theory. If the rule is set for the following simple two-figure multiplications

$$\sqrt{}\ \ \sqrt{}$$
$$2 \times 8 = 16 \qquad (1)$$
$$\sqrt{}\ \ \sqrt{}$$
$$2 \times 80 = 160 \qquad (2)$$
$$\sqrt{}\ \ \sqrt{}$$
$$2 \times 8{,}000 = 16{,}000 \qquad (3)$$
$$\sqrt{}\ \ \sqrt{}$$
$$2 \times 0.8 = 1.6 \qquad (4)$$
$$\sqrt{}\ \ \sqrt{}$$
$$2 \times 0.0008 = 0.0016 \qquad (5)$$
$$\sqrt{}\ \ \sqrt{}$$
$$0.2 \times 0.008 = 0.0016 \qquad (6)$$

the following points will be noted. First, in all these operations the slide projects to the *left* of the rule and this is true independent of the order of taking the numbers as well as whether the top or bottom scales are used. That is, it makes no difference which number is set on the rule and which on the slide, or whether the

A-B or C-D scales are used. Second, in examples (1) to (4), inclusive, the number of places or digits in the answer to the left of the decimal point is equal to the sum of the number of digits to the left of the decimal point in the two numbers multiplied together. Third, in examples (5) and (6) the location of the point will be found by counting the number of positive digits, those to the left of the decimal point, in either of the numbers and from it subtracting the sum of the number of zeros to the right of decimal point before the first significant figures.

The negative number will be the number of zeros to the right of the decimal point before the first significant figure in the answer.

Similarly with the multiplications

√ –
2 x 4 = 8 (7)
√ –
2 x 40 = 80 (8)
√ –
2 x 4,000 = 8,000 (9)
√ –
2 x 0.4 = 0.8 (10)
√ –
2 x 0.0004 = 0.0008 (11)
√ –
0.2 x 0.004 = 0.0008 (12)

the following points will be noted. First, the slide projects always to the *right* and this is again true independent of the order of setting the numbers as well as of the scales used. Second, in examples (7) to (10), inclusive, the number of digits to the left of the decimal point in the answer is *one less* than the sum of the digits to the left of the decimal point in the two numbers multiplied together. Third, in examples (11) and (12), the location of the point will be found by counting the number of positive digits in either of the numbers and from it subtracting the numbers of negative zeros, those to the right of the decimal point before the first significant figure. Add one to this negative number and it will be the number of zeros to the right of the decimal point before the first significant figure in the answer.

Multiplication of Two Numbers. (1) If either of the numbers is raised to fractional power or root, replace it by its evaluation. (2) Start the multiplication with either of the numbers, placing above this number a positive check (√). (2) Set the slide to multiply by the second number and read on the rule the digits series resulting. (3) Over this second number place a positive check (√) if the slide projects to the left beyond the rule and a negative check (—) if the slide projects to the right. (4) For the positive count add up the total number of digits to the left of the decimal point in the two numbers. (5) From this positive count subtract as negative count, (a) one for the negative check, if there is one over the second number, (b) the sum of the zeros to the right of the decimal point before the first significant figure in either of the numbers if they are decimal fractions. (6) The resulting difference (algebraic sum) will be, (a) if positive, the number of digits in the answer to the left of the decimal point, (b) if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer. The positive checks are not counted but should be placed over the numbers to be certain that each number has been used as an operator.

If there is any question about remembering which projection gives the positive check and which one the negative, it is a simple matter to scratch a positive check (√) on the right hand end of the rule, darkening the scratch with ink if desired, and to put a similar negative check (—) at the right hand end.

The counts for the problems given are as follows:

	Example Number											
	1	2	3	4	5	6	7	8	9	10	11	12
Count:												
Positive digits	2	3	5	1	1	0	2	3	5	1	1	0
Negative: sum of												
(a) negative checks	0	0	0	0	0	0	1	1	1	1	1	1
(b) zeros to right of point	0	0	0	0	3	2	0	0	0	0	3	2
Result:												
Positive: digits to left of point	2	3	5	1			1	2	4	0		
Negative: zeros to right of point					2	2				0	3	3

This rule may be extended and applied to multiplication of any number of terms. Start with anyone of the terms, placing a positive check above this term. Alternate the setting of the slide and the hair line of the cursor, reading on the rule, after the last multiplication, the resulting digit series. Place above each of the numbers as used a positive or negative check according to whether the slide projects in each case to left or right. The order of multiplication of the terms is immaterial. Example:

√ — √ √ —
125.63 x 47,937 x 0.0000094 x 0.00305 x 1,384,792 = ? (13)

Digit series 2391

Count:	Pos.		Neg.
Positive digits	15		
Negative checks			2
Negative zeros			7
	—		—
Result:	15	—	9 = 6

Answer: 239,100.

Multiplication of Several Terms: (1) If any of the terms are raised to any fractional power (root) evaluate them before proceeding with the multiplication. (2) Start with any one of the terms, always placing above it a positive check, and setting on the body of the rule. Set the proper end line of the slide over this number and place the cursor line opposite any second term, set on the slide. Against this term place a positive or negative check according as the slide projects to the left or right hand of the body of the rule. (3) Leaving the cursor untouched, place the proper end line of the slide under the cursor line, then move the cursor along the slide until it registers over a third term, read on the slide. Continue in this way until the last multiplication is made, placing a proper check against each term. Read the digit progression on the A or D scales, according to whether the A-B or C-D scales have been used. (4) In case a term is raised to an integral power (a) use this term as many times as a multiplier as its power, placing against it a proper check for each time it is so used, (b) count its positive digits or its negative zeros over as many times as the given power. (5) Count the positive digits, those to the left of the decimal point. From this subtract the sum of (a) all the negative checks, (b) the negative zeros, those before the first significant figure to the right of the decimal point. A positive difference gives the number of digits to the left of the decimal point in the answer, a negative difference gives the number of zeros to the right of the decimal point before the first significant figure in the answer

Examples:

$\sqrt[3]{85} \times 62.5 \times \sqrt{3} \times 550 = ?$ (14)

√ √ - √

$4.38 \times 62.5 \times 1.732 \times 550 = ?$

Digit progression 2609

Count: $7 - 1 = 6$

Answer: 260,090.

√ -√- √ √-√ -

$1.25 \times (3.14)^3 \times (0.00625)^4 \times 2{,}365{,}192 = ?$ (15)

Digit progression: 1397

Count: $11 - 11 = 0$

Answer: 0.1397

II. Division. Fundamental Theory. If the following simple divisions are performed on the rule

$\dfrac{\overset{\surd}{40}}{\underset{\surd}{5}} = 8$ (16) $\dfrac{\overset{\surd}{50}}{\underset{-}{4}} = 12.5$ (21)

$\dfrac{\overset{\surd}{4}}{\underset{\surd}{5}} = 0.8$ (17) $\dfrac{\overset{\surd}{5}}{\underset{-}{4}} = 1.25$ (22)

$\dfrac{\overset{\surd}{4}}{\underset{\surd}{50}} = 0.08$ (18) $\dfrac{\overset{\surd}{5}}{\underset{-}{40}} = 0.125$ (23)

$\dfrac{\overset{\surd}{0.04}}{\underset{\surd}{.5}} = 0.08$ (19) $\dfrac{\overset{\surd}{0.05}}{\underset{-}{4}} = 0.0125$ (24)

$\dfrac{\overset{\surd}{0.04}}{\underset{\surd}{0.005}} = 8.0$ (20) $\dfrac{\overset{\surd}{0.05}}{\underset{-}{0.004}} = 12.5$ (25)

the accompanying rule for simple division is readily established.

Simple Division. (1) If either of both terms are raised to fractional powers, evaluate them first. (2) Against the dividend (numerator) place a positive check. Set this number on the rule (D or A) by the aid of the cursor. Under the cursor line set on the slide (C or B) the divisor (denominator), placing against it a positive or negative check according as the slide projects to the left or right. Read the resulting figures on the rule (D or A). (3) As a positive count sum up (a) the positive digits in the dividend, (b) any negative check against the divisor, and (c) any negative zeros in the divisor. (4) As the negative count add (a) the positive digits of the devisor, (b) any negative check in the dividend. (5) The algebraic sum gives, (a) if positive, the number of digits to the left of the decimal point in the answer, (b) if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer.

This can be enlarged to cover extended fractions of the type so frequently met with in engineering computations. It is this type of equation that shows the slide rule in its greatest saving of time and energy. It is, however, the type of calculation that a large percentage of engineers can not correctly perform on the slide rule.

√

4.472 — √ -- — √ —— √

—

$\sqrt{20} \times (17.8)^4 \times 1{,}874{,}900 \times 0.000945 \times (0{,}00018)^3$

$(3.14)^2 \times 33{,}000 \times (84{,}950)^3 \times (0.0000015)^2 \times 8{,}450{,}000$

-√ - √ √ √ - - √

Digit progression: 1223

Count:	Pos.	Neg.
(1) Positive: sum of		
(a) positive digits in numerator	16	
(b) negative checks in denominator	4	
(c) negative zeros in denominator	10	
(2) Negative: sum of		
(a) positive digits in denominator		29
(b) negative checks in numerator		6
(c) negative zeros in numerator		12
	30	— 47 = -17

Answer: 12.23×10^{-16}

Extended Fractions. General Rule. (1) If there are any terms raised to a fractional power, obtain the evaluation and substitute it for the term. (2) Start with any term in the numerator, placing a positive check above it always. (3) Multiply this number successively by the other terms of the numerator, taken in any order, placing above each term a positive or negative check according as the slide projects to the left or right when that term is used as an operator. (4) When the last term in the numerator has been used as a multiplier, move the cursor to bring the hair line over the end line of the slide, then set any term of the numerator on the slide under the cursor line, placing a positive or negative check against the term according to the projection of the slide. Then divide successively by the remaining terms of the denominator, giving to each term its proper check. Read on the rule the final digit series. (5) In case any terms are raised to an integral power, use this number as multiplier or divisor as many times as the indicated power, (a) putting a proper check against the term for each time it is used as an operator, (b) the positive digits or negative zeros, as the case may be, are to be counted as many times as the power. (6) To obtain the point location, take the algebraic sum of the positive and negative counts, obtained as follows:

(a) Positive count: sum of—
- (1) positive digits in numerator
- (2) negative checks in denominator
- (3) negative zeros in denominator

(b) Negative count: sum of —
- (1) positive digits in denominator
- (2) negative checks in numerator
- (3) negative zeros in numerator

If the sum is positive it represents the number of digits to the left of the decimal point in the answer, if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer.

Extended Fractions. Alternate Method. A variation upon the last method is to alternate the operation of multiplication and division, taking the terms alternately from numerator and denominator, in place of multiplying all the numerator terms then dividing by the denominator terms. The positive and negative checks and the method of count is the same. (1) After evaluating all root terms, set any one of the numerator terms on the rule by means of the cursor, then set any one of the denominator terms on the slide under the cursor line. (2) Now, without changing the slide, move the cursor until the line lies over another numerator term read on the slide. (3) Move the slide to bring another denominator term under the cursor line. Proceed in this manner, setting cursor, slide, cursor, slide, taking the numbers from numerator, denominator, numerator, denominator. Any excess terms left in numerator or denominator will have to be used as final multipliers or devisors as in the previous method. The only advantage of this method is that it shortens the time through decreasing the number of sets. It is, however, more liable to error in the hands of the beginner.

III. Reciprocals. The evaluation of reciprocals follows the general rule for fractions with one additional point to be strictly regarded; the *left hand* end line of the rule must be taken for the unity numerator. If the right hand end line is taken and the first divisor set against this, the digit series will be correct but the point count will place the decimal point one digit out of place. Examples —

(a) using left end; correct position of point,

$$\frac{\overset{\checkmark}{1}}{\underset{\checkmark}{25} \times \underset{-}{0.02} \times \underset{\checkmark}{5}} = 0.4 \qquad (27)$$

$$3 - 3 = 0$$

(b) using right end; incorrect place of point,

$$\frac{\overset{\checkmark}{1}}{\underset{-}{25} \times \underset{-}{0.02} \times \underset{\checkmark}{5}} = 4.0 \qquad (28)$$

$$4 - 3 = 1$$

By writing out a number of examples, the rules for extended multiplication and for complex fractions can be quickly learned. The increase in speed of solving such equations and the feeling of certainty as to the location of the decimal point will repay many thousand fold the time and energy required to make these simple rules a part of the engineer's equipment.

THE ENGINEER, A DOER

From an address by Gov. Neff of Texas

The engineer is the wonder worker of the world. What others dream, he accomplishes. What others visualize, he brings to fruition. What others imagine, he makes real. What others put into words, he works into deeds. What wild forces of nature others only admire, he tames to do man's bidding. He is the wizard of workers, and subdues the elements of earth and sea and sky.

From the building of the pyramids to the digging of the Panama Canal there has been amid the achievements of peace no obstacle too difficult for him to surmount. From changing an ancient river channel that turned, in a night, the tide of battle, to the construction of the breastworks that immortalized the fields of France, there has been amid the victories or martial conflict no problem that involved the life or death of a nation that he has not solved.

He is a man of vast and varied intellectual accomplishments in the field of human service. He harnesses the forces of the flowing streams and thus distributes through electric current, light and heat and power. He drains the swamps, destroys the abiding places of disease, lays out cities, constructs irrigation systems and makes the desert blossom as the rose. He tunnels the mountains and bridges the streams, as he builds railroads, highways and waterways. He lays the pulsing cables and stretches the reverberating wires under the deep sea and through the viewless air, and makes neighbors of all the sons of men, and turns the busy world into a whispering gallery. He plans and builds and digs and delves and dives and toils, and the inhabited earth is resonant with the music of his labors.

THE COURSE IN CHEMICAL MANUFACTURE

M. A. HIRSHBERG,
Senior Chemical

"Moon-shining" will be your comment when you reach a certain part of this account. But, seriously, students taking Prof. Kowalke's practical course learn many details of actual commercial chemical manufacture, making the course highly valuable to them after leaving school.

No history of 1921 would be complete without a full account of the Chemical Engineers' summer course in Chemical Manufacture. In brilliant research, and successful endeavor, the work may not have been better than that of previous years, but a more realistic practical shop experience than ever before was gained by the men. This was due to the fact that the number of students was much larger than in any previous year, and the spirit of co-operative good fellowship was at its best.

Five minutes after the last examination of the regular spring term was written, the forty ambitious chemicals gathered about Professor Kowalke, the "Boss", and listened to the words which spelled their fate for the next five weeks. In a real heart-to-heart talk, warning was given that any "boners pulled" would be held up to the ridicule of the rest of the gang during the discussion period at the beginning of each day's work. At this Pekofsky and Kellet were seen to grow pale, but looked happier when they were told that it was expected and quite usual for some members of the class to furnish amusement for the rest. The various problems were assigned, and partners chosen. Rau and Ledin did a dance of joy just after that first class was dismissed; they were assigned the job of distilling pure grain alcohol from waste residues obtained from the pharmaceutical experiment station. Bulfer and Anderson went around taking orders for soap, which they were to make from grease brought over from the Lathrop kitchen. Drew and Hubbard—the twins—were to manufacture a blue pigment and promised to produce enough to paint forty rows of blue Sundays. A good many of the remaining thirty-four simply scratched their heads, and wandered around with a dazed expression on their faces, as though they had just attended a lecture rendered in the original Arabic.

Thirty minutes later, and for three or four days thereafter, Mr. Volk, in the library, was overpowered by this eager throng of reference hunters. Every book in the library pertaining to chemical engineering, or allied subjects, was ransacked for methods of analysis. Never before in the history of the engineering library was there such a great demand for books. Ancient files of "Chem & Met", and even the encyclopedia were perused. When all of these failed to produce desired results, the Boss was appealed to for aid. A broad smile and the question, "Well, what do you think about it?" usually was the only assistance offered. All of this taught the men to be independent and to stick to their guns until the problem was solved without outside help.

At eight o'clock every morning the class held a conference, and heard of their misdeeds of the day before. At one of these, the midget of the class got sidetracked, and insisted that Great Salt Lake was even more treacherous than Mendota, and differed from all other lakes because the head of a would-be swimmer had a tendency to sink while nothing could keep his feet from floating on top. In spite of a few flights like this, the gang was unusually sane, and certainly did no more foolish things than any previous class. The summer was very hot, and the sun beat down unmercifully, heating the ground to a temperature high enough to cook eggs to the correct degree of hardness. One of the boys conceived the idea of making

(Concluded on page 30) 32

CLASS IN CHEMICAL MANUFACTURE, 1921
The spirit of co-operation and good fellowship was at its best.

AN EXPERIMENTAL STUDY OF GAS TURBINE CHAMBERS AND NOZZLES

GLENN B. WARREN,
Wis., m '19

Continued from the October Issue

Calculations

The results of each run were based on an average of the eight readings taken every two minutes over a period of fourteen minutes as described in the preceding paragraph. The differences between the weights of the water and fuel tanks at the beginning and end of the fourteen minute periods were taken respectively as the total water and fuel consumed during the run. These were checked against the rate of flow as determined by the readings taken every two minutes.

The air flow was determined from the average of the readings of the Venturi meter pressure, temperature, and pressure difference at the inlet and throat. The method of calculation and coefficients used are given in a paper by the writer referred to in a previous paragraph.

The total weight of fluid passing through the nozzle per second was then the sum of the air, fuel, and water flows.

Inasmuch as the reaction of a jet leaving a nozzle is given by the product of its mass per second and its velocity, the reaction is

$$R = MV = \frac{W}{g} V \tag{1}$$

where R is reaction in pounds per second

M is mass and equals $\frac{W}{g}$

W is weight in pounds

g is 32.2

and V is velocity of discharge in feet per second when a final equalization of pressure between the issuing jet and the surrounding medium has taken place. From this equation it was, therefore, a simple matter to determine the value of the exit velocity when we have determined experimentally the reaction and the weight flow.

Knowing the velocity of the jet the kinetic energy per pound of products of combustion and water vapor can be determined from the well known equation

$$E = \frac{V^2}{2g} \tag{2}$$

where E is kinetic energy of jet in foot pounds.

From the thermocouple readings the temperature in the combustion chamber could be determined, and from the pressure gage and the barometer the pressure ratio through which the nozzle was working could be obtained. Knowing the total weight of products of combustion and water vapor passing the nozzle per second, and the weight of fuel used together with its heating value, it was possible to calculate the heat put in per pound of gas and vapor passing the nozzle. The kinetic energy of the jet in B. t. u. divided by the heat put in would then give the overall efficiency of the nozzle and combustion chamber for the used conditions of pressure ratio and initial temperature, neglecting the energy put in by the air compressor, fuel and water pumps. It is this value which is to be compared with the theoretical efficiency for the same initial temperature, pressure, and composition of gas in determining the "efficiency ratio."

So far the measured initial temperature has not been used in the calculations at all, but when an effort is made to determine the heat required to raise the products of combustion to the initial temperature and to vaporize the injection water this quantity must be used. It was found when the calculations for heat put in and heat available during expansion were made that these two quantities were both considerably higher than they should have been. In other words, the theoretical heat necessary to raise the products of combustion to the observed temperature and to vaporize the water of injection was oftimes greater than the actual heat put in, and the theoretical energy of the jet with the measured initial temperature and pressure ratio was very much greater than the actual jet energy. These two things would result in a combustion chamber efficiency which was greater than unity, and a nozzle efficiency which was abnormally low.

From a careful analysis of the results and the methods of making the tests it would seem as though either one of two things or a combination of both would produce the above results. First, if the Venturi meter were to actually pass less air than indicated the apparent combustion chamber efficiency would be high and the nozzle coefficient low. On the other hand, were the observed temperature in the combustion chamber higher than the correct temperature it would give this same discrepancy. Inasmuch as the Venturi meter had been very carefully calibrated and since it was discovered that the water jacket had cracked between the nozzle and the thermocouple it was concluded that the observed temperature was much higher than the mean temperature in front of the nozzle.

Accordingly an effort was made to determine what the actual temperature was in an indirect manner. The efficiency of the nozzle was assumed to be 94%, which corresponds to a velocity coefficient of about 0.97. This is not unreasonable, although if anything, just a bit too high. Knowing the kinetic energy of the jet and assuming 0.25 for the specific heat of the products of combustion and 0.50 for the superheated steam it was possible to arrive at the required drop in temperature during expansion. Then, inasmuch as

$$T_1 = T_2 \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}} \tag{3}$$

where T_1 is final absolute temperature

T_2 is final absolute temperature

P_1 is initial absolute pressure

P_2 is final absolute pressure

and n, ratio of specific heat, was assumed to be 1.37, and since we now know ($T_1 - T_2$) from the kinetic energy of the jet, we can solve for T_1 and T_2 by simple algebra. If the calculated temperatures are plotted against total weight flow a smooth curve results, indicating the correctness of the calculated results.

Having determined the initial temperature more exactly we can then calculate the theoretical heat to be put in and the theoretical available energy. From these values we can get by division the theoretical efficiency of the combustion chamber and nozzle, neglecting as before the compressor and the pumps. This value we will later compare with the actual test efficiency.

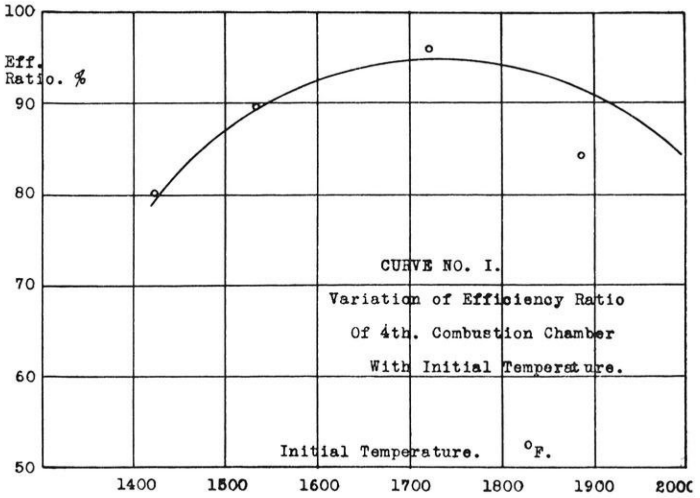
The fact which justifies the above method of temperature determination is that the theoretical efficiency varies very little with a change in the initial temperature so long as the pressure ratio is not changed. Thus the final value of efficiency ratio is approximately correct to within about one per cent, even though the actual mean temperature may differ from either the observed or the calculated temperature.

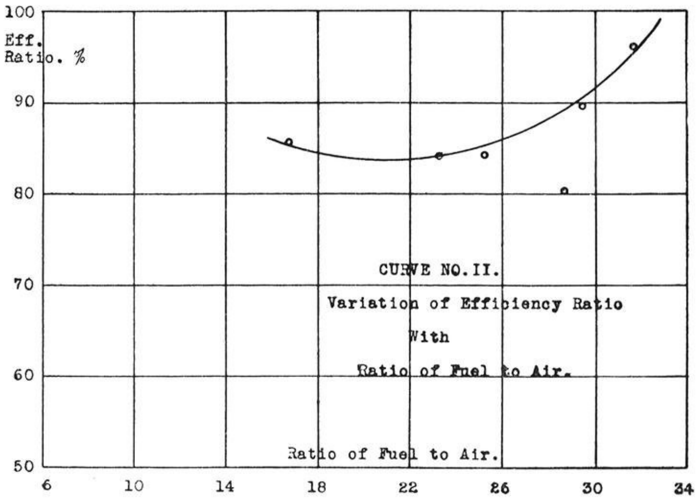
In order to simplify the calculations as much as possible the above calculations have all been based upon an assumed value for the specific heat (Cp) of 0.25 for the products of combustion and of 0.50 for the superheated steam, together with an assumed value of $\frac{Cp}{Cv}$ equal to 1.37 for the mixture. Inasmuch as the actual specific heats vary considerably at high temperatures, the theoretical efficiency was calculated for the assumed temperature in each run on a basis of the actual specific heats using Langen's formulæ, (Mark's Handbook, page 366,) for the specific heats of each constituent of the mixture, and taking an average dependent upon the composition and temperature range. This calculation was somewhat lengthy and tedious, but the results justified the effort, inasmuch as it was found that the theoretical efficiency was somewhat lower when figured this way than when figured on the previous basis. Thus the more correct "efficiency ratio" values obtained for the nozzle and combustion chamber were considerably higher than those originally obtained.

Results and Conclusions

The efficiency ratio of the third combustion chamber and nozzle averaged about 77%, using exact specific heats. The results of five runs with the largest nozzle on the fourth combustion chamber are tabulated in Table I. Curves I and II show the results of these tests plotted against two different variables. These results average about ten per cent higher than those on the previous combustion chamber.

The writer does not feel that these tests are accurate enough nor was the apparatus perfected enough to be taken as an exact criterion of the efficiencies which might be obtained with a gas turbine combustion chamber and nozzle. Nor is it felt that much weight should be attached to the maximum points on the two efficiency curves. The tests do indicate, however, that with a combustion chamber and nozzle of proper design a combined efficiency of over 90% should be obtained, and in large sizes it might be possible to exceed this. By efficiency it is meant, of course, that the actual kinetic energy of the jet in any cycle divided by the heat put in will be ninety per cent of what it should be in the theoretical cycle using





the same initial temperature and pressure ratio, and basing the figures upon the exact values of the specific heats as nearly as such can be obtained. This efficiency will, of course, vary somewhat with the total temperature, pressure ratio, fuel used, percentage of water added to the products of combustion, and constructional features of the apparatus.

The mechanical conditions and design of these two combustion chambers were not nearly as satisfactory as they might have been. As a result of the experience gained with these two combustion chambers the writer has several concrete points of design which it is believed should be incorporated into any future gas turbine combustion chamber tests in order to avoid as much as possible the same difficulties which were encountered here.

The first and foremost point that should be guarded against is any condition which might tend to set up expansion strains. In order to eliminate such strains it is the writer's opinion that the inner and outer walls of the combustion chamber should be made of thin steel plate, and that at least one should be corrugated circumferencially in order to provide for longitudinal flexibility. The combustion chamber should be as symmetrical as possible. The nozzles should by all means be water jacketed, and in tests of this kind should if possible be symmetrical. The water jacket should be either of flexible construction or arranged with sliding joints, inasmuch as the nozzle wall will attain a temperature considerably higher than the outside water jacket wall.

In any cycle in which a large amount of water injection is used it is unnecessary to cover the entire inside of the combustion chamber with refractory material, inasmuch as a certain amount of water has to be vaporized and this might just as well be accomplished by the heat that flows through the walls as to inject the water into the combustion chamber before vaporization. It is thought, however, that better combustion can be attained by surrounding the walls in the lower part of the combustion chamber with a refractory material, and thus secure complete combustion by virtue of the high temperature attained, and then to inject the water vapor into the products of combustion in the upper part of the chamber.

In any future tests it would be highly desirable to have at least two thermocouples in the combustion chamber near the entrance to the nozzle, and to use the average temperature of the two in the calculations. This test value is highly important for a number of reasons, and the absence of correct readings of this temperature puts the present results at a serious disadvantage. With correct values of the initial temperature it becomes possible to segregate the losses, and to apportion certain ones to radiation and incomplete combustion, others to friction in the nozzle, nozzle radiation, etc. Great care should be taken to see that no water or steam passes into the combustion chamber between the thermocouples and the nozzle, since this then renders the temperature readings almost worthless as far as analysis is concerned.

Further work might also include the analysis of the exhaust gases in an effort to determine the maximum flow through any given combustion chamber which would at the same time obtain complete combustion. This would be of value inasmuch as the radiation losses would then be a minimum.

TABLE NO. 1

RESULT OF TESTS

(4th Combustion Chamber)

1.	Run No.	1	2	3	4	5
2.	Weight of Air/sec.	0.306	0.3118	0.258	0.3107	0.296
3	Weight of fuel/sec.	0.0106	0.01055	0.01533	0.00979	0.01179
4.	Weight of water/sec.	0.0369	0.0381	0.0506	0.0292	0.0262
5.	Weight of total/sec.	0.35355	0.36045	0.3239	0.34969	0.33399
6.	Reaction of Jet.	34.56	36.85	38.11	37.15	36.6
7.	Velocity of Jet. Ft./sec.	3147	3290	3790	3420	3480
8.	Kinetic Energy, B. t. u.	198	216.2	287	233.7	242
9.	Initial Temperature °F.	2006	1938	2072	2003	1970
10.	Init. Temp. °F. (Calc.)	1425	1535	2030	1720	1885
11.	Pressure Ratio	7.00	7.55	7.55	7.49	7.35
12.	Percent water injected (4)/(2)	12.05	12.2	19.65	9.4	8.85
13.	B. t. u. added/pound	578	562	909	538	678
14.	Ratio of air to fuel	28.7	29.5	16.8	31.7	25.1
	THEORETICAL CONDITIONS AND RESULTS OF TEST. (Exact specific heats.)					
15.	B. t. u. required /lb.	500	536	804	545	618
16.	Final temp. after exp. °F.	728	790	1207	923	1058
17.	Energy Available B. t. u.	213.8	230	295.5	246.5	262
18.	Theoretical Eff.	42.76	42.9	36.8	45.2	42.4
19.	Nozzle Efficiency	92.7	94	97.2	94.7	92.3
20.	Combustion Cham. Eff.	86.5	95.5	87.4	101.1	91.2
21.	Overall Eff. Com. Ch. & Noz.	34.3	38.5	31.2	43.4	35.7
22.	Efficiency ratio	80.25	89.8	85.8	96.0	84.2

Explanatory Notes Regarding Table

Weights in pounds. B. t. u. content of gasoline used as fuel taken as 19,200 B. t. u./lb.

Item #9: Initial temperature measured with thermocouple.

Item #15: Based upon calculated initial temperature. Item #18: Equal to Item #17/Item #15.

Itemm#19: Equal to Item #8/Item #17. Item #20: Equal to Item #15/Item #13.

Item #21: Actual test efficiency, equal to Item #8/Item #13.

Item #22: Ratio actual to theoretical efficiencies, Item #21/Item #18.

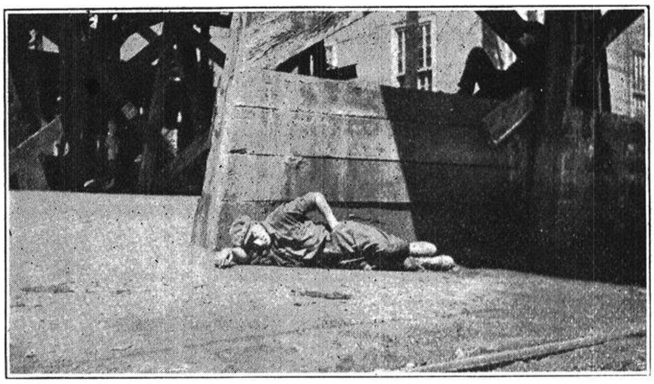
THE MINERS' WESTERN TRIP

By LAWRENCE H. HAHN,
Graduate Student.

Nine Miners left on the 17th of June for the West, all of them expectant and adventurous, ever anxious to call attention to something new, or to reassure themselves through the medium of Prof. Shorey that they were on the right train, and that eventually they would reach Omaha if the coaches held together under the repeated stress of the syncopated melodies issuing from Louie Mann's banjo. Prof. Shorey was our guiding hand, and early in the trip he was unanimously elected official ouster.

The first lap of our trip ended at Omaha, and we made good use of the Y. showers and pool to cool off after a hot and dusty train ride. We visited a lead smelter in the morning, and left in the afternoon for Edgemont, S. Dak. We arrived in Edgemont early the next morning, had a soul-disturbing breakfast of ham sandwiches and coffee which the lunchroom attendants were so considerate to have had ready for us a week in advance, and then went on to Lead. The ride through the Bad Lands was interesting but depressing; so it was with a sigh of relief that we first viewed the Black Hills which towered on each side of us as we steadily climbed toward Lead, clinging first to one side of a valley and then to the other, just like a "side-hill gouger".

NINE MINERS, EXPECTANT AND ADVENTUROUS, LEFT FOR THE WEST



WHEN THE TAIL FEATHERS DROOP
"Squirrel" Fourness on the ground and "Louie" Mann on the perch, after a hard morning in Butte.

Our first impression of Lead was unfavorable; a steady drizzle that had accompanied us through the Hills was still with us, and the streets were deserted with leaden clouds hanging low overhead. Our first thought was that of "eats", so the "Greasy Spoon" found us willing victims. The clouds seemed brighter when we emerged, due either to the fact that our hunger had been satisfied or to the contrast with the murky indoor atmosphere. Rooms were soon engaged, and, after a careful examination, the gang collected to compare notes on bed springs, heating, and expectoration facilities. We spent five days in Lead visiting the underground and surface workings of the Homestake Mining Co. We also took a twenty-mile geology hike through the Hills, so that before we left we were "intimately" acquainted with the region. One evening several of the fellows "tripped the light fantastic" to what they considered wretched music. "Squirrel" Fourness innocently made known his opinion to the cornetist, and was saved from annihilation only because the musician "wouldn't pick on a kid". It was in Lead, too, that Prof. Shorey began to weaken. He created a furore over the disappearance of his eye-glasses only to be told by one of the fellows that they perched safely on his nose.

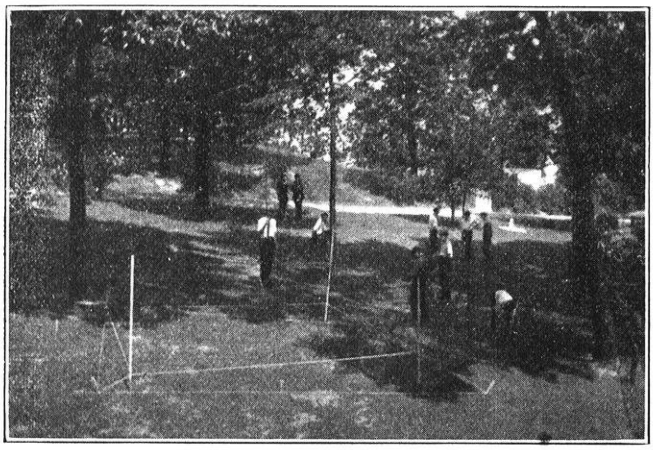
On our way to Osage, Wyo., one of the fellows spent a night on the locomotive tender even though he possessed first-class transportation—showing the perversity of human nature. The derivation of the name "Osage" was evident when we saw the bountiful crop of sagebrush that was the chief form of vegetation. We hiked to the oil wells over the heat-baked prairie, and we sweltered under a broiling sun. Jack-rabbits were numerous, and the scent of sage and oil-soaked sand oppressed our nostrils. When we returned to Osage, we were quite mystified to see Louie Mann tear up Main Street in a Ford driven by a hard-looking individual heading for the open country. Shortly before our train left, Louie came back like a blue streak and gave us a clue as to his journey when he said, "It was darn good stuff, too".

Sheridan, Wyoming, seemed home-like to us because of its ocean-dip street-cars and the wretched service. Two of the fellows had an exciting encounter with bedbugs the first night. Experience being a good teacher, they inspected carefully every bed they drew later in the trip. Prof. Shorey felt adventurous one night, so he inveigled four of us to go horse-back riding. We were not exactly at ease when we saw our broncs, but simulating nonchalance, we managed to mount them and get them started off in a general direction away from the stable. After a few endearing words to our mounts by Prof. Shorey, we found ourselves galloping toward the distant horizon, leaving Louie somewhere in the rear because he couldn't find "high-gear". We returned safely —to the great disappointment of the natives who ex-

(Two pages over; bottom)

THE 1921 RAILWAY SURVEY

What will probably be the last railway survey ever made on the campus was carried out during the two weeks from June 18 to July 1. Thirty five students—ten of them seniors and twenty-five of them juniors—made up the group. Professor Van Hagan was in charge of the instructional work with Mr. Stivers assisting. The weather was unusually hot.

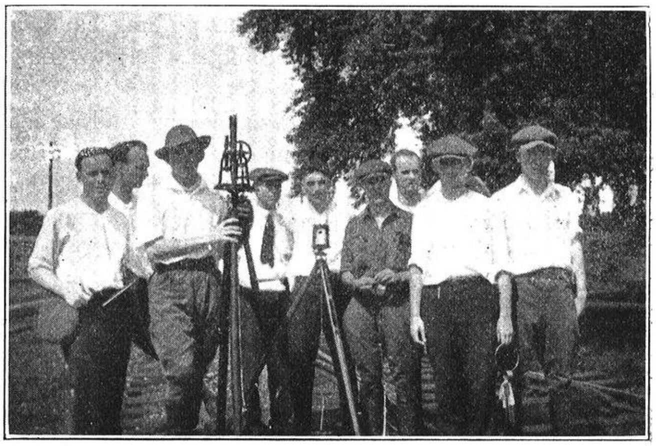


MAKING CROSS-SECTIONING EASY

A short length of line was cross-sectioned, and then the outline of the finished roadbed was marked by means of white cord.

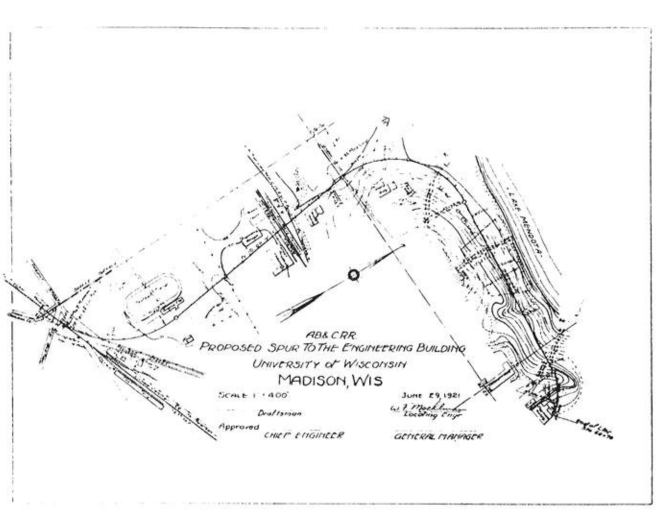
The number of students made it possible to organize four field parties. These parties remained intact throughout the work, and each party ran a line of its own. Each line was about 6500 feet long and lay practically altogether in university property.

A chief was appointed for each group, and he was responsible for the work of that group. The instructors acted in a consulting capacity; they were present to answer questions and give advice, but refrained from directing operations. Of course, some chiefs were more self-reliant than others and took a greater share of responsibility. The other members of the group were shifted from place to place so that each had as complete an insight into the work as was possible in the short time.



ONE OF THE RAILWAY FIELD PARTIES

The number of students made it possible to organize four field parties.



A MAP OF THE LINE

Each party ran a line of its own about 6500 feet long, and each student projected a location of his own, so that no two maps, estimates, or reports were alike.

The idea of cross-sectioning was made clear by schemes which had been used with previous classes with success. A short length of line was cross-sectioned, and then the outline of the finished roadbed was marked by means of white cord. The difficulties that cluster around the change from cut to fill disappeared quickly as the outline of the roadbed took shape.

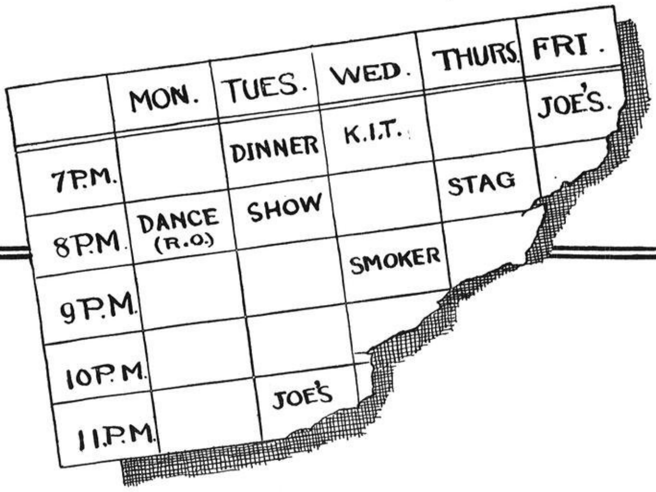
Each student projected a location of his own so that no two maps, estimates, or reports were alike. The office work included maps, profiles, estimate, and report.

It is planned for next year to take the railway survey to Devil's Lake and run it in conjunction with the topographic work, making a six weeks survey altogether. This would have the advantage of providing more elbow room for the survey work at one time instead of spreading it over two summers as at present.

and would permit students to do all of their summer survey

The department of mining engineering has received a gift of an 18" x 20" Blake Breaker and a set of 18" crushing rolls from the Mineral Point Zinc Co., of Galena, Ill.

Several seniors in the department of mining and metallurgical engineering have voluntarily arranged for a weekly seminar in Technical German. The work will be directed by Professor Hohlfeld of the German department.



Does your P. M. schedule read like this?

If your burning ambition is to excel as an all-around society man, you couldn't have planned your evenings better. Such persistence will win out over the indolence of the rank and file, for as the poet says,

> "The heights by great men reached and kept
> Were not attained by sudden flight,
> But they while their companions slept
> Were toiling upward in the night."

But if you intend to make your mark in engineering or business, don't expect that supremacy on the waxed floor will help when you start hunting a job.

Not that you need swing to the other extreme as a "grind" or a hermit. Let's concede it is all right to minor in sociabilities—but certainly it is only common sense to major in the math and sciences and English that will mean bread and butter to you later on.

Remember this—the harder you work right now in getting a grip on fundamentals, the easier things will come to you when you must solve still bigger problems. And if you take it easy now—well, look out for the law of compensation.

It's up to you. While you've got the chance, seize it, dig in, plug hard. It will pay—in cold cash.

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Western Electric Company

Maybe it's against all campus tradition, but some men who stood in the upper third in their class and who entered this Company years ago have since become its executives.

SLIPSTICKING 300 YEARS AGO

A Short History of the Slide Rule

Could you do the computations in a mechanics quiz with only a logarithmic scale and a pair of dividers? Possibly you could, but wouldn't you soon discard the dividers and borrow the log scale of your neighbor, using it in connection with your own to multiply and divide? And after the quiz wouldn't you and your neighbor prepare for following exams by spending a few hours in the shops constructing a more convenient device?

These few simple developments, which nowadays would occur over-night, originally happened in a period no shorter than 34 years. But probably no mechanics exams were given 300 years ago, you will decide.

In 1620, about a century and a half before the steam engine was invented and six years after Napier compiled his table of logarithms, Edmund Gunter, an astronomer in London, conceived the idea of doing his computations with a logarithmic scale and a pair of dividers. Since he describes the construction of the scale with considerable care, it was possibly the first one made. He said that because the logarithm of one was zero, he would call the starting mark of the scale 1, then would lay off from that point the log of two, naming it 2, and would continue the process with all the digits. To find the product of two numbers, say 2 and 3, he would open the dividers to a width representing the log of 3, then would place one leg of the instrument at point 2 of the scale. The other leg, being log 2 distance plus log 3 distance from the index, would fall upon 6, the answer. Theoretically the results were correct, but practically they probably depended much upon the patience and juggling ability of the operator.

Evidently, engineers had trouble with the lawyers even in those early days, for one Edward Wingate, an English lawyer, gave publicity to the new invention in such a manner that he was credited with being its inventor. (A typical "Law," perhaps (?) you will say). The resulting erroneous belief has persisted even until the present time.

Ten years after the first apparatus—the scale and dividers—was used, William Oughtred, the inventor of our multiplication and proportion signs, x and : :, found that by substituting a scale for the dividers, the operation of the device was made more satisfactory. Instead of setting the dividers each time, he obtained the desired results by holding the second scale adjacent to the first so that the logarithms were added or subtracted directly.

It was Seth Partridge, a surveyor, who first recognized the practicability of a slide. History does not tell whether he disliked to carry the two scales about or whether he saw the large inaccuracies of holding the scales together, but it does say that he made the improvement in 1657, just 27 years after Oughtred decided that two scales should be used.

The first slide rule runner, also commonly called the glass indicator was not made until about 150 years later, for the oldest printed information of one is dated 1778. It is said that Newton first conceived the use of a runner, although Oughtred possessed a somewhat similar idea when he affixed a movable radial line on a circular slide rule that he developed. In those times, a century and a half passed before an indicator was found useful, but now we hurry to the Co-op as soon as our slip-stick happens to drop.

The designing of the log-log rule and the making of special commercial rules have been the only recent important slide rule developments. The trigonometric scales were attached at about the time when the slide was first used.

What form will the next development assume? Shouldn't it be a "Safety First" device which will diminish the hazard of making those academic mistakes which result in so many scholastic "casualties" and even "fatalities"? Prof. Rood's article on the first pages of this issue furnishes a very adequate means of overcoming these chances to err and of learning how to use the slide rule, an engineer's almost indispensable instrument, efficiently.

THE MINERS' WESTERN TRIP

(Continued from page 27)

pected to pick up pieces of the "yankee dudes" somewhere out in the "brush". We visited the various coal mines of the Acme Coal Company, and were informed that the Wyoming coal fields alone could furnish the world with coal for 500 years.

After three days in Sheridan, we left for Butte, Montana, where we were to visit copper mines, mills, and smelters. The Elks and Eagles were holding conventions while we were there, but we were drily unfortunate in that none of us belonged. The gay-colored pennants and flags hung forlornly in the downpour of rain and snow, or flapped dismally as an occasional gust of chilly wind swept up the street. Not exactly the best weather for a convention, but they made the best of it, and the results made our stay in Butte very enjoyable. We were there for four days, and then left on the Butte, Anaconda and Pacific, an electrified railway, for Anaconda to visit the Anaconda Smelting and Refining Company's plant.

Wallace, Idaho, was our next destination, which we reached after a winding trip through the Bitter Root Mountains. In the vicinity of Wallace we traveled through miles of fire-scarred timberlands where gaunt timbers raised their seared limbs to the sky out of dense

(Continued on page 36)

EDITORIALS

FORMULAS AND COMMON SENSE

Perhaps many of us can remember how, back in our grade school days, the principal came into our room one day and gave us, as a mental drill, problems similar to the following:

1. If one apple costs 6 cents, what will two apples cost?

2. If one cubic foot of wood weighs forty pounds what will two cubic feet weigh?

3. If a square mile contains 640 acres, what will two square miles contain?

4. If a boy weighs seventy pounds standing on one leg, what will he weigh standing on two legs?

Perhaps we can likewise remember that, after answering the first three questions correctly, we gained such momentum that we answered the fourth question by the same rule and said that the boy would weigh 140 pounds, standing on two legs.

Some of us probably learned to do some original thinking after that humiliating experience, but don't some of us make similar foolish blunders?

We engineering students learn many rules and formulas for solving problems of design and construction. Are we not in danger, sometimes, of letting too great a dependence upon these formulas cause us to misapply them, and draw conclusions as false as that of the boy being able to double his weight by standing on both legs?

Formulas are good servants but poor masters. They must be used with understanding and common sense.

F. A. S.

THE AGE OF SUBSTITUTES

"How long will our wood supply last?" you will be asked in at least one engineering course this fall. Possibly you may remember that the text set the time at 50 years, provided the present rate of consumption prevailed. The fact that a board 12 feet wide and 900 feet long made from bagasse, the almost worthless by-product of the cane-sugar industry, has recently been made shows the importance of the proviso. Heretofore bagasse has been used merely to feed the flames in generating steam at the sugar plants, but since it contained nearly 50 per cent water, it fed them very poorly. Now it is made into building board which is light, waterproof, a good heat and sound insulator, and may be sawed much the same as ordinary lumber Despite continual increase in the demand for wood we may expect our forests to be gradually spared through the use of substitutes. Therefore, don't forget the proviso!

GREAT LAKES WATERWAY PROJECT

Before construction can begin on the Great Lakes Waterway Project, the United States and Canadian Governments must pass certain legislation. One of the bitterest political fights in the history of Congress must be fought on this issue this coming winter.

The eastern interests opposing the project will have a powerful lobby in Washington long before the proposed legislation is presented, and, if this legislation is to go through, the middle west must have, not only a power lobby in Washington, but a powerful public sentiment at home.

In the near future the commercial interests of Wisconsin will hold a conference in the Capitol at Madison to discuss plans and methods of furthering this legisla-

THE SUCCESS FAMILY

Suggested by Prof. D. W. Mead

The father of Success is—
Work
The mother of Success is—
Ambition
The oldest son is—
Common Sense
Some of the older boys are—
Stability
Perseverance
Honesty
Thoroughness
Foresight
Enthusiasm
Co-operation
The oldest daughter is—
Character
Some of her sisters are—
Cheerfulness
Loyalty
Courtesy
Care
Economy
Sincerity
Harmony
The baby is—
Opportunity

Get acquainted with the "old man" and you will be able to get along pretty well with all the rest of the family. Anonymous.

tion. The engineers of the state should take an active interest in this conference. They should throw off their aversion for anything that involves politics, and work shoulder to shoulder with the commercial men in this fight. They should help to get the voters of the middle west so interested in the success of the Great Lakes Waterway project that the republican party dare not fail to put it across. A. J. R.

ONE HUNDRED PERCENT SCHOLARSHIP EFFORT

The expression "getting by", sometimes heard about the campus, reflects an attitude carried over from the high school where "the big stick" of compulsion was kept always in sight to spur the laggards and where to "get by" was deemed sufficient; it should have no place in college life. Especially, should the engineer rid himself of the idea that he has done enough when the minimum requirement has been performed, for his future problems will be those too hard for others to solve and hard problems are not solved by "just getting by" methods.

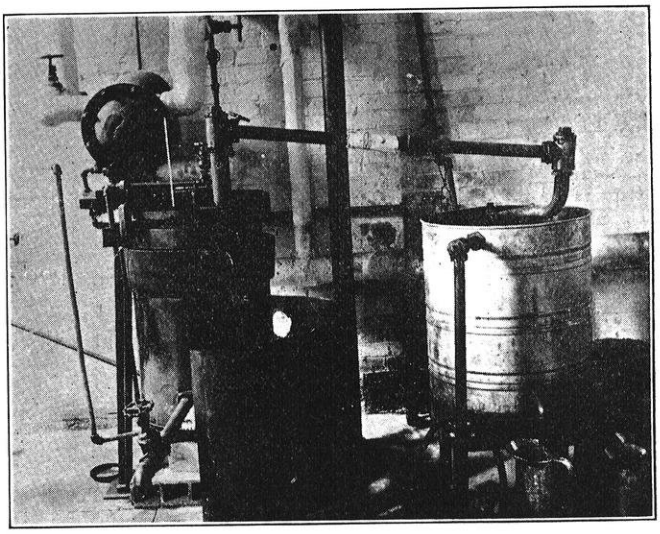
The habits an engineer forms while in school stay by him during all his life. If he learns in college to "just get by", he need never expect to go far in his profession. He should, therefore, attack even the smallest problems of his school routine in the same thorough-going manner that he would build a bridge or drive a tunnel. A bridge joint which comes within seventy per cent of being strong enough, or a tunnel which almost stands up, will hardly reflect honor on the builder. To avoid acquiring the seventy per cent habits, which mean failure in the industrial world, the engineer should, during his school career, put forth a hundred per cent effort in all of his scholastic undertakings. E. C. M.

THE COURSE IN CHEMICAL MANUFACTURE

(Continued from page 23)

use of this heat. He had an evaporating dish full of a product which he had taken great pains to purify. and wanted to evaporate. To hasten the somewhat tedious process, he set the dish outside in the sun, forgetful of the fact that hot weather means much dust. The Boss's eagle eye saw this stunt, just as it was sure to see any irregularity, great or small, and the offender was told to take in the dish. The latter looked up innocently, saw the bright blue of the sky, and asked, "Why, do you think it will rain?" Even now, when Pekofsky is asked if he thinks it will rain, he blushes a bright vermillion, as though he had been caught stealing apples. Try it some time.

The boys learned that vacuum evaporators, crushers, stills, filter presses, fusion pots, and countless other pieces of apparatus were not merely figments of the brains of the writers of technical books, but were of real practical value, and had as many peculiarities and individualities as any of the men operating them. It was an excellent supplement to the course in Chemical Machinery which they had studied the semester before and perhaps had looked upon as rather lacking in the concrete applications which they later found. The number of the products turned out by the plant shows that the eight hours a day spent in the Chemical Engineering Building were not wasted by the men, but were actually productive of much good experience. Some of these products were: Potash from alunite, naphthalene from



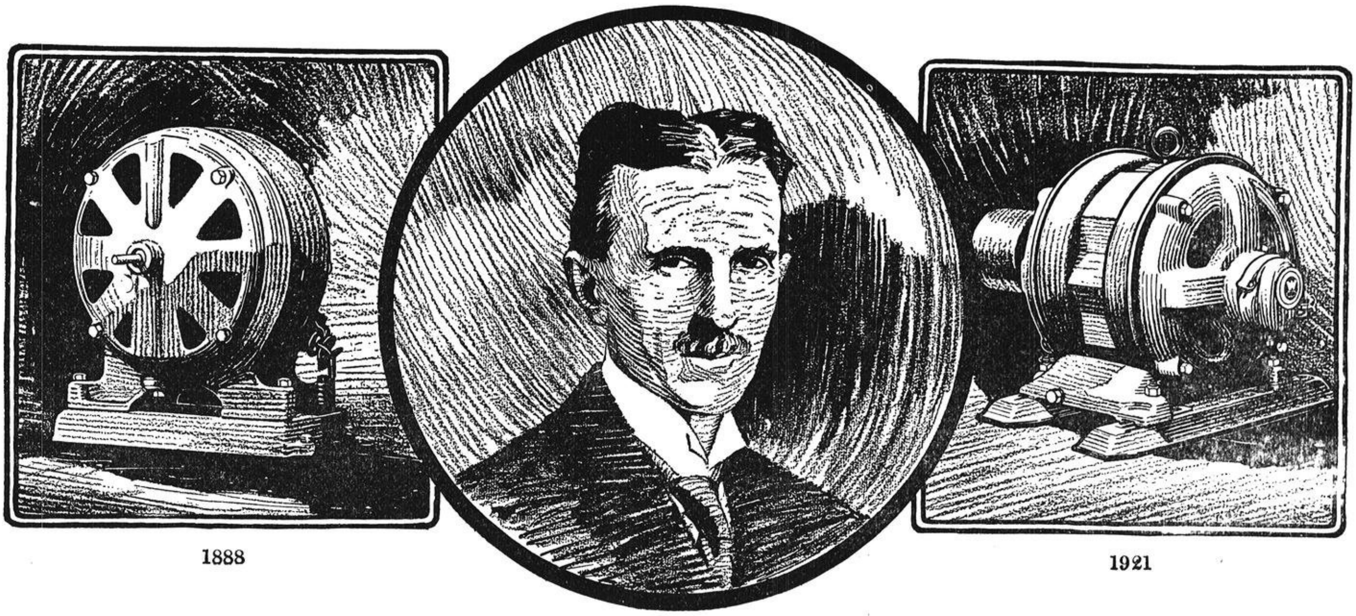
A Crude Oil Still

The students learned that evaporators, crushers, presses, and stills have many peculiarities and individualities.

gas main condensate, soap, sandlime brick, acetone from gray acetate of lime, lithopone, prussian blue, potassium chloride from kelp, refined bauxite, Permutit, a water softener for boiler water, linseed oil from flaxseed, oxalic acid from sawdust, and chrome yellow.

Not only was the Boss always on the job with ready advice, help, or a word of warning, but his two able assistants showed themselves equal to the task before them. Ragatz and Ramsay were always ready to help either out of their fund of practical knowledge, or with the wrench and hammer. One of the boys said, "The first week they (the instructors) ran around every minute, the second week they walked, the third they sat down and during the last two weeks we had to wake them up at twelve o'clock to keep them from missing their lunch." This was due to the fact that they worked so hard the first two weeks, that there was nothing more to be done during the last part of the course. Frank, the man with the ready set of tools and cheerful word, will always be fondly remembered. His stock of good nature never seemed to run out. He, too, helped to make the course mean more to the gang.

After each problem was successfully completed, a report was written, detailing the methods of analysis and manufacture, and giving conclusions as to the cost and practicability of the process. The course taught the men to be resourceful, and compelled them to review a great deal of their previous work. The last day was a general cleanup occasion, and after the last piece of apparatus was in its place, the Boss treated the men to an ice cream social under the trees on the shore of Lake Mendota.



1888 1921

Nikola Tesla

THE NAME of Nikola Tesla will always be associated with the invention and earlier developments of the induction motor. In fact, at one time this type of apparatus was known almost exclusively as the "Tesla" motor.

Tesla devised this motor back near the beginnings of the electrical business, when practically everything was built by "cut and try" methods, and none of the accurate analytical processes of later days had been developed. It may be said broadly that Tesla knew two fundamental facts—first, that if a magnet were moved across a sheet of conducting metal, it would tend to drag this metal along; and,—second, that the *effects* of such a moving magnet could be produced by suitably disposed polyphase currents acting on a *stationary* magnetic structure.

Perhaps others, at that time, also knew these two facts, but if so, apparently they knew them only as two isolated facts. Tesla considered them *in combination* and the result was the Tesla motor, or what is now known broadly as the "induction motor." These two facts, in combination, represent a fundamental conception, and all of the many millions of horsepower of induction motors in use today throughout the world, are based upon these two fundamentals.

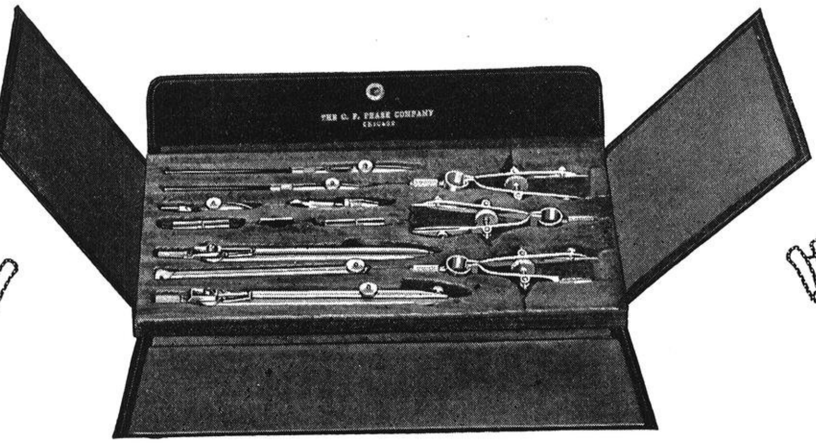
Naturally, Westinghouse, having fought single handed to advance the alternating current system, was supremely interested in the new type of motor. What if the new motor did require polyphase circuits, while all existing circuits were single phase? What if it did require lower frequency than any existing commercial circuits? These were merely details of the future universal alternating system. The important thing was to obtain an ideally simple type of alternating current motor, which Tesla's invention offered. Tesla furnished the fundamental idea.

He and his associates, working for Mr. Westinghouse, proved that thoroughly operative induction motors could be built, provided suitable frequencies and phases were available. What matter if they did not produce an operative commercial system at the time? What matter if it needed the powerful analytical engineers of later date to bring the system to a truly practicable stage—men with intimate constructive knowledge of magnetic circuits—men on intimate terms with reactive coefficients and other magnetic attributes totally unknown to Tesla and his co-workers? In time the motor was made commercial, and it has been a tremendous factor in revolutionizing the electrical industry.

Probably no one electrical device has had more high-power analytical and mathematical ability expended upon it than the induction motor. The practical result has been one of the simplest and most effective types of power machinery in use today. Thus Tesla's fundamental ideas and Westinghouse's foresight have led to an enormous advance in the world's development.

Westinghouse

W
WESTINGHOUSE ELECTRIC



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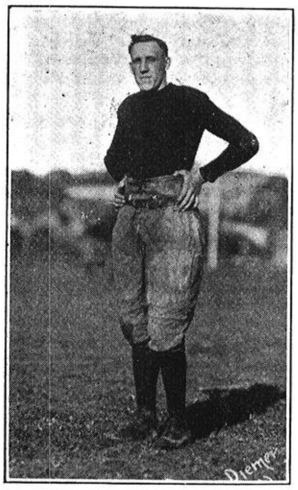
Opposite Majestic Theatre

One of the famous bridges of the world is the Puente de San Martin which spans the Tagus river at Toledo, Spain, with five high arches. It was built in 1212, and rebuilt in 1390. It is said that the "architect" discovered, during construction, that the arches would surely fall if the centering were removed. He confided the fact to his wife who promptly set fire to the scaffolding and destroyed both it and the bridge. The collapse of the arches was accepted as the natural result of the fire and the reputation of her husband was saved, at least for the moment. The Illustrated London News of October 8, 1921, has a full page engraving of this interesting structure.

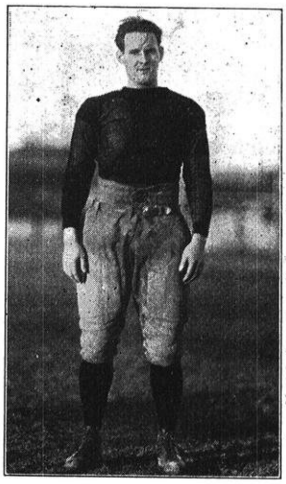
ATHLETICS

H. A. Phillips

BRUMM AND WOODS STAR



Roman "Kibo" Brumm



Jim Woods

In Roman "Kibo" Brumm and Jim Woods, the Engineering College has two representatives on the football team of which it may well be proud. Brumm is playing his first year of varsity football as right tackle. He has had experience as center and guard. Kibo is not a heavy man, but he has been playing a wonderful game in the line. He not only opens up the holes for the backs when on the offense, but when on defense has the wonderful facility of kniving through his opponents and nailing his man for a loss. In the Illinois game he grabbed the ball after Bunge had blocked a punt, and went over the line for a touchdown. This was the break which got the Badgers "started" in that game. Later in the same game, Woods, playing right half, grabbed the ball as an Illinois end fumbled, and repeated Brumm's stunt. Jim is the heaviest man in the backfield, and is fast, too. He runs interference well, and is a hard driver through the line. In the Minnesota game Jim played left end on offense and left half on defense, alternating at these positions with "T" Gould.

Wisconsin 27 — Northwestern 0.
Wisconsin 20 — Illinois 0.
Wisconsin 35 — Minnesota 0.

Minnesota was the victim at Homecoming, October 29, to the tune of 35 to 0. It was the worst defeat Wisconsin has dealt the Gophers in years, and goes a long way to even up times when the "shifters" were on the long end of the score. The game was played on a muddy field. "Rollie" Williams, who had been shifted from half to quarter to fill Gibson's shoes, selected his plays perfectly, and had the Gophers guessing at all times. In addition he tore off several long runs, one for seventy-five yards and a touchdown. Wonderful interference by Sundt, Elliot, and Gould made it possible for him to get started. In the last quarter Sundt intercepted a pass and ran sixty yards for a touchdown. Gould's steady off-tackle drives were a feature. Elliot made three touchdowns. The whole team worked as a unit.

During basketball season last year Coach Stagg was not so popular on the Campus at Chicago as he is now. Similarly, Coach Yost, at Michigan, is in bad grace because Ohio defeated the Wolverines. Now, maybe Wisconsin will not win the conference this year, and then some of our sage advisors, in and out of school, will tell us what Richards' faults are.

If a team wins it gets the credit, and if its loses, the coach accepts the "donations."

Finkle Winner

George Finkle, a junior in the Engineering College, finished first in the dual cross-country meet with Minnesota. Finkle did some fine work running the two mile last spring, and is expected to be even better this year. He should place well up in the conference cross-country meet.

And did you ever stop to think what an important part the "scout" has to do with the success of a team? As a scout, Guy Lowman ranks in the same class John Richards ranks as a coach, which means among the best in the country.

Coach Roper of Princeton, who probably gets good U. S. money for his football articles, wrote before his team met Chicago that in the east a football team was built up brick by brick, and seemed to think that western football coaching was a sort of joke. But Chicago outplayed Princeton in the fundamentals of the game. The following week Roper decided that Princeton was a third rate team in the east and Chicago was easily the best in the west. Maybe he's right, but——— Chicago hasn't defeated Wisconsin since 1916. And its record against the other leading schools of the conference shows more losses than wins in the last five years. Maybe it will do better this year. Stagg is a mighty good coach, and the Maroons always have a good team.

ALUMNI NOTES

E. D. Bader

Well, "Old-Timers", we are awfully sorry that the weather man saw fit to make your homecoming a rainy one, but, say, wasn't it worth the trip just to see our ancient enemy get a drubbing. We imagine that a score of 35-0, with Minnesota on the small end sounds like music to the ears of you who have seen her victorious so many times.

Among those who were here for the big celebration were: **Adolph Meiselwitz**, c 18; **Ernest Schwartz**, min '18; **Alfred Brill**, c '16; **Bernard Conaty**, c '18; **Ray Phelps**, c '16; **John Tanghe**, c '16; **H. F. Hosler**, c '18; **Frank Quimby**, e '20; **Glenn Gustin**, c '21; **Scranton Gregg**, c '21; **Warren Walters**, min '21; **Peter Walraven**, c '21; **V. G. McGraw**, c '20; **T. W. Ayton**, ex-e '22; **Wm. F. Gettelman**, c '14; **Geo. T. Moore**, m '18; **A. E. Cummings**, c '15; **Emil F. Stern**, m '19; **A. P. Gerhardt**, e '21; **Frank B. Bowley**, m '05; **Homer J. Ludden**, e '17; **Walter S. Nathan**, c '18; **Walter A. Zinn**, m '98; **E. J. Arps**, e '13; **Henry M. Ford**, c '21; **W. H. Lange**, ex-c '20; **Carl J. Anderson**, e '20; **Ray Hanson**, ex-c '22; **Herbert Neuman**, ex-c '22; **Emil Zapfe**, ex-c '23; **Karl Zander**, ex-c '23; **W. H. Lange**, ex-c '20; **E. Dames**, c '20; **Victor H. Jones**, e '17; **Walter F. Blair**, m '15; **L. R. Morris**, c '14; **Carlton Saecker**, m '18; **Glenn E. Smith**, e '09; **C. F. Kottler**, e '19; **E. H. Morse**, e '19; **W. R. Steele**, c '20; **E. L. Wieland**, ex-m '24; **C. S. Sowers**, ex-m '23; **J. N. Kuchel**, ex-e '22; **C. J. Goldammer**, e '17; **L. B. Nash**, e '17; **O. W. Marshall**, m '19; **W. B. Bellack**, m '19; **M. M. Hanson**, c '19; **L. C. Childs**, c '13; **Judson E. Fuller**, m '12; **E. H. Ahara**, c '92.

CIVIL ENGINEERS

E. P. Abbott, c '08, has charge of the construction of the Baytown refinery of 10,000 barrel daily capacity for the Humble Oil and Refining Company at Goose Creek, Texas.

Edwin Hugh Ahara, c '92, spoke at the massmeeting before the Minnesota game. **Mr. Ahara** was captain of the first Wisconsin team to play Minnesota.

W. O. Axtell, c '18, now lives in Woodlands, W. Va.

K. P. Barth, c '21, did not go to Mexico as he planned to do. He is in Milwaukee.

Eugene F. Bespalow, c '21, is with the U. S. Bureau of Public Roads at South Chicago, Ill. His address is 1218 South Albany Ave., Chicago, Ill. He writes "I have been anxiously waiting the arrival of the WISCONSIN ENGINEER. I never realized how lonesome I would be for some news of the ol' timers and news in general of the school."

J. F. Case, c '90, of the American International Corporation, 120 Broadway, has gone to Europe where he expects to be for some time.

A. J. Chandler, c '98, is senior engineer with the Interstate Commerce Commission, Kansas City, Mo.

L. C. Childs, c '13, is chief engineer for the Bates and Rogers Construction Company, Chicago.

B. M. Conaty, c '18, has offices at 466 Peoples Gas Bldg., Chicago.

Robert M. Connelly, c '16, Dean of the Knights of Columbus Evening Schools at Fort Wayne, has opened an office in that city for consulting practice.

A. E. Cummings, c '15, office engineer, Room 1912, 111 W. Monroe, Chicago. His home address is 452 Fullerton Parkway, Chicago.

R. E. Davis, g '06, is a consulting engineer at 902 Peoples Gas Building, Pittsburgh, Pa.

James Hopkins Dousman, c '84, is now living at Kansas City, Mo. He is the inventor and patentee of the Dousman hangers for carrying falsework on steel construction where concrete or terra cotta is used for fireproofing, and is at present the Designing and Construction Engineer for numerous pumping and hydraulic propositions.

C. R. Fisher, c '11, is with the U. S. Geological Survey, Washington, D. C.

Henry M. Ford, c '21, is living at 1113 Racine St., Janesville, Wisconsin.

Ray Hanson, ex-c '22, is managing his father's laundry at Milwaukee for the present, but expects to be back in school next year.

E. H. Hinkley, c '21, is located at 212, 6th Avenue, W., Ashland, Wisconsin. In a recent letter he says, "During the summer I have been drafting, surveying and inspecting. At present I am inspecting the construction of a concrete bridge on which I have had an opportunity to exercise the 'Engineering-News' pile formula."

Paul Huntzicker, c '19, has changed his address from Boulder to Holly, Colorado.

A. E. Kringel, c '10, has been appointed city engineer of Green Bay.

V. G. McGraw, c '20, is with the Dravo Contracting Company, Pittsburgh, Pa.

J. O. Merrill, ex-c '18, completed work in architecture at Massachusetts Institute of Technology in 1920, and is now with Lowe and Bollenbocher, Architects.

E. A. Moritz, c '04, Effingham, Illinois.

M. N. Murphy, c '01, lives at 822 44th St., Chicago.

Herbert Neuman, ex-c '22, is working in the chemical laboratory of the Palmolive Company at Milwaukee.

A. O. Powell, c '80, consulting engineer, has offices at 613 Thompson Biulding, 4th Avenue and Cherry St., Seattle, Washington.

Max Rather, c '13, 2028 E. 22nd Street, Cleveland, Ohio, is with the Johnson Service Company. He is married and has a little boy, Hugh, five years old. He and his family recently made a camping trip from Cleveland via Chicago to Madison and return.

L. C. Rockett, c '15, is with the Wisconsin Highway Commission, and is now located at Oshkosh.

E. G. Schroeder, c '14, is engineer of building construction with Robert L. Reisinger & Co., general contractors, Milwaukee.

M. E. Sjoblom, c '13, is sanitary engineer, Division of Waterways, State of Illinois, at 1404 Kimbark Building, Chicago.

D. Y. Swaty, c '98, vice-president of the Cleveland Engineering Construction Company, saw the Lawrence game and visited old friends on October 1.

J. R. Vernon, c '18, is now assistant division engineer for the Highway Commission at Lancaster, Wisconsin.

"Pete" Walraven, c '21, assistant resident engineer, Greiling Brothers Company, Kenosha, Wisconsin. He is now living at 511 Collins St. Kenosha, Wisconsin.

H. J. Wiedenbeck, c '12, is now living at 21 S. Karlov Avenue, Chicago.

J. P. Woodson, c '16, is now engineer for the Dixie Construction Co., at Verbena, Alabama.

Pond Sheppon Wu, c '15, is in charge of the Bldg. Dept., The Pacific Trading Co., Engineers and Contractors, Shanghai, China. He was recently admitted to membership in the A. S. C. E.

Karl Zander, ex-c '22, and **W. H. Lange**, ex-c '20, are with the Highway Commission at Green Bay.

Emil Zapfe, ex-c '23, is doing some curve survey work for a consulting engineer at Green Bay.

ELECTRICALS

E. L. Andrews, e '16, lives at 1010 Rebecka Avenue, Wilkinsburg, Pa.

E. J. Arps, e '13, is in business for himself at Chilton, Wisconsin.

T. E. Bennett, e '16, 22 McDaniel St., Dayton, Ohioo.o

P. A. Bertrand, e '95, is general manager of Gray's Harbor Railway and Light Company, Aberdeen, Washington. He was visiting Mr. Woy in Madison a few days this summer.

A. J. Goedjen, e '07, has offices at 1408 First Wis. National Bank Building, Milwaukee.

Victor H. Jones, e '17, is Sales Engineer for the Green Engineering Corporation of Chicago.

G. R. Kuhns, e '13, is an engineer with the Western Electric Company, and lives at 931 Leland Avenue, Chicago.

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BETTER LIGHTING NEEDED IN INDUSTRIAL PLANTS.

In a paper read before the Illuminating Engineering Society, February, 1920, entitled, "A Survey of Industrial Lighting in Fifteen States," R. O. Eastman submitted some very interesting data regarding the lighting conditions in industrial institutions. The survey comprises some 446 institutions, in which lighting was considered by 55.4% as being vitally important, and by 31.6% as being moderately important, and by 13% as being of little importance. Practically 58% considered that lighting was as important as power in the operation of the plant, and a small proportion would give more attention to lighting than to anything else.

In considering the present condition of lighting as found in the various plants, only 9% ranked as excellent, about ⅓ ranked as good, 29% fair, 18.8% poor, 3.5% very poor, and 7.8% partly good and partly poor. It was found that the lighting in the offices was far superior to that in the shops; 19% being excellent, 36% good, 31% fair, and only 13% poor and none very poor.

On consulting the executives regarding what factors were most important in considering lighting, the following facts were revealed: Increase of production 79.4%, decrease of spoilage 71.1%, prevention of accidents 59.5%, improvement of good discipline 51.2%, and improvement of hygienic conditions 41.4%. Manufacturers who have good lighting appreciated its value largely from the standpoint of its stimulating effect upon output.

There is no question that any intelligent man who carefully considers the necessity for good lighting in an industrial plant, will agree that it is impossible for a person to do as good work, either in quality or quantity, in poor light as in good light, but yet the result of a careful analysis discloses the fact that only about 40% of industrial plants are furnishing good light to their workers and 60% are operating under poor lighting. It is hard to understand why such a proportion of concerns can be satisfied with a condition which is universally admitted to be a curtailer of efficiency and a prolific causer of accidents. The principal cause of this condition is that those in charge of such establishments have not given the attention to lighting that it demands. They do not know what constitutes good lighting, and in their absorbing interest of other factors of production have overlooked a vital one.

Every safety official should deeply interest himself in the lighting of his plant and insist upon good lighting as much as good goggles, good guards and other necessary accident prevention equipment. Every production manager should insist upon good lighting because the efficiency of the working force is increased by the condition of the lighting furnished. The plant physician should examine the lighting, for eye strain and eye fatigue are directly affected by poor lighting, as is the hygienic condition. Well lighted plants are invariably cleaner than poor lighted places. Plants equipped with Factrolite Glass in all windows are well lighted.

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E. B. Kurtz, e '17, has been made an associate professor in electrical engineering at Iowa State; his address is 1216 Second Street, Ames, Iowa.

Homer J. Ludden, e '17, Elkhorn, Wisconsin.

A breezy letter from **"Morley"**, e '21, blew into the office a few days ago with the assurance that the WISCONSIN ENGINEER still appeals to the "old timers". He says, " 'Butts' James and I are attending the Electrical Engineering School at the works, pending the opening of the design school. I am laboring in the transformer section at present, and have so many scratches and cuts on my hands from handling the laminations that they look like the surface of a glacier-scarred bowlder. I might work up a pun about laminations causing lamentations, but my time is limited; besides, I want to visit Madison again."

We'll say it would take more than a pun to make Morley unwelcome at Madison. Not so? He is now located at 924 South Avenue, Wilkinsburg, Pa.

F. J. Natwick, e '09, is district manager for the Delco Light Company and lives at 1511 N. Perry Avenue, Peoria, Ill.

L. B. Orr, e '09, is consulting electrical engineer for the American Technical Society, and head of the electrical department of the American School. His home address is Mt. Hope, Wisconsin.

C. R. Poe, e '17, is telephone engineer for the A. T. & T. Co., Room 514, 195 Broadway, New York City.

E. A. Richardson, e '10, is Chief Chemist for the Libby Glass Works at Toledo, Ohio.

Ross W. Rogers, e '21, is with the Electric Company at Blue Island, Ill.

W. A. Royce, e '16, is chief electrical engineer for the Morococha division of the Cerro de Pasco Copper Corp., Morococha, Peru.

F. J. Schmidt, e '14, lives at 254 Mason St., Apt. 407, Milwaukee.

J. C. Taylor, e '01, of the Denver Rock Drill Company, has been making an extensive trip through the South American countries. The months of March and April were spent in various mining destricts of Bolivia and Peru.

J. G. Zimmerman, e '04, EE '15, chief instructor in ignition, Milwaukee School of Engineering, assisted by A. L. Sudduth, laboratory instructor in ignition, recently perfected a new type of ignition system known as the Z-S Ignition System for use on Ford cars, which is proclaimed by many to be a wonderful improvement over the present type of Ford ignition.

CHEMICALS

L. E. Buckingham, ch. '21, is employed in the Research Laboratory of the Carborundum Company, Niagara Falls, New York.

William E. Erickson, ch '21, is chemical engineer for the Flintkote Company, of Chicago Heights, Ill.

C. A. Hansen, ch '05, is a metallurgist in the Power and Mining Department of the General Electric Company, Schenectady, N. Y.

Keith S. McHugh, ch '17, is General Commercial Engineer for the Chesapeake and Potomac Telephone Company, Washington, D. C.

C. L. Nash, ch '21, has taken employment in the Milwaukee Office of the Sales Department of the York Ice Machine Company of York, Pa.

R. M. Paddock, ch '20, is Assistant Resident Mgr. of the Chicago Office of the Witte Richardson Company, Chicago.

Alvin F. Pitzner, ch '21, is with Miller, Chindahl & Parker, Monadnock Block, Chicago. He writes. "Real Wisconsin men can never forget their Alma Mater," and backs us his sentiments by asking to have the news of the college sent to him regularly via the ENGINEER.

C. L. Schmidt, ch '21, is on the engineering staff of the Sinclair Refining Company, Whiting, Indiana.

W. H. Steinburg, ch '13, is head of the Rubber Belt Department of the Manhattan Rubber Company, Passaic, New Jersey.

H. F. Zabel, ch '14, has returned to the United States from Hamilton, Ontario, where he was in charge of the lamp works for the Westinghouse Lamp Company. He is temporarily on a vacation at Sharon, Wisconsin.

MECHANICALS

V. R. Anderson, m '08, is sales manager for the Dominion Fire Proofing Company, of Calgary, Alta, Canada, who manufacture hollow building tile, flue lining, wall coping, drain tile, brick and sewer pipe. At present he is located at Medicine Hat, Alta.

C. M. Barbour, m '14, is employed in the general offices of the Southern Pacific Co., at Room 1008, 65 Market St., San Francisco, Cal.

Willard B. Bellack, m '19, is general manager of The Better Products Co., of Columbus, Wisconsin, a firm engaged in the manufacture of incubators and brooders. Catalogue No. 38, of the company is at hand, and on page 4 we note the classic features of the famous former editor of our own Campus Notes department together with the information that he is Secretary of the Columbus Poultry and Pet Stock Association and "takes a keen interest in poultry." We'll say he does. He was one of the keenest chicken fanciers that ever matriculated at this institution. With Bill as a secretary, the success of the poultry and pet association is assured.

Frank B. Bowley, m '05, is professor of mechanical engineering, University of Minnesota. Home address, 63 Barton Avenue, S. E., Minneapolis, Minn.

E. S. Burnett, m '05, is sales engineer with the Bahnson Co., N. Y.

W. C. Erstein, m '15, is sales manager of the Peerless Foundry Co., Cincinnati, O.

Judson E. Fuller, m '12, is Secretary of the Harrington and King Perforating Company, Chicago. He is married to Jessie Bonar, '13, and has one son seven years old.

G. A. Gerdtzen, m '93, ME '95, 317 E. 5th St., Winona, Minnesota.

A. P. Gerhardt, m '21, and member of the staff of the WISCONSIN ENGINEER during his college course, is student engineer with the Western Electric Co., at Chicago. He is taking a 48 weeks' course of training at the plant at 48th Ave. and 22nd St.

Berger A. Hagen, m '21, is a student engineer with the Western Electric Co., at Chicago.

Andrew B. Hawkins, m '21, is with the Flintkote Company, manufacturers of prepared roofing material, at Chicago Heights. His address is 1410 Vincennes Ave., Chicago Heights, Ill.

C. E. Ives, m '19, 632 Milwaukee Road, Beloit.

Burton E. James, m '21, gives his new address as 924 South Avenue, Wilkinsburg, Penna.

Paul H. Kurtz, m '21, is a student engineer with the Western Electric Co., at Chicago.

W. G. Mantonya, m '19, one-time poet of the WISCONSIN ENGINEER, now lives at 313 Pine Grove Avenue, Chicago.

Geo. T. Moore, m '18, Sales Manager, Wisconsin Parts Company, Oshkosh.

Walter S. Nathan, m '18, junior engineer, City of Milwaukee. Home address is 602 Frederick Avenue.

Henry Rekersdres, m '14, is an industrial engineer with the Shur-on Optical Company, Rochester, New York.

Jack Rubenstyne, m '21, is an instructor in machine drawing and design at Kansas State.

R .G. Teschan, m '14, **W. F. Teschan**, m '07, **and Frank Schroeder**, c '07, have organized the Sphinx Machine Company in Milwaukee for the manufacture of small refrigerating machines.

J. B. Wilkinson, m '17, now lives at 230 West 15th Place, Chicago Heights, Ill.

Walter A. Zinn, m '98, Vice President, Evinrude Motor Company, Milwaukee, Wisconsin. Home address, 909 Hackett, Milwaukee.

MINERS

A. F. Robertson, min '11, 2411 Harvard Ave., Butte, Montana.

ENGAGEMENTS

Louise Sargent to **Dwight Stiles**, c '19.

Marion Olbrich to **Lawrence P. Works**, e '19.

MARRIAGES

The announcement of the marriage of Adeline Parmelee of Cooperstown, New York, to **Clarence E. Cooper**, ch '17, has been received. Mr. Cooper is employed by the New Jersey Zinc Company at Depue, Illinois.

Mr. Jacob Reineck announces the marriage of his daughter, Lydia Katherine, to **Charles J. Goldammer**, e '17, October 20th, at Elkhart Lake, Wisconsin.

Lydia Mary Begole of Denver, and **Arthur E. Van Hagan**, e '06, EE '10, were married on October 7. They will live in New York City.

Lillian Hanan, Oregon, to **M. D. Jackson**, e '21, Madison.

Imogene Kriskey, '16, to **John W. Griswold** m '13, Aug. 10. Mr. Griswold is with the Crew Levich Co., Philadelphia, Pa.

BIRTHS

To Mr. and Mrs. **Harlow Bradley**, Paris, France, a daughter, Jacqueline Chase, July 13. Mr. Bradley received his B. S. degree in chemical engineering in 1914.

To Mr. and Mrs. **F. S. Halladay**, Green Bay, a daughter. Mr. Halladay graduated in 1913 as a civil engineer.

To Mr. and Mrs. **W. R. McCann**, Newtonville, Mass., a daughter, Adrianna, Aug. 25. Mr. McCann received his masters degree in electrical engineering in 1915.

CAMPUS NOTES

R. B. Bohman

TO OUR NEIGHBORS

It seems that the law students have at last been convinced of the fact that they need something with heads on.

Copied in Ohio State Engineer Vol 5 No 2 p 20

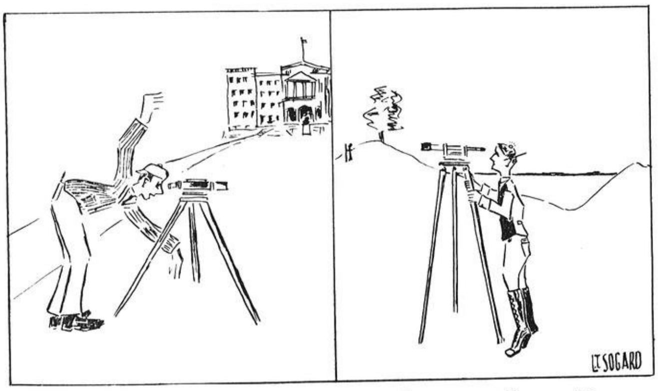
Instructor (to Engineering Geologists): "Fossils are commonly found imbedded in sedimentary rocks such as sandstone. The Law Building is a splendid example of sandstone".

WHAT SORT OF BAIT?

Co-ed: Did you get your Badger?

Frosh: No, but pretty near.

Why is it That:



Tall Birds Set 'em Up This Way — Little Guys Do it Thusly

ENGINEERS VS. LAWYERS

Almost five weeks of school have passed and not once have we heard on the campus the old Engineers' welcome to our friends from the Law School. Why? Is it that we can't yell while laughing at their canes? Is it that the invasion of girls from the merchants' school into our sacred portals keeps us too busy looking? Or, is it that we have lost our traditional good humor? Let's show that we haven't.

Walter Mackey, instructor in the department of drawing, admits that he considers the subject of negative logarithms to be exceedingly "obtruse" mathematics.

And while we are barking about this rather multi-branched subject, we might define the status of Professor Slichter in this neck of the woods. It seems that several of our greater or lesser lights about town regard the Professor as having charge of Logarithms in the University.

But said lights are laboring under a busted filament. We are informed that the subject of Logs. is taught in the Math. department by Mr. Wood.

WHY GEOLOGY CANNOT BE TAUGHT IN KANSAS: Says Professor Twenhofel to his would-be geologists on a recent field trip, "When in doubt as to what to do next, just climb to the top of the nearest steep hill."

A senior mechanical and a senior electrical were waiting in line at the Y. M. C. A. cafeteria. The mechanical was scanning the religious notices, the electrical the bill of fare.

Sez the mechanical: "What are vespers?"

Ditto electrical: "Haven't tried them. How much do they cost?"

The City of Madison has erected a fine pressed brick engine house for its fire department, and the notables of the city were recently gathered to dedicate the structure. During the ceremony, the fire truck was to back into the station,—but alas and alack,—when the attempt was made, the door was found to be one foot too small to allow the truck to pass.

Professor Berrgren (in Steam & Gas 1): "Now I wish to impress upon you men the fact that every hour you spend in this class room is worth two dollars".

Last row mechanical: "I owe you eight dollars, Berg, I haven't been paying attention for the past week".

We prescribe a 10-fifths dose of Steam and Gas to the Frosh who asked if the hot-looking, leaky Corliss in the shops was an *ice* machine. Being about 'steen dozen years old, the engine can't even be called a *nice* machine, so hunt him up, Berg.

It has been reported that all good junior electricals, now studying the text on Langsdorf, have had their recently used copies of "the notes" bound in substantial fashion for future reference. In the halls, however, we overheard one black sheep of the class who said to another: "Yes, I got mine bound in morocco, and I guess I'll let it stay there, too".

"All dated up for next summer", joyfully boasts friend co-ed, a summer native of Devils Lake regions. After reading the account in last month's issue of the Civil's social rampages up there we believed her, too.

A Few

XMAS

Suggestions

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Rings	Photo Lockets
Vanity Cases	Beauty Pins
Earings	Cuff Pins

FOR HIM

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Pocket Combs	Scarf Pins
Pocket Knives	Cuff Links
Chains	Binocular
Fobs	Field Glass
Watches	Pedeometer
Rings	Match Boxes
Belts	Emblem Jewelry
Cigarette Cases	Receipt Cases

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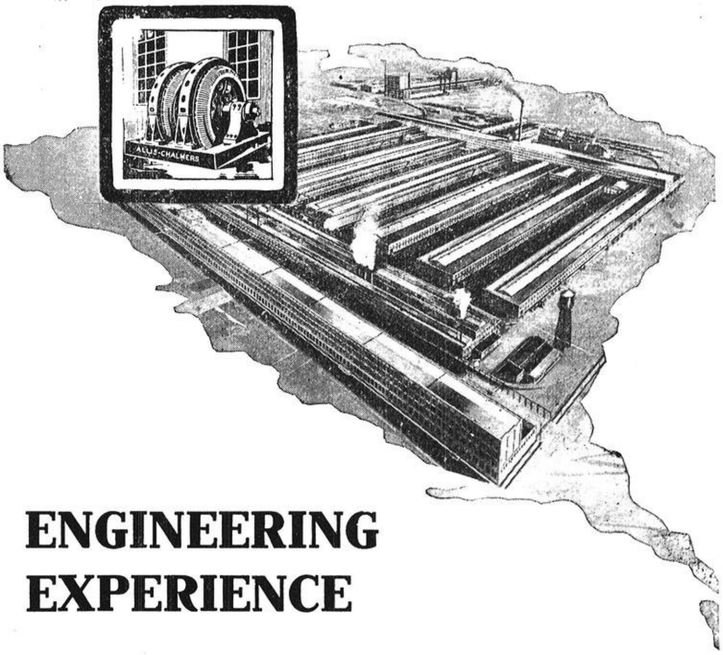

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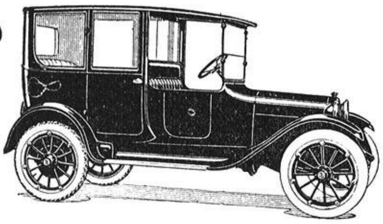

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Professor Ingersoll has a promising class in physics. In explaining a problem in force, he used as an illustration the well-known striking machine seen at county fairs. "Now just what happens," he asked, "when you hit that lever arm and ring the bell?" "You get a cigar," was the response in chorus.

PERAMBULATION

That one-fifths course in Perambulation promised by Prof. Dabney to shorten the trips to the new shops on Breese Terrace has been looked for in vain by Shop 1, 9, and 13 men this semester. The distance is mentally shortened, however, if one visits the new shops and compares them with the ones vacated.

University postal authorities would have us believe that in the near future it will cost $1.75 to mail a letter to the new University shops on Breese Terrace, and that said expense may be itemized as follows: Twenty-five cents for postage, and $1.50 to cover the cost of re-soling the postman's shoes.

MORE AGRICULTURAL ENGINEERING

The professional Agrics who didn't want "that thar water after all the 'lectricity had ben tuk out'er it", thereby spoiling a hydro-electric-irrigation project, belong in the same class with the farmer who attempted to solve one of Prof. Danny Mead's water power problems. Said he, "Ain't got no fall, hev ye? Wall, dig a hole off ta one side. Then ye'll hev fall."

ENGINEERING VS. THE 18TH AMENDMENT: "A road should be built like a house," said Professor Smith, "with a tight roof and a dry cellar." And the class responded in chorus, "Houses aren't built with dry cellars now-a-days."

REMARKABLE REMARKS

(With apologies to the Independent).

"It is time that you began to realize that this university is not a complex system of suction pumps designed to transfer knowledge from professorial heads to the heads of students."

W. H. Kiekhofer.

"If a man tells me that he wants his house painted black, (ahem) I'll paint it black; but if he wants a rotten foundation, then I quit, (ahem)."

D. W. Mead.

"You there in the seventh row, wake up; your parents should never have sent you here; you could do your sleeping at home where it's much cheaper.

Louis Kahlenberg.

"Now, we as engineers, and men of affairs, would look at it from purely an analytical point of view."

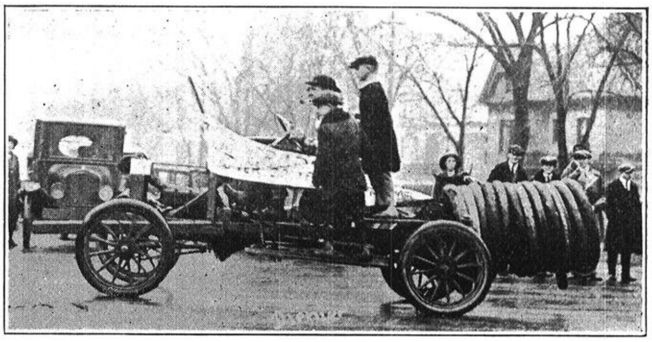
C. P. Woy.

"Now, as I was saying at the close of the last period, —". *Eight out of every ten*

"That's the Capitol up there!" yelled '22 across the campus to several T. E's seated on the grass measuring angles in that direction.

SLIDE RULE FOR HIGHEST FRESHMAN

To the freshman of our college who at the end of this school year possesses the highest weighted grade average goes an engraved slide rule of special design; a gift of Tau Beta Pi in the interests of fostering scholastic attainment. The rule will be formally presented early next year before the new freshman class. It is hoped that each year a rule may be offered and that the idea may bcome traditional.



One of the Prize Winners

HOME-COMING HOBO PARADE

Saturday, October 29, saw the Engineers take part in an unusually well-staged Varsity Home-coming Hobo Parade; its success being due, no doubt, to its able management by an engineer, Frank P. Hyer, e '22. Steam and Gas entered largely into the various methods of locomotion, as the time-honored quadrupeds were not to be trusted on a wet and slippery pavement. A scheduled hand-car race via State St., between the Engineers and the Lawyers, a feature of the show, was won from the Laws by default. It was reported that our neighbors raised Cain over the matter, but to no avail. Engineers figured prominently in the final awards as is shown by the fact that "Wid" Hance, m '24, and "Les" Garber, e '22, walked away with first and third prizes, respectively. "Hap" Phillips, m '22, was awarded the distinction of ownership and management of the longest, toughest and stiffest beard in the University. Yea, verily, our sons represent the College well.

Shop 12 men receive the additional training this semester of directing the work of Shop 7 men. This is believed to be an innovation in shop training methods and it promises to be beneficial to both parties. Among the problems given in these courses is the construction of a centrifugal pump for Prof. Ward, the establishment of a modern filing system in the shops, and the making of new tools and fixtures preparatory to the installation of the machinery in the new shop buildings.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Many hints as to what one who is spending time, and incidentally considerable money, shall see when taking an automobile trip to the Pacific Coast were dropped by Professor Ray Owen in his informal talk to the A. S. C. E. chapter on Wednesday evening, October 12, describing the trip he made during the past summer. He intimated that the railway companies who control some of the parks, such as Glacier Parks, have the routes well planned to extract the maximum fare from the traveler who is so unlucky as to go that way. The autoist is made to feel about as much at home in these parks as a fly in a plate of soup.

"Too much city planning" was evident in some of the "scenic" drives on the coast, according to Professor Owen, and crews were busy straightening the curves to prevent accidents which were so often occasioned by the winding roads.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

"The Electricals 'show was the best of them all".

"I stood for an hour outside their booth".

These and similar remarks, overheard on the campus while the University Exposition was in progress, serve to show the competence of the "E. E's" in organizing and directing student projects. Who was responsible for the success of this exhibit which proved so attractive to hundreds of visitors?

Who lays plans for the parades in which the Electricals take part? Somewhere there is a group of men which thinks and cares for several hundred. This group is organized as a student chapter of the American Institute of Electrical Engineers. During the past year, it has greatly increased its membership, thus allowing it to function more successfully than it has in the past. Plans for its activities during the coming year are now being laid. The A. I. E. E. is entering upon a year which will prove invaluable to those of its members who support it.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

That ball and roller bearings are "immortal" if properly cared for, and that their design and manufacture involves the most complicated of mathematical applications and the highest degree of accuracy and skill was pointed out by Dr. Danzig, of the S. K. F. industries, in a talk before the A. S. M. E. chapter, Thursday evening, October 27. The talk was illustrated with slides, and proved both interesting and of technical value to members and others who attended.

ALUMNI NOTES

(Continued from page 33)

To Mr. and Mrs. **S. A. MacDougall,** 321 Drexel Avenue, Indianapolis, Ind., a second son, Malcolm, March 31. Mr. MacDougall is a chemical engineer with Bordens Milk Co., and is of the class of '13.

To Mr. and Mrs. **W. D. Moyer,** Newport, Me., a daughter Ethel Fox, Sept. 11. Mr. Moyer is a mechanical of the class of 1912.

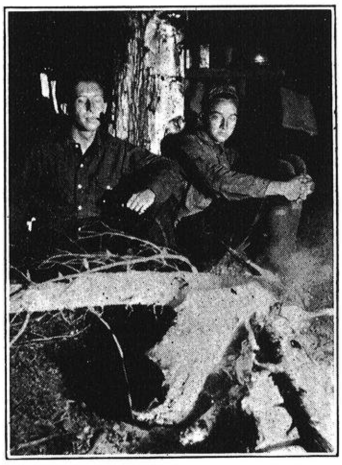
To Mr. and Mrs. **H. K. Weld,** Wilmette, Ill., April 12, a son, Raymond Topping. Mr. Weld received his degree in general engineering in 1905.

To Mr. and Mrs. **V. E. Williams,** Chicago, Illinois, a daughter, Jean, Sept. 14. Mr. Williams is a 1915 Electrical.

THE MINERS' WESTERN TRIP

(Continued from page 30)

green underbrush that was trying to conceal the ravages of the flames long past. Wallace nestles in a bowl-like valley, shut in from the world by the mountains that tower about. It is hardly a mining town, but more of a



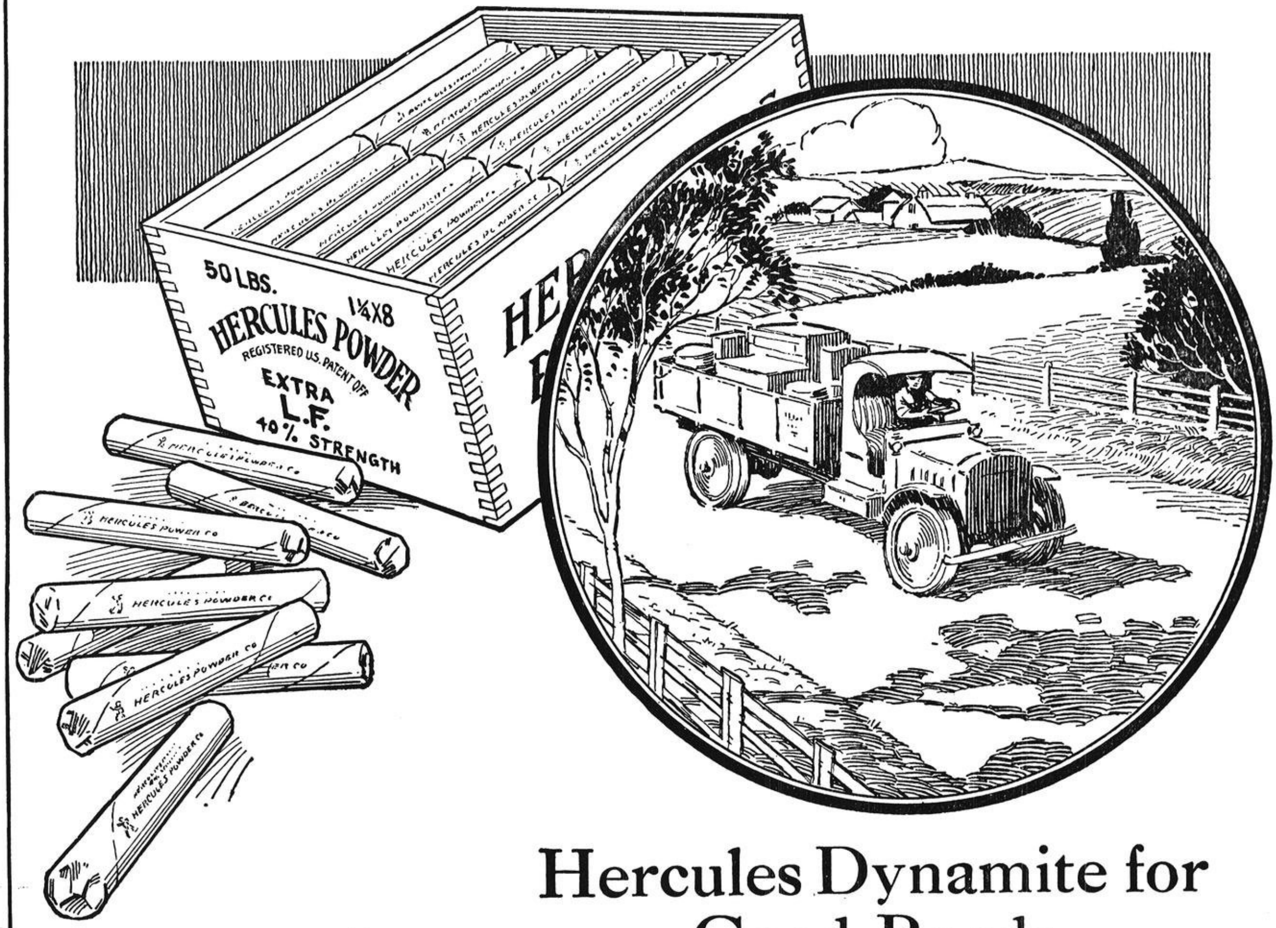
MANN AND HAHN GO PROSPECTING

We found an ideal camping spot, where we remained for a month.

commercial center for the mining towns of Burke and Mullen. We visited the Hecla and Morning Mines at Burke and Mullen, and the Bunker Hill Mine and Smelter at Kellogg. We also went to see a gold-dredger in operation near Beaver Creek where we tried our luck as trout fishermen and that being poor went in swimming instead. A party of fishermen from Wallace that had been more successful than we treated us to part of their catch, and we enjoyed our first taste of mountain trout, the supreme delectableness of which we know will never be duplicated.

Jones and Wolters remained in Wallace to work at Bunker Hill in Kellogg where they put in a month's time before they returned home. The rest of the party went on to Spokane by way of Lake Coeur de Alene. From Spokane, Fourness and Uhlig went on to the coast on their way home, and Redin left for Los Angeles, leaving four of us who were going to Trail and Rossland, B. C. We left the following day, our route, for the greater part, lying along the Columbia River. We visited the mines and smelter of the Consolidated Smelting and Refining Co. at Trail and at Rossland, after which Prof. Shorey and Lars Humel started on their homeward journey. Mann and I had contracted the gold fever, so as a cure we decided to go prospecting. We found an ideal camping spot on the shores of a mountain lake, where we remained for a month and where we found a mine of experience and happiness with which we were quite satisfied.

The Miners found the trip very profitable not only from the experience derived from seeing mine and smelter practice, but from the standpoint of better citizenship. Because we became better acquainted with our country, and with our countrymen and their mode of living, we found a greater love for it and great pride in the good old U. S. A.



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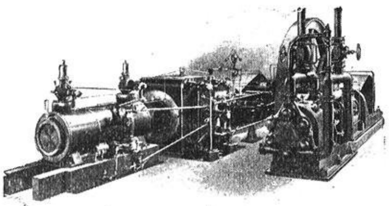

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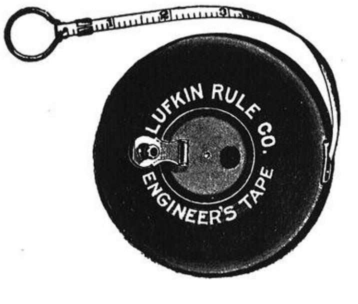

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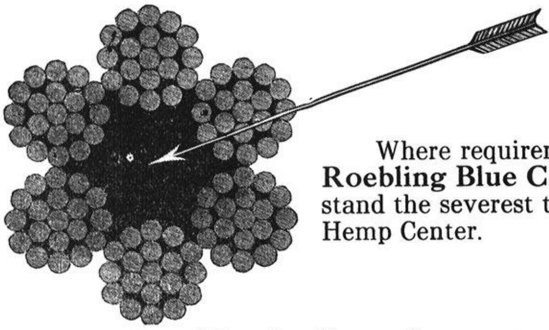
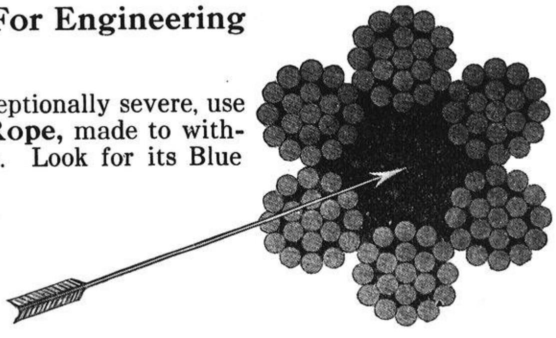


Where requirements are exceptionally severe, use **Roebling Blue Center Steel Rope,** made to withstand the severest tests of service. Look for its Blue Hemp Center.

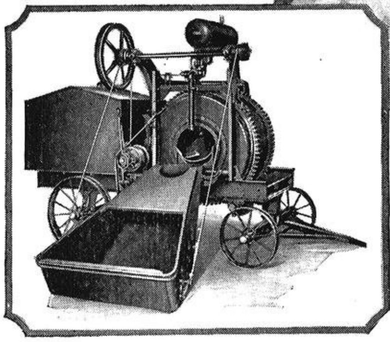


John A. Roebling's Sons Co., Trenton, New Jersey

IN the construction of modern highways, time-saving machinery has taken the place of the huge armies of artisans which, by brute strength accomplished the road-building of the Egyptians and Romans.

The nerve center from which modern highway building radiates is the concrete mixer. Without it, the present wonderfully developed system of paved roads would be only a chimerical dream.

The concrete mixer has made possible the economical building of culverts, the rapid construction of bridges and approaches, the placing of concrete foundation for brick and other two-course pavements, and—probably its greatest achievement of all—the construction of the thousands of miles of smooth, hard and enduring concrete roads reaching across all sections of the land.



There is a particular type of concrete mixer for each of these phases of road engineering.

Culvert construction demands very much different equipment from paving construction. An average culvert requires the mixing of only a few cubic yards of concrete. Wherever, along the road to be paved, a cross ditch or sharp hollow happens to lie, there a culvert must be built.

To meet these conditions the Koehring Dandy Light Mixer is used. It is sturdy and substantial, yet light in weight and easily portable from culvert to culvert in quick time by truck or team.

The Dandie's quick mobility arises in part from its small size; its capacity of 4 and 7 cubic feet of mixed concrete are just right for the well planned culvert project.

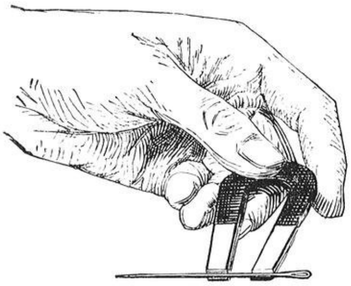
KOEHRING COMPANY

Manufacturers of Concrete Mixers and Locomotive Cranes

MILWAUKEE, WISCONSIN

KOEHRING

Kindly mention The Wisconsin Engineer when you write.



Why Is Iron Magnetic?

A horse-shoe magnet attracts a steel needle. But why? We don't know exactly. We do know that electricity and magnetism are related.

In dynamos and motors we apply electro-magnetic effects. All our power-stations, lighting systems, electric traction and motor drives, even the ignition systems of our automobiles, depend upon these magnetic effects which we use and do not understand.

Perhaps if we understood them we could utilize them much more efficiently. Perhaps we could discover combinations of metals more magnetic than iron.

The Research Laboratories of the General Electric Company investigate magnetism by trying to find out more about electrons and their arrangement in atoms.

X-rays have shown that each iron atom consists of electrons grouped around a central nucleus—like planets around an infinitesimal sun. X-rays enable us to some extent to see into the atom and may at last reveal to us what makes for magnetism.

This is research in pure science, and nothing else. Only thus can real progress be made.

Studies of this kind are constantly resulting in minor improvements. But some day a discovery may be made which will enable a metallurgist to work out the formula for a magnetic alloy which has not yet been cast, but which will surely have the properties required. Such a result would be an achievement with tremendous possibilities. It would improve all electric generators, motors, and magnetic devices.

In the meantime the continual improvement in electrical machinery proceeds, in lesser steps. These summed up, constitute the phenomenal progress experienced in the electrical art during the past twenty-five years.

General Electric Company

General Office Schenectady, N. Y.

95-453H