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THE CUTTING OF METALS BY OXIDATION

JAMES ASTON

An interesting application of simple and well-known chemical principles, and one which has been attracting a good deal of attention because of its utility, is the cutting of metals by the oxyhydrogen or oxyacetylene blow pipe.

The oxyhydrogen blow pipe is a piece of apparatus which has been in use for so long a time as to be familiar, at least by name, to most engineers. It is an adaptation of the ordinary gas and air blast lamp, in which the temperature limits of this device are raised by the substitution of hydrogen as the combustible and oxygen to support this combustion; the latter being especially advantageous, since ordinary dry air consists of 20.8 per cent of oxygen, which is of service in the combustion reaction, and 79.2 per cent of nitrogen, which is useless in supporting combustion and yet plays the larger part in limiting the flame temperature attainable. The influence is shown in the following figures of theoretical maximum flame temperatures, that of the oxyhydrogen flame being 3190°C, of hydrogen with dry air 2010°C, and of hydrogen with 25 per cent excess air 1760°C. The oxyacetylene blow pipe differs in no essential from the above, except that acetylene gas is used instead of hydrogen.

The oxyhydrogen or oxyacetylene flames are thus adapted to localized heating to high temperatures, and are used in the socalled autogenous welding of various articles. By raising the material to temperatures slightly higher than those required for welding the point of fusion could be reached, and the separation or cutting of the metal effected by this melting. However, this method of cutting is of little service; for several reasons. First, the metal to be cut (considering steels as a concrete example) has a high fusion point, between 1400 and 1500°C; second, should the material be of appreciable size, its heat conductivity is so great as to decrease the effective temperature very markedly; third, this effect is especially pronounced since the heat generated is from an external source.

The real development of the burner for the cutting of metals came with the utilization of the principle that metals oxidize, the rate of oxidation being a function of the temperature, and becoming very rapid when the material is raised to a high heat and subjected to an atmosphere of oxygen. The metal burns, a fact in every day evidence in the blacksmith shop, when a piece of steel at welding heat is subjected to the air blast.

In the case of iron the reaction which takes place may be taken for purposes of illustration as

$$Fe_3 + O_4 = Fe_3O_4$$

This reaction is accompanied by an evolution of heat amounting to 270,800 small calories for each 168 grams of iron oxidized. The product resulting from the oxidation is Fe_3O_4, the black magnetic oxide of iron, fusible at about 1250°C, or 250 degrees lower than the temperature necessary to melt the iron itself.

Using the above heat of formation of Fe_3O_4, and its specific heat, calculation gives 1370°C as the temperature to which the oxide will be raised; or in the very act of formation, the oxide will keep itself fused, provided there is no loss of heat.

In the earlier type of apparatus, a single burner or nozzle was used. The hydrogen and oxygen gases were mixed in the proper proportions just before the outlet of the nozzle, and the flame caused to impinge upon the metal until it was heated to a bright red. At this temperature of 700 to 800°C the metal oxidized very rapidly, and the hydrogen supply was cut off, the temperature being kept up by the heat of reaction.

The advantages of this method over that of direct fusion are obvious. The temperature necessary is a few hundred degrees below that of fusion of the steel; but of greatest importance is the fact that the generation of heat is internal. We may liken the conditions to the heating of a wire by the passage through it of the electric current, or by means of a Bunsen burner. In the former case, the maximum temperature reached must be in the wire itself and the heat is transmitted from it to the surroundings; whereas in the second instance the wire receives its heat from an external source which source must of necessity have the greatest temperature.

This oxidation method of heat generation finds an extensive application in the Bessemer process, where the molten pig iron is added to the converter, and subjected to a blast of air. The rapid oxidation of the silicon, manganese and carbon generates sufficient heat to not only keep the bath molten without further fuel supply, but also to appreciably raise its temperature. The temperature increment depends largely upon the rapidity of oxidation, which in turn is dependent upon the volume of air supplied per unit of time.

Oxidation cutting is really a continuation of the Bessemer process beyond the point which is the bane of the steel worker; the point where the bath becomes overblown, or burnt, due to the oxidation of the iron after the impurities have been removed. In cutting steels, then, the principal generation of heat will come from the formation of magnetic oxide of iron. The small quantities of carbon, manganese, silicon and phosphorus are also oxidized with generation of even greater heat per unit weight than is obtained from the iron; and with the added advantage that their oxides, combining with the Fe_3O_4 will form a slag of even lower melting point than that of the iron oxide. This latter effect, however, is small with the small amounts of impurity in ordinary steels.

The great detriment in the single nozzle type of burner is that the temperatures obtained are not far enough above the fusion point of the oxide, the theoretical difference being 1370° – 1250° = 120°C. Consequently the oxidation is not sufficiently rapid, making the cutting rate slow, and subjecting the metal to the heat for too long a period of time. This effect is more pronounced if the piece to be cut is large, since it causes a lowering of temperature because of the rapid conduction of heat away from the reaction zone. As a result, the cut is irregular and dirty, due to the viscous oxides, which lack the fluidity necessary for clean elimination.

The great improvement in the oxyhydrogen blow pipe for the cutting of metals came about 1901, with the adoption of a multiple nozzle burner, with two nozzles as the simplest type, mounted in tandem; the oxyhydric, or preheating nozzle being directly in advance of the oxidizing, or oxygen nozzle. This arrangement provides for the continuous heating of the metal by the straight blow pipe action of the oxyhydrogen flame, in preparation for the reaction caused by the oxygen jet, which does the cutting. Calculation shows that this preheating to 800°C raises the reaction temperature to 1440°C, or 70° higher than is possible without preheating, and furnishes sufficient additional heat to make the iron oxide fluid enough to be quickly driven away by the force of the jet. The increased rapidity of the oxidation results in quicker and cleaner cutting, with less overheating of the metal adjoining the cut edge, and less loss of heat by conduction away from the zone of reaction.

The complete apparatus consists of the burner, which may have two or more nozzles, armored flexible tubing for the conveyance of the gases, a chamber for the proper mixing of the oxygen and hydrogen for the preheating nozzles, and the heavy cylinders for holding the gases, stored under pressures of 1500 to 2000 lbs. per square inch. Also there are the necessary regulating and reducing valves, gauges, and safety devices for elimination of danger due to back flashing in the torch.

The burners are provided with two or more nozzles from

$\frac{1}{16}$ to $\frac{1}{8}$ inch in diameter, and arranged in tandem, with the preheating nozzles in advance in the direction of cutting. This tandem arrangement of small nozzles allows rapid working with a very narrow cut. For sections six inches in thickness one style of torch has two oxygen nozzles for cutting and four oxyhydrogen for preheating. The multiplication in the number of jets is mainly in the preheating section, and is greater for the cutting of thick pieces, because of the point brought out earlier in the article that the temperature attainable by external heating is very markedly decreased by the loss due to the conduction of the surrounding metal. With the oxygen jet, on the other hand, the greater dissipation of the heat is after it has served its useful end.

The advantages of the process over ordinary methods of cutting by cold sawing are obvious. The cut is as clean as that of a saw and no wider, being only $\frac{1}{4}$ to $\frac{3}{8}$ of an inch even on thick sections. While in special cases the cost of cold sawing may be less than by the new process, the oxidation method will of course accomplish the work in very much less time (about $\frac{1}{20}$ of that of customary methods), and has the added merits of portability and flexibility.

For example, the burner can be mounted upon special mechanical devices for guiding it in straight lines, or for cutting circles or special shapes. Again, the hardness of the metal does not affect the cutting speed. Hardened or annealed, cast or rolled, high carbon or low carbon steels are all cut with equal facility. Also, nickel, chrome, or manganese steels, which could not be touched with a saw, are as readily cut by the oxidation flame as are soft steels, since nickel, chromium, or manganese oxidize with even greater heats of reaction than that of iron.

Many applications of the method to special purposes could be cited. Around the iron blast furnace, plugged tap-holes or cinder notches can be opened in minutes of time, where formerly hours were required; or holes can be cut through the shell for the installation of special tuyeres to fuse away some obstruction which is causing hanging of the stock. In the steel foundry, risers can readily be cut from castings too large to be mounted under a saw. Armor plate or large special forgings can be worked to approximate shapes, and finished by means of the blow pipe. Holes can be readily cut in places where formerly it was necessary to resort to the drill and chisel. Steel piling can be cut off close to the water line after driving has been completed.

A most interesting application was the result of the explosion of the boiler plant of the Pabst Brewing Company at Milwaukee last fall, in which four large boilers, the coal bunkers, structural steel work, etc., made a tangled mass of debris which would by ordinary methods have taken a number of workmen several days to cut up for removal. By means of four torches, the mass was in six hours cut into small pieces ready for rapid removal.

Some data regarding the burners, gas consumption, and speed of cutting for various thicknesses of steel are given in the appended table, taken from a manufacturer's catalogue.

Table of Consumption

Thickness of the metal in inches.	Nozzles of cutter.	Nozzles of heater.	Gas consumption in cubic feet for each lineal foot of metal cutting.		Time in minutes and seconds for cutting of metals 12 in. long.	
			O.	H.	Min.	Sec.
¼	1	3	1.5	1.5	1	.00
½	1	3	2.5	2.5	1	.00
¾	1	3	3	3	1	.00
1	1	3	3.5	3.3	1	.30
1½	2	4	4.4	3.8	1	.30
2	2	4	6	4	1	.30
2½	2	4	7.8	4.5	2	.00
3	2	4	9.6	5	2	.00
3½	2	4	12.	6	2	.00
4	2	4	16.	7.6	3	.00
4½	2	4	19.5	9.3	3	.00
5	2	4	22.6	9.8	3	.00
5½	2	4	25.	10.5	3	.00
6	2	4	27.5	11.2	3	.00
6½	2	4	32.	12.	3	.00

As will be noted the speed of cutting varies from twelve inches per minute for thin sections using a four nozzle torch, to four inches per minute for a thickness of steel of six inches, in this case with a six nozzle burner. The nozzle diameters are given as 0.06 to 0.08 inches for the oxygen jet, and 0.12 to 0.16 inches for the preheater.

A pertinent question in connection with the use of high

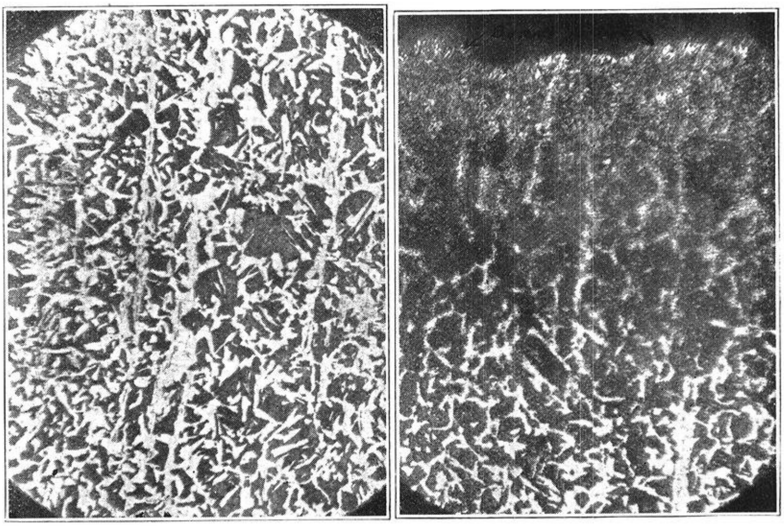
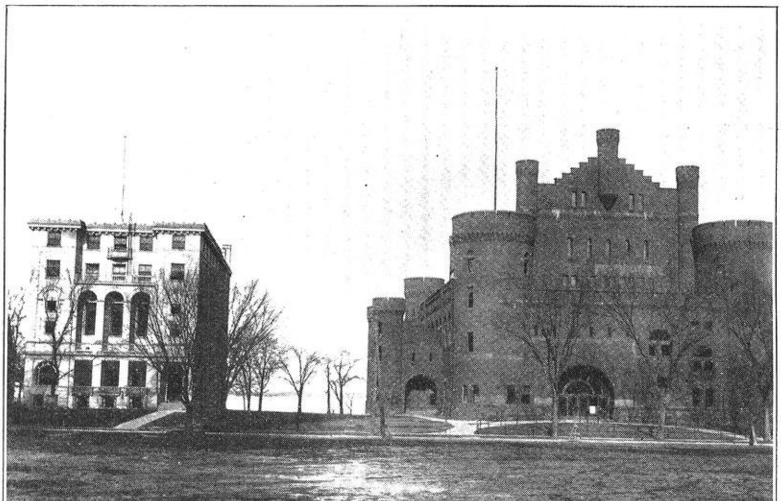


Fig. 1. Normal Structure of Interior of Casting *Fig. 2. Gradation of Structure from Cut Edge Inwards*

Steel Casting Cut by Oxyhydrogen Blowpipe

temperatures for cutting steels, is the effect of the heat on the material, and the depth of penetration of this effect. The writer examined a sample obtained from a steel casting which had been cut by the oxygen jet, and prepared the photomicrographs shown in Figures 1 and 2, the magnification in these reproductions being 43 diameters. Figure 1 shows the normal structures of the casting, with its dark pearlite and light ferrite areas in a proportion indicating about 0.40 to 0.50 per cent carbon. At the left of Fig. 2 is shown this same structure, gradually changing into the very confused structure which extends to the cut edge of the section. This confused structure is typical of a steel which has been burnt, or overheated to the point at which oxides have formed and the value of the steel destroyed. While measurement of the depth of this burnt region on the figure shows it to be about $1\frac{3}{4}$ inches, at first thought a considerable penetration, reduction to its true depth on the casting by dividing by the magnification of 43 diameters, gives the actual detrimental penetration of 0.04 inches, an amount too small to be of moment.



Association Hall and Gymnasium

FREIGHT YARD CONSTRUCTION

Claude L. Van Auken

The construction of a railway freight yard presents many phases which one does not see unless he observes very closely. The writer has had some experience in this kind of work and will attempt to give a general account of the work as it has been carried on in the construction of some freight yards, special reference being made to a large terminal freight yard near Chicago.

Locating or Staking Out Leads and Side Tracks

The location and layout of a yard having been decided upon, engineers are sent to the location to stake out the leads and side tracks. On leads, three stakes are usually set for each switch; one at the head-block or switch point, and the other two locate the frog point. These two latter stakes are set on the center line of the two tracks so that the frog can be set midway between them, its axis being at right angles to the line of the two stakes. Thus the original location stakes are not disturbed, and can be referred to at any time.

Track centers and grade stakes for the side tracks are set every 100 feet. It has been assumed that grading was done previous to this. Wherever it is convenient, yards are located on level ground that requires little grading.

Distribution of Material

The distribution of material is a matter which requires much skill and some experience. If the material is properly distributed the work can be done speedily, while if the material is not properly distributed, general confusion will result, causing delay and added expense.

On all of the larger pieces of construction, material yards are built. All material is shipped to this yard, and it is checked up before being distributed. From this point material is sorted, loaded, and carried by train as near to the place where it is to be used as is possible. Material for the leads is placed near the point where the lead runs into the main line or previously existing track. Sometimes a temporary track is laid on the site of the proposed lead, and all material for the leads is distributed from this track. When no temporary track is laid the material for each switch is carried forward on push cars running on the track which has just been laid. Material for the side tracks between the leads is distributed either from the temporary track or by bringing up material from the rear by push cars running on the newly laid track, and then carrying it ahead by hand. When one track is laid clear through the entire yard, material for the next track is distributed from trains running on this track, and this method is repeated then with the next track, and so on across the entire yard until all of the material is on the ground in the proper place.

If material is not properly distributed there will be a tendency on the part of the individual foreman to supply their needs from the nearest source, without regard as to whether or not such material is needed at the place it was taken from. When this practice is resorted to, general confusion and delay result immediately. It is far more economical of both time and expense to provide proper and early distribution of material. In ordinary practice, even with skillful men, material cannot be perfectly distributed for all parts of the work on any piece of construction of considerable size. It is therefore customary, and good practice to keep a "material gang" on the work from beginning to end. When not employed with material, this "gang" may be used to help out in other lines of work. This gang should promptly take care of material that has been used in temporary work. If this is not done, in large cities there is a liability that the material may be stolen. This is especially true of timber.

The work of handling material properly is seen to be of primary importance, for without material, the work of construction cannot be commenced, and even when once commenced it is at all times dependent upon material for its continuance and completion.

Laying Switches

As soon as the material is on the ground the laying of the switches is commenced. For this work a gang of about fourteen men with one foreman, or a gang of about twenty-five men with a foreman and an assistant, is best. This assumes that the laborers employed are foreigners or a class of men not familiar with the work. Under these circumstances, larger gangs cannot be conveniently handled, for the foreman must not only watch each and every part of the work, but he must also, from time to time, demonstrate the method of using tools. The handling and organization of the men is a very important factor and is discussed more fully in an article entitled, "Practical Railway Track Work," in the February and April (1909) issues of this publication.

The first thing to be done is to level off the ground, upon which the switch is to lie, so that the ties can be laid down and spaced. The switch ties are either piled according to assorted lengths or with all the different lengths intermingled. In either case, a set of a certain number of each length must be obtained, and the supervision of a foreman is necessary in picking out the proper lengths and sending them to the site of the switch in the proper order. Another foreman can well be used to see that the ties are spaced and laid down in their proper places. Ties are not all cut to exact even foot lengths and usually anything between 9 and 10 feet in length is called a 9-foot tie, and anything between 10 and 11 feet in length, a 10-foot tie, etc. Thus a switch requiring eight 9-foot ties, is likely to contain, in the 9-foot lengths, ties which are over nine feet in length. All the ties should be measured exactly and the longest ones, in any one assortment placed nearest the frog. The required number of ties and their spacing, together with all necessary dimensions and data as to material, is found on the drawings showing standards of practice, which are provided by all railways of any considerable size.

The ties having been laid down, the frog is then placed in its proper position as shown by the stakes. The stakes, however, always show the theoretical frog point, and the actual point of the frog should be located a few inches back of the stakes, the distance depending on the number of the frog, as shown in the standards. The rails are now set up from the frog toward the switch point. In fitting rails between the toe of the frog and the heel of the switch point, the number of rail cuttings is made as small as possible, and in many cases the length of the switch lead is changed in order to avoid cutting rails. In a No. 7 switch (a quite common yard switch) for instance, the theoretical lead is 65.92 feet; the practical lead used is 61.15 feet; for this requires the cutting of but one rail. A 30-foot rail is cut into two pieces, one 14.9 feet long; the other 15.1 feet. The 14.9-foot piece is placed against the toe of the frog in the straight side and the 15.1-foot piece in the curved side; and thus the difference in length between the straight and curved rail (about 2 inches) is taken care of. Against these pieces, 28-foot rails are placed, and then the switch points against these the length of the switch point and the distance from the toe of frog to the point of frog making up the balance of the practical lead. When practical switch leads are used, the head block stakes are disregarded; the frog is located according to the stakes and the head block then falls where the practical lead brings it. Frog stakes always take precedence over head block stakes. The rails, set up as above, are bolted together, the switch rods are bolted on the switch points, and then the spiking is commenced.

The spacing of the ties, as shown in the book of standards, is marked on the rails, and the ties brought to the proper position directly beneath these marks and "square across the rails," i. e. at right angles to the straight track. The outside rail on the straight track is spiked first. This side is also the "line side" for the ties, i. e., the rail is spiked at a given constant distance from the end of the tie, so that when the rail is "lined" straight, the ends of the ties will also be lined straight. Starting from the frog end of the switch, the first gang of spikers, spike every other tie on the line side; a second gang follows and spikes the remaining ties on the line side. On the opposite rail another gang of spikers follows with a track gage, spiking the straight track to standard gage. The spiking from the heel to the toe of the switch point presents some difficulties. Here, the sliding of the points must be provided for. To allow this, switch plates are used on the ties. The outside spike on the line side is driven, the plate is then tapped toward the spike until the spike is in place in its slot; then the inside spike is driven. Since the inside spike does not rest against the base of the rail, the tie must be held with a bar so that the outside spike is firmly against the rail when the opposite end of the tie is being spiked. "Loose gage" (slightly wide gage) should prevail at and near the head blocks. To make the switch points fit snugly against the rail when gaging, the turn-out rail on the inside of the curve is "stocked" or bent at a slight angle with a rail bender (called a "Jim Crow"), at a distance of about 10 to 16 inches ahead of the point.

When the straight track is spiked in full and aligned, the outside rail of the curved track between the switch points and the frog (sometimes called the "switch lead") is thrown to proper alignment as determined by "lining in" with the eye. This rail is then spiked and the inside rail of the curve is gaged and spiked. The switch stand can now be set. The connecting rod, between the stand and the points, is put in place. With the lever and target of the switch stand in the desired positions, the switch is thrown over with a bar so that one of the points fits snugly against the rail, and the stand is then spiked so that its connecting rod holds the points snugly against the rail. The amount of "throw" of the switch is then made the required distance by means of the adjustable switch rod connecting the points.

The guard rails are now set. Guard rails protect the frog point and prevent derailment at the frog. These rails are usually 15 feet in length, but for sake of economy, various available lengths from 10 to 20 feet are used. The first few inches on each end of the guard rail are bent at an angle, and the base of the rail on the side away from which the bend is made, is chiseled off so that the ball of the guard rail can be set at a distance of, from about $1\frac{3}{4}$ to $1\frac{7}{8}$ inches from the ball of the main rail. If filler blocks are provided to fit between the webs of the rails, the distance between rails is thus fixed. The longitudinal position of the guard rail varies greatly. It is good practice to locate it with two-thirds of its length ahead of the frog point. It is spiked in position and prevented from overturning by rail braces. Rail braces are also used against the main rail on the ties between the heel and point of the switch rail, and in other places about a switch where the curve is sharp and the rail is liable to overturn. To be effective, rail braces should always be set opposite each other in the track, and on the same tie. The switch is now complete and it is surfaced and "relined." Connections with other switches in the lead, and with the side tracks can now be made.

Laying Side Tracks

The yard tracks between the two leads are usually straight and the construction of them is much more simple than the construction of the switches. Sometimes second hand or used material is laid in side tracks and often rails of different lengths and weight are used. This fact introduces many little difficulties which do not arise in main line construction, where new material is used; but as yard tracks are never used for high speeds, the niceties of construction may be overlooked. Here, as in many phases of railroad work, the object is not to produce a perfect piece of work, but to make it amply adequate, for the purpose in view, in the quickest possible time, with the least expenditure.

Surfacing

Directly behind the track laying crew (or "steel gang") a surfacing gang follows. The surfacing material, usually either sand or gravel, is unloaded from cars either by hand or by patent dump cars and then spread with plows. A method of spreading material sometimes used, is to run the rear wheels of the rear truck of the train upon iron shoes which slide upon the rail and hook over a tie placed upon the rails directly in front of the wheels. When the train backs up this tie slides along on the rails and on top of this tie two planks, placed edgewise, one on top of the other, are held against the truck by the surfacing material. This arrangement forms a flat faced plow which spreads the material even with the top of the rail, and prevents the material from getting under the wheels and derailing the gravel train.

Men with shovels now dig out the gravel from the rail at the joint and center of each rail so that track jacks can be put in position for raising the track. Four jacks can be used advantageously in surfacing work. They are worked opposite each other in the track, one pair taking joints, the other the centers of the rails. At some distance ahead, usually about two or three hundred feet, a "spot board" is placed on top of a grade stake and leveled up. A spot board consists of a plank about fifteen feet long in which a spirit level is placed. About four or five inches from the bottom of the board a black stripe about one inch wide is painted. The rest of the board is painted white. The foreman is provided with two blocks, equal in height to the distance from the bottom of the board to the top of the black stripe. The track opposite a grade stake behind the spot board is brought to grade and one of the blocks placed on the joint at this point. One rail length ahead the jacks are set and the remaining block is placed on this joint. The track is then raised until the second block is sighted in with the first block and the stripe on the spot board. The center of each rail is raised to grade in the same way. Ties are tamped with shovels sufficiently to support the track, then the jacks are moved ahead. Each rail length is surfaced in this manner.

Following the jacks are the tampers who tamp up the ends of the ties, and, following these men, still another gang tamps the "centers" of the ties, or the part between the rails. This arrangement of tampers is used only under certain conditions. Each individual foreman usually has a method of his own as regards tamping, and conditions vary so greatly that among any number of arrangements which might be given, none would be satisfactory for all conditions which one engaged in this kind of work is liable to meet with. After the track has been surfaced as above, or by other methods, it is dressed up according to the standard required by the engineer in charge, ane then is complete and ready for use.

Sewers and Drains

Frequently the drainage of a yard is left until the other construction is finished. This is especially true of yards where little or no fill is made. The course of the main drainage pipe and the laterals is staked out by the engineers, grade stakes being placed at convenient intervals. On each stake is marked the depth of the bottom of the trench below the top of the stake. The width of the top of the ditch depends upon the depth, the width desired at the bottom, and the material in which the excavation is being made. Lines are stretched along the surface of the ground to mark the limits within which to excavate. Usually, conditions do not warrant the use of trenching machines, and the excavation is done by hand with the laborers used in the track work.

A long straight edge, with a track level on top of it, placed on top of a grade stake and leveled up with one end held against a graduated rod placed in the trench, will give the depth of the bottom at the point where the rod is held. As soon as a few feet of the trench are completed, the pipe laying is commenced. It is well to keep the pipe laid right up to the completed excavation; so that in case of "cave in" or excessive storms, little excavation will have to be done over again. Where the grade is slight, the pipe should be laid level between stakes, except for the last few lengths, and the entire grade for the distance is put in these last few lengths. This will prevent running below grade at any point, and with the class of labor usually employed by railroads in the west, this is a necessary precaution.

For the building of manholes and catch basins a brick mason should be employed. If for any reason there is a tendency for water to collect and stand in any part of the yard, additions to the drainage system should be made to remove the water.

RIVER GAUGING WITH ROD FLOATS

BY GEO. W. BROWN, B. S., '86, C. E., '90

The young engineer, just out of school, particularly if that school was so located as to afford him no practical experience in hydrography, is apt to feel very lonely upon receiving a wire from his chief directing him to gauge the flow of a certain river. To supply him by next passing steamer, with a current-meter and its accompanying paraphernalia, does not add materially to his composure. Besides, the meter may not have been used for several months and is not accompanied by a table of rating. Then, to make matters worse, there may not be within a day's journey of his camp a larger expanse of still water than is contained in the converted pork barrel serving as a camp cistern.

Given the time, our young adapter of nature's laws would rate his meter in a running stream, and then with it would determine the velocity of the stream itself; all with a considerable degree of accuracy. But in these days, except in the public classified civil service, no delay can be allowed for these approximations. Not only must the stream be gauged at once but the results must be reported without delay. Our young friend soon collects himself and, after spending about as much time in preparing other appliances with which to do the work as he would in repacking the meter outfit for return shipment, he proceeds to gauge the stream with rod floats. The chances are that he will find the work, as well as the reductions, so simple that for river gaugings, under ordinary conditions, he will use rod floats in preference to a meter, even if it be supplied with a most satisfactory certificate of character. The accuracy of his results will not be materially less than of those obtained by the use of a modern current-meter.

It is not to be doubted that within the years since '86 was turned loose on a long-suffering public, the Engineering Department of the University of Wisconsin, has added to its appliances and facilities for hydrographic investigations. That class did its stream gauging upon the bosom of the raging Yahara, at one of the railroad bridges in East Madison. A meter of the Ellis type was used. We rated it in the lake just west of the University grounds. Its constants were both so large that, while it rotated feebly in the strength of Yahara's flood, a large percentage of the flow passed by unchallenged in other portions of its section. So we guessed at the discharge, and the work was done. The experience we acquired, except in the matter of guessing, was of a negative character.

It is often desirable to determine, on short notice, the flow of a stream. One cannot be expected always to have a current-meter at hand. To accomplish the result with a considerable degree of accuracy, and with such appliances as almost any locality affords, is the problem. At the risk of saying much with which the reader is already acquainted, I give in detail a method of stream gauging by use of rod floats, with an outline of the reductions.

The example given is that of gauging the French Broad River, near Asheville, N. C., in November, 1896. The place chosen was a fairly straight section of the river, and reasonably free from the influence of obstructions. This being a mountain stream of small depth and steep slope, a place was chosen where the water was deep and the local slope light. At that stage, which was considerably above low water, the river had a surface width of about 350 feet. A base-line 200 feet in length was laid off on the right bank as near to the water and as nearly parallel to the main thread of the stream as practicable. Three sections or ranges were laid off at right angles to the base-line at either end and from middle point, and were marked by range flags on either shore. The sections were sounded with a 12-foot pole shod at lower end and graduated to feet and tenths from a boat rowed slowly across the stream and against the current, upon the marked range.

The soundings were taken as nearly as possible at equal intervals and were located in the following manner: With transit set at intersection of base-line and range, and with stadia rod held in boat abreast of sounder, the stadia distance was read off direct. In lieu of a stadia, a level rod might have been used for this distance; but either should be inverted in order that one wire of the instrument might be kept at the zero point of the rod. Not much practice is required to catch distances at a glance with a considerable degree of accuracy. With a recorder at the instrument, every sounding may be located; but with a reasonably regular bottom the location of every alternate sounding will suffice.

One foot to five foot rod floats had previously been prepared and adjusted to differ in submerged length by six inches, having each a freeboard of about two inches. The rods were of white pine, one and one-half inches in diameter, and were weighted by lead pipe of some external diameter fitted at the lower end. Final adjustment for submersion of rod was made with shot held in the lower end of the pipe with a plug. The rods were fitted with a staff of No. 10 wire, some of eight inches long, carrying a flag some 6 inches square, by means of which the rod could be kept in view. Any light material, or a section of tin pipe, might be used for a float, and it might be ballasted with an iron bolt. Whether its length is an even unit or if it projects a considerable distance above the water, is immaterial, so long as it is not affected by the wind. It is not necessary to have so many rods, or that they float so near the bottom of the stream, so long as we have the data for reducing from rod velocity to mean velocity, through wide variations. The writer has gauged a stream of 800 feet in width and from 3 to 15 feet in depth with only four length of floats.

In the French Broad gauging, in question, the rods were run across the ranges about every thirty feet, or as near that spacing as it was convenient to place them without undue delay. From inspection of sections the longest rod was started, in each case, which it was presumed would float without touching the bottom. If a particular rod struck bottom the flag announced that fact; the observation was cancelled, and a shorter rod started. With transit on base-line at upper section, and with stadia rod held in boat as for sounding, the boat was placed in the approximate thread of the stream some 15 or 20 feet above the range. The float was dropped from stern of boat and started on its trip. The second of crossing the upper range line was noted and recorded. The stadia distance to the boat, which was made to follow the rod only as far as this range, was then noted. An assistant preceded the rod to the lower range, 200 feet away. As it approached that range he called out, "stand by," and at the instant of crossing he called "mark;" the time being noted and recorded. The rod being followed by the transit, its angular position with reference to the base line, at the instant of crossing the lower range, was determined. At the signal from shore the rod was picked up by the boat and returned to its starting line. To facilitate the recovering of the rod a light linen or silk line was made fast to its upper end and paid out freely from the boat, which was kept well above and to one side of the rod during its run.

All of the notes of this survey, not given in the first six columns of Tab'e I, below, are shown graphically upon the accompanying diagram. The basis of the diagram is a plan of the base-line and the ranges, with the water lines of the river. With the range lines as water surface lines, cross-sections of the river were constructed from the sounding notes. Sections of the river at upper, middle and lower ranges are shown by the polygons U u u U′, M m m M′ and L l l L′, respectively in light full lines. The paths of the twelve floats were platted from notes in columns 3 and 4 of Table I. It will be noticed that all of the floats, in this particular case, inclined more or less toward the base-line; showing that line not to have been located parallel to the average thread of the current. This, or any reasonable inclination of float paths, does not effect the accuracy of the results obtained; since the increased distance run is inversely propor-

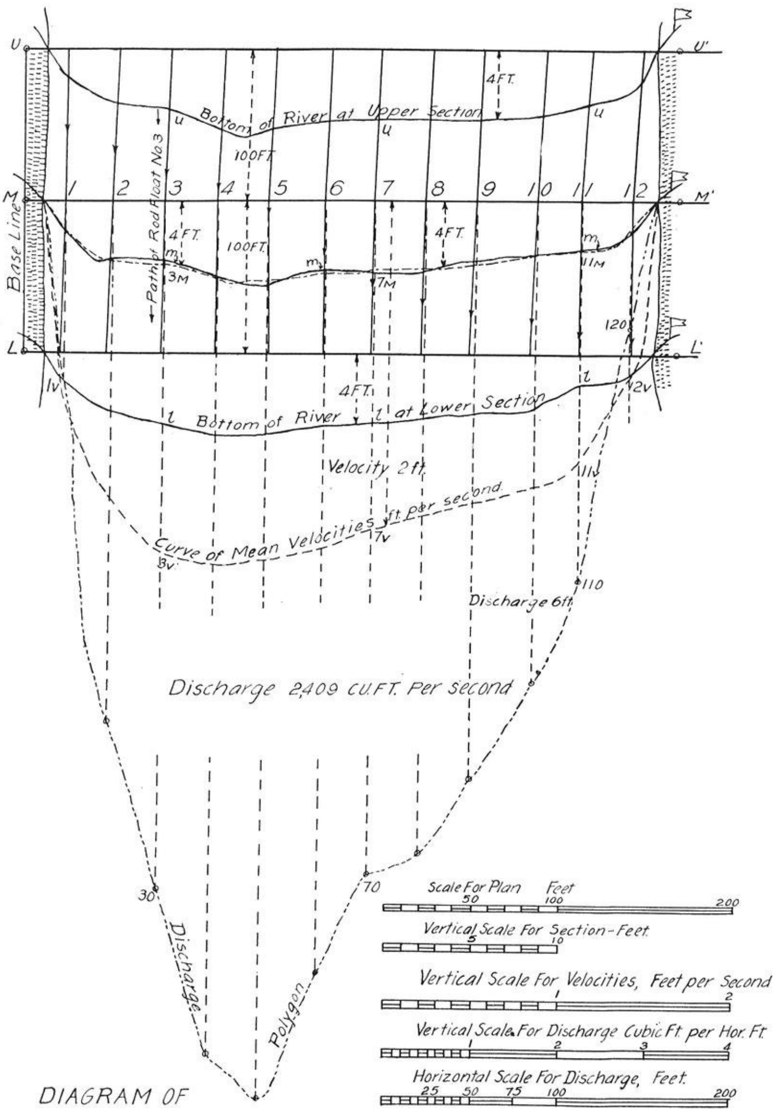


DIAGRAM OF

RIVER GAUGING with ROD FLOATS.

THE FRENCH BROAD RIVER, NEAR ASHEVILLE N.C.

November 1896

tioned to decreased perpendicular distance between their paths. The depths of the stream, perpendicularly below the intersection of each path with the range lines are then scaled, and a fourth cross-section is constructed on the middle range, from depths which are the weighted means of the depths at the three intersections. This mean depth is taken as $\frac{1}{4}$ the sum of the upper depth, the lower depth and twice the middle depth. This mean section is shown by the polygon M 3M 7M 11M M′; in a dashed line thus: - - - - - - -, and these depths are entered in column 9 of table: The time of passage of floats over this 200 feet stretch of river is then deducted from the difference between columns 5 and 6 of table and entered in column 7. The velocity of float in feet per second is then computed and entered in column 8.

This brings us to a consideration of the reduction from the velocity of the rod as run, to the mean velocity of that thread of the stream from the surface to the bottom. The accompanying formula for such reduction is that given by Mr. Francis, in his Lowell Hydraulic Experiments:

$V_m = V_r\ [1 - 0.116\ (\sqrt{D} - 0.10)$., in which

V_m = mean velocity for full depth;

V_r = observed velocity of rod float, and

$D = \dfrac{\text{depth of stream below bottom of rod,}}{\text{depth of stream,}}$ or

D = The percentage of the depth of the stream which is below the bottom of the rod.

The above formula is strictly true when the bottom of the rod is approximately 5 per cent. above the bottom of the stream, and should not be used without modifications when it is more than 10 per cent. above the bottom. The writer has made experiments to determine what modifications could be used in such cases. In a stream 12 feet in depth, five rod floats ranging from 7 to 11 feet in length were dropped into the same thread of water, from a boat anchored in the stream at a point above the upper range, and some two or three seconds apart. The passage of these rods across the ranges was noted and recorded. The rods were picked up by a second boat, returned to the starting point, and were run over and over again, in order to eliminate local effects, as far as possible, and to secure a mean velocity for the thread of the stream. The mean of the several observed velocities for each float was taken as the mean velocity of the stream for the depth to which the float extended. Such a modification of the Francis formula was required that the mean velocity for the full depth might be determined from the mean velocity of the shorter floats. It was found that within the range in question, that is when the distance below the bottom of the rod was no more than one-third of the depth of the stream, the value of V_m would be given, with a great degree of accuracy, by substituting a variable for the quantity ".10" in the last term of the formula. This term was found to increase algebraically about one per cent. for every one per cent. increase in the value of D. With the term "–.10" correct then D equals 5 per cent., the terms within the parenthesis will vary as follows:

$$\sqrt{.05} - 0.10;\ \sqrt{.10} - 0.05;\ \sqrt{15} - 0.00;\ \sqrt{20} + 0.05;$$
$$\sqrt{25} + 0.10;\ \sqrt{30} + 0.15;\ \sqrt{35} + 0.20\,.$$

in the .20. In the French Broad gauging the values of D varied from 7 to 33 per cent. and the consequent corrections to $\sqrt{D}$ varied from + 0.18 to – 0.08. These corrections are given in column 10 of table. The corrections to V, are given in column 11, and the value of V_m in column 12. In column 13 is shown the discharge for one foot in width of stream, in cubic feet per second; the product of the mean depth (Col. 9) by the mean velocity (Col. 12).

With the middle range line of diagram as a base the various mean velocities are platted in vertical ordinates immediately under the inter-section of that line by the corresponding floats. These points being connected with each other and with the middle range at shore lines (as shown in dash and dot line), gives the curve of mean velocities. Upon the same base line, and with convenient scale, volumes of discharge (Col. 13) are laid off in vertical ordinates, and being

TABLE I

Number of float.	Submersion of float—feet.	Distance from base line at intersection of upper range—feet.	Angle at U between base line and float at its crossing of lower range.	Time of crossing upper range.	Time of crossing lower range.	Time of float in drifting with current 200 feet—seconds.	Velocity of floats in feet per second, equals Vr.	Mean depth of water in path taken by float—feet.	Correction "—X" to be applied to "√D" in formula.	Correction from rod velocity (Vr), to mean velocity (Vm).	Mean velocity (Vm) of vertical film,—feet per second.	Volume of discharge for one foot in width of stream,—cubic feet per second.	Number of float.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.5	25	6 35	10 11 03	10 13 49	166	1.20	1.8	+.02	.95	1.140	2.052	1
2	3.0	53	13 53	18 06	19 50	104	1.92	3.4	−.03	.96	1.843	6.266	2
3	3.5	84	21 36	24 09	25 40	91	2.20	3.8	−.07	.98	2.156	8.193	3
4	4.0	115	28 57	30 05	31 32	87	2.30	4.6	−.02	.96	2.208	10.157	4
5	4.0	144	35 16	36 52	38 13	86	2.32	4.8	+.02	.95	2.204	10.579	5
6	4.0	175	40 50	44 50	46 22	92	2.17	4.3	−.08	.98	2.127	9.146	6
7	3.5	203	44 58	50 47	52 23	96	2.08	4.0	−.02	.96	2.000	8.000	7
8	3.5	233	49 02	56 46	58 25	99	2.02	4.0	−.02	.96	1.939	7.756	8
9	3.0	264	52 14	11 03 41	11 05 23	102	1.96	3.7	+.04	.95	1.862	6.889	9
10	3.0	295	55 31	11 18	13 08	110	1.82	3.3	−.06	.97	1.765	5.824	10
11	2.5	326	58 04	17 54	19 52	118	1.70	2.8	−.04	.97	1.649	4.617	11
12	1.0	352	60 13	25 22	28 06	164	1.22	1.5	+.18	.91	1.110	1.665	12

connected with each other, and with the base line gives the discharge polygon, the area of which, interpreted by proper scales, gives the discharge of the stream in cubic feet per second. It will be observed that, in a general way, the mean velocity and discharge polygons are parallel to the curve of mean depth. The area of the discharge polygon can be determined with a planimeter, or from cross-section paper, or it can be computed directly.

The field work of the gauging in question began after eight o'clock in the morning, and was finished at 11:30 A. M., by a party consisting of a chief, a recorder, one boatman and two helpers. The work was reduced and platted, and the results obtained by the chief of party and his recorder in less than an equal length of time.

Three or four gaugings of a stream at low, mean and high stages, will afford a diagram by which its discharge may be determined for any reading of the river staff. For stream gauging, this method affords sufficient accuracy, since the uncertainties of the volume thus obtained are very much less than the uncertainty of the particular stage of the stream, with reference to its high, low or medium stage.

The method of stream gauging with rod floats is better adapted to deeper than to shallower streams, to a limit of 18 to 20 feet in depth; and is applicable to widths up to 800 or 1,000 feet. Rod floats are also adaptable to tidal streams of reasonable depths, but the methods of use and of the reductions are not so simple as in the case given.

COPPER PROSPECTING WITH CHURN DRILLS IN ARIZONA

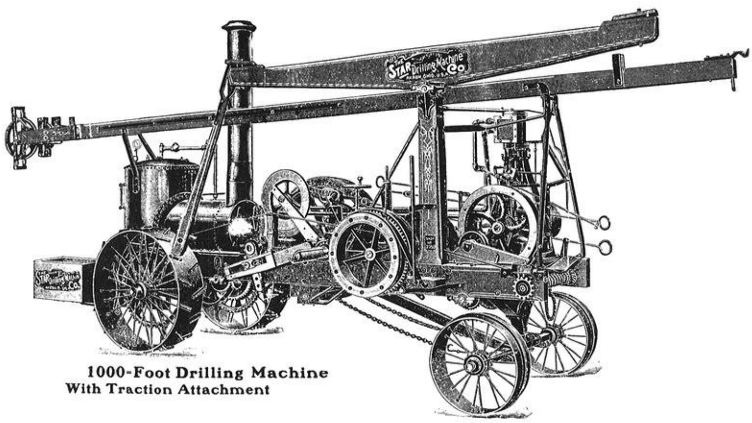
BY WILLIAM G. WEBER, '09

Arizona has long been a prominent copper-producing territory. The rich deposits at Bisbee, Jerome, Clifton-Morenci, and Globe have been worked for many years, and the output from these sources has steadily increased, until, in 1907, Arizona headed the list of states in the tonnage of red metal placed upon the market. This copper almost all came from two classes of deposits; lode and vein-like deposits, and replacement masses in the country rock. Both of these classes carry comparatively high-grade ore, and both require rather expensive methods of mining.

A third class of copper-ore deposit has long been known to occur in the territory, namely, the low-grade bodies of chalcocite bearing schist and granite now being worked at Miama, at Ray, and at one or two other places. These ore-bodies are well marked by their bright green and red-brown oxidized outcroppings and early attracted the attention of the prospector and the mine-promoter. Their importance was not realized, however, until within the last few years. Formerly only the higher grades and usually the oxidized portions of the ore-bodies were worked, and several dismantled leaching plants stand as witnesses to the attempts to extract the copper at a profitable rate. It was not until western engineers and operators demonstrated at Ely and Bingham, the applicability of the cheaper mining methods of the Minnesota and Michigan iron ranges to these great copper-bearing deposits, that development on a commercial scale was really commenced. Simultaneous with the opening of a new era in the history of copper mining in Arizona, was the advent of the churn drill into the field of copper-prospecting in the same territory.

The churn drilling machine has long been known to engineer and layman alike. As the light, portable, water-wheel drilling outfit, hauled from place to place by a team of horses, and as the "standard rig" of the oil fields, with its tall, tower-like derrick, it has become familiar to us all. Nor is it new as a means of prospecting for such valuable minerals as occur in flat-lying or blanket deposits—placer gold for example. Its use in connection with these copper deposits is therefore only a broadening of older fields.

The ground to be prospected is divided into 200 ft. squares, each corner being marked as a drill-hole location. Roads



1000-Foot Drilling Machine
With Traction Attachment

are then built to these locations, the road work being kept far enough in advance of the drills to avoid delays on this score. As the roads must be at least 9 ft. wide and substantially built, and as the surface of the ground prospected is almost invariably rough, these roads are quite an item of expense.

Moreover, since they can seldom be used for any other purpose, they must usually be charged entirely to drilling. The roads should not exceed 15 per cent in grade. A drilling machine can pull up a steeper grade, but the team of horses hauling the coal and supplies must be considered.

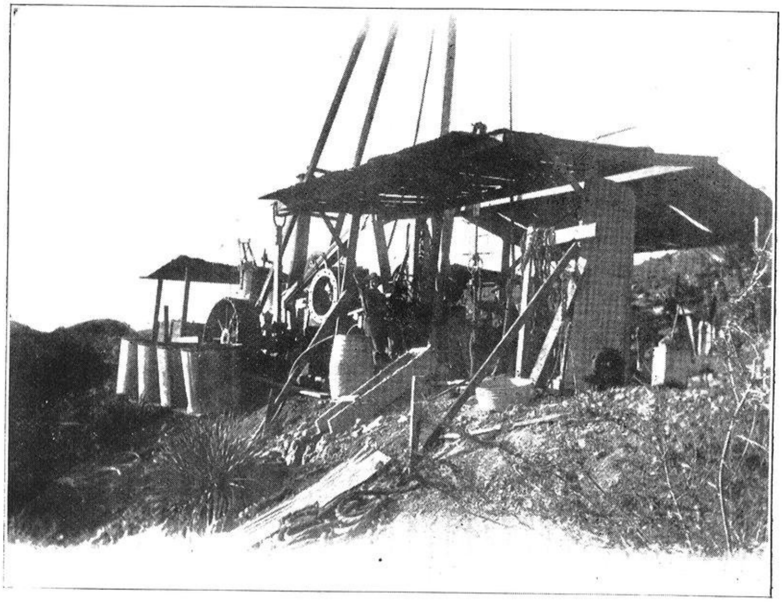
Before drilling can be commenced an adequate water supply must also be provided, and this is not always easy in the Miami district. Water is pumped from wells, springs, or underground workings, through pipe lines as much as three miles in length, to tanks placed at the highest points on the ground to be drilled, and thence through temporary lines to the machines. Between an actual shortage of water in periods of drought and the freezing and bursting of these temporary lines in cold weather, much time may be lost in the shut downs.

The machines now in use in Arizona are of the traction type. Both Keystone and Star outfits are in use. The latter, however, have the preference; they seem to run better and more smoothly, are less subject to break downs, have a simpler mechanism, and in general, may be said to be better adapted to the work. The Star machine is illustrated in the accompanying photos and maker's cut. The latter is correct except for the vertical sampson post, and shows the machine ready to be moved. There are now thirty or more machines operating in the territory. Drilling practice is practically the same in all cases, so the following description of Miami methods is applicable to all.

When a machine arrives at a location, it is blocked and leveled; the drive wheels are disconnected from the engine, and the spudding arm is attached to it. The mast is raised and steadied with wooden braces and with $\frac{5}{8}''$ steel guy wires. A floor, 14 ft. x 18 or 20 ft., built of 2″ plank, is laid in front of the machine; in the summer a simple roof of corrugated iron is built over this floor, sides and ends of the same material being added in winter. A longitudinal opening about three feet wide is left in the roof to allow the handling of casing and tools. Water tanks and a portable coal box are also placed before drilling commences.

The string of tools for starting a hole, or "spudding in," usually consists of a 10″ bit, 4″ x 20 ft. auger stem, and rope socket. The tools are strung up, a hole is cut in the floor where they will drop, and "spudding in" commences. When spudding, the cable passes direct from the tools over the crown pulley, down to the spudding wheel, and thence to the drum where the excess cable is wound. This spudding line is generally a section cut from a worn drilling cable; $1\frac{7}{8}''$ to $2''$ manila cable is used.

The spudding wheel is moved on an arm in such a way as alternately to raise and drop the tools in the hole. As the depth increases, cable is unwound from the drum, so that the tools may always strike a fair blow on the bottom. When about five feet of progress has been made, the cable is



Drilling

thrown off the spudding wheel so that it passes direct from the crown pulley to the drum; it is then wound on the latter, pulling the tools out of the hole.

A bailer is then lowered into the hole on $\frac{7}{16}''$ steel line wound on a separate reel. The bailer is often made of casing pipe—$4''$ to $8''$ in diameter, and 10 ft. to 20 ft. long. A dart valve on the bottom opens when the bottom of the hole is reached, thus admitting the sludge. The bailer is then hoisted to the surface and emptied into a trough which conducts the sludge to the sampling device. The bailer is run until the hole is dry, or all the cuttlings have been removed. It is then swung back out of the way, the drilling tools are run back into the hole, and spudding is resumed.

A varying amount of water is needed in the hole to keep the tools cool and to take up the sludge. When the natural flow is not sufficient, this water is thrown in from the surface.

Star Drilling Machine "Pulling Out"

With a Keystone machine, spudding may be continued to a depth of several hundred feet. With a Star machine, however, the wear and tear on machine and cable are too great, and consequently the Star driller "hitches on" as soon as practicable, generally at a depth of from 100 to 125 ft. Then, instead of carrying the motion up over the crown pulley and back again, the rope is attached by clamps and a temper-screw to a beam extending out over the hole, and operated by a crank and pitman. That part of the cable above the clamps is not used while drilling is going on, but is pulled aside out of the way. In pulling out, the cable is unclamped, the pitman taken off the crank and the beam pulled up out of the way, as shown in the photo, and the cable is then wound on the drum just as when spudding. A pair of short-stroke jars is inserted in the string of drilling tools between the stem and the rope-socket.

A drilling crew consists of two men—a driller and a helper or "tool dresser." There are two crews to a machine, each working a 12-hour shift or "tower," changing at noon and at midnight. When moving or casing, both crews work in the daytime.

Holes are drilled on the average to a depth of 500 ft. or until below the limits of commercial ore. The rate of drilling is quite variable, depending on the rock encountered, the depth, and the amount of water flowing into the hole. With a 10″ bit in average dry rock, which stands up well, 40 or 50 ft. per tower is not uncommon. On the other hand shattered and silicified schist which tend to cave and settle in the hole, and soft, sandy schist and granite which tend to run in at the bottom, are often encountered in the Miami district, and in such material, a drill may work a week or so and make little or no progress; in fact, the ground may come in faster than it can be drilled out. The presence of much water in a deep hole may also retard drilling, both by flotation of tools and cable, and by resisting the motion. In such cases it appears advisable to use a wire cable, with 100 to 150 ft. of manila cable, inserted immediately above the tools to absorb the shock and lessen the strain on the machine. The following tables show in a general way the variations in the rate of progress with respect to depth of hole and nature of work:

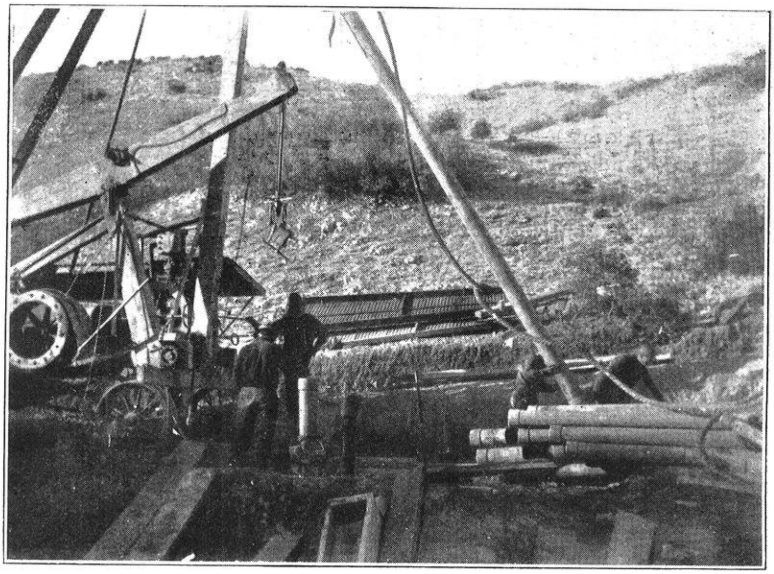
	TIME (HOURS)						Depth of hole (ft.)	Depth of permanent water level (ft.)	Rock	Kind of drilling	Ft. per 24 hrs.
	Drilling	Repairs	Delays	Moving	Casing	Total					
1	72	11	12	41	....	136	103	......	Granite	Fair	18.2
2	17[illegible]	12	60	45	14	303	252	......	Granite and Schist	Poor (Caving)	19.9
2	(Same as above + total time fishing)					684	252	......	"	"	8.8
3	....	....	....	....	....	336	340	(?)	Schist	Fair	24.3
4	....	....	....	....	....	456	421	290	"	"	22.1
5	....	....	....	....	....	420	427	(?)	Granite and Schist	"	24.5
6	369	8	113	47	43	580	468	320	"	Poor (Caving)	19.4
7	....	....	....	..	....	468	505	3[illegible]0	Schist	Fair	25.9
8	487	5	120	52	66	730	527	1[illegible]	Schist and Granite	Poor (wet & Caving	17.3
9	292	6	197	47	33	575	555	255	Granite	Poor (Caving)	23.3
10	481	37	44	40	34	636	608	465	"	Fair	22.9
11	....	....	....	....	....	588	635	380	Schist	Fair	25.5
12	376	32	86	35	...	529	645	(?)	Granite	Good	29.3

It is evident that in very shallow holes, the time required for moving and setting up may become a prominent factor in determination of the average rate of progress. Under delays are included shut-downs, redrilling bad holes, cleaning out after casing, and except in No. 2, time spent in fishing for tools lost in the hole. A drilling machine is expected to average 750 feet a month, everything included.

Delays in drilling may be due to various causes, as noted above, some of the chief of these being briefly explained here.

Crooked holes, and flat holes are sometimes encountered. Theoretically a drill hole should always be vertical, round and up to gauge, but either through carelessness on the part of the driller or otherwise, variations from the ideal hole are many and troublesome. As a result the bit sticks or the tools lag and do not hit an effective blow. The common remedy is to fill the hole up above the bad place with fragments of quartz gathered on the surface, and then redrill it. Sometimes a four-winged star bit is used in place of the regular I shaped bit and extra wide rope sockets are also used to reduce the play of the upper end of the tools in the hole. Shooting the hole with dynamite is occasionally attempted with rather indifferent success. In spite of all precautions few drill holes are vertical or straight, the tendency being to deflect a foot or two in a hundred.

Cavings, or pieces of rock falling from the sides of a hole



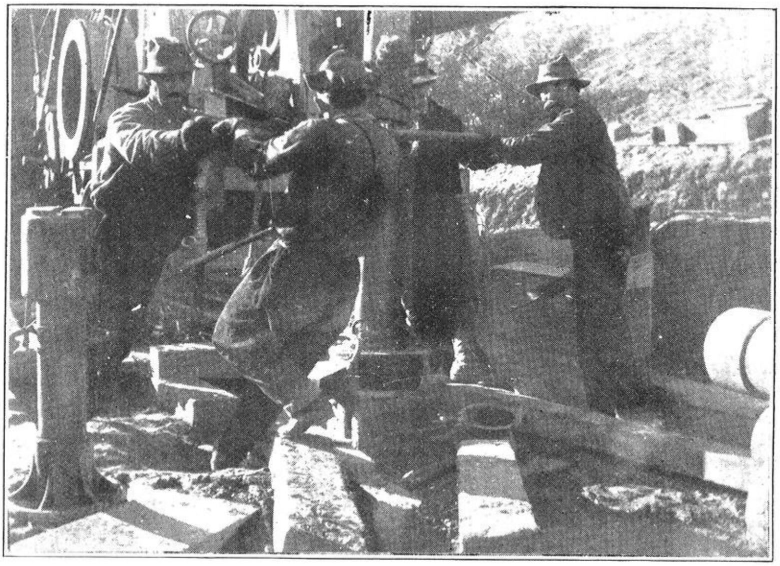
Pulling Casing
The Casing is seen projecting about 4 feet out of the hole
Beside it stands one of the hydraulic jacks

may seriously delay drilling, as well as interfere with sampling. Large quantities of rock often fall suddenly on the tools and may wedge them in so tightly as to make it necessary to cut the cable, if indeed it does not break, and fish for them with a second string. Sands running in from below may produce the same effect. These cavings occasionally fill the hole as much as fifty feet or even more above the bottom, and even if they do not catch the tools, much time is lost removing them. Usually casing the hole will stop the caving. Three sizes of casing are used in Miami, $7\frac{5}{8}''$, $6\frac{1}{4}''$ and $4\frac{1}{2}''$ in diameter, weighing 8 to 13 lbs. per foot. When a hole is cased, it is of course necessary to use smaller bits and tools. Four sizes of bits are used, $10''$, $7\frac{5}{8}''$, $6\frac{1}{4}''$ and $4\frac{1}{2}''$, these figures representing the diameter when dressed to gauge. With the last named bits, a smaller string of tools, $3\frac{1}{4}''$ in diameter, is used.

A hole may thus be cased several times if necessary. Each size of casing reaches to the top of the hole, and all are removed when the hole is finished. When casing is being handled, the drilling tools are lashed to the mast, and usually the manila cable is unwound from the drum, a wire cable being put on in its place. With this line, the joints of casing, each 18 ft. to 20 ft. long are hoisted up, over the hole one by one, threaded together and lowered until the bottom is reached, or until they will go no further. The casing rarely needs to be driven, and then only with light blows, this being accomplished by stringing up the tools and dropping them gently on a block placed on the upper joint of the casing.

To remove casing the process of lowering is reversed. When it does not pull readily, pulley blocks or hydraulic jacks or both are used, and occasionally dynamite is lowered into the hole and exploded to jar the ground loose. There are also a number of special tools, such as steel nipples, casing spears and the like, used in special cases and better described in the makers' catalogues than is possible here.

Finally, a serious factor in delaying drilling is the fishing job. The cable or one of the tools may break, a joint may become unscrewed, or the tools may be wedged so tightly by sudden falls of ground or runs of sand, that the jars will not work and the rope must be cut. Then the fishing job commences. Many and various tools are kept ready for emergencies, for it takes weeks to get anything from the supply houses. A fishing job is delightfully uncertain; it may last an hour or a week, or the hole may eventually have to be abandoned. In the last case, a new hole is usually started a few feet away. A second and a third string of tools may be lowered into a hole, to recover the ones already there, only to be lost in turn. Sometimes when success seems assured, some unexpected occurrence puts things in worse shape than before. Thus in one hole, a bit broke off at the pin, and the driller lowered a horn socket gently, to feel for the part remaining and learn, if possible, how it lay. The horn socket is aptly described by its name,—resembling a megaphone



Removing Casing from a Hole

somewhat, in shape,—and in this case it slipped over the bit and took just enough friction hold to bring it along to the surface and then drop it back in the hole, where it remains yet, all further efforts to recover it proving unavailing.

The object of this drilling is, of course, to obtain information concerning the ground penetrated. For this purpose the sludge is bailed out at five-foot intervals, approximately the true depth being determined each time by measuring on the boiler line. The sludge is dumped into a trough and conducted to a split divider which diverts $\frac{1}{8}$ of the material into a tub. This amount may subsequently be reduced to $\frac{1}{16}$, $\frac{1}{32}$, or $\frac{1}{64}$ if desired, by repouring the contents of the tub through the divider. The sludge is then dried over a fire, care being taken to prevent loss of sulphur through roasting; and the dried sample—which should weigh 25 or 30 lbs.—is sacked, tagged with the number of the hole and the depth at which it was obtained, and sent to the assay office. A sampler is employed on each shift to do this work. When two machines are working close together he can attend to both. He also takes a portion of each sample and pans it, noting the copper and iron minerals present, and their approximate abundance. The sulphides and oxides concentrate in the bottom of the pan; the copper carbonates and silicates are washed off, but may readily be detected even in minute quantities because of their bright colors. This and other information is recorded on a report blank.

The nature of the rock penetrated may be determined by the relative quantities of various minerals found in the sludge, and also by examination of such small uncrushed fragments as are often bailed out. When the formation is not the same from top to bottom, and the hole is caving, the exact nature of the rock penetrated may be indeterminable.

Faults and veins are quite readily detected in the capping over the ore through the presence of clay in the sample, also through marked variations in the amounts of iron oxides, copper carbonates, or quartz present in the sample. The width of the fault is represented by the distance through which this marked difference in mineralization occurs, but when the fault is steeply inclined, this is of course much greater than the true width. Faults in the sulphide zone are not so readily detected and doubtless are often overlooked.

Too much reliance should not be placed on the results obtained by drilling. Raises have been put up on a number of holes both at Ray and Miami, and while in some cases the drill returns and those from the raise check out quite satisfactorily, in other cases very poor results are obtained. A variation as great as 0.5 per cent has been found to occur in ores averaging 3 per cent or less. As a rule, the drill returns are low, a fact which is rather hard to explain. It is possible that the heavy sulphides tend to settle in the bottom of the hole and in fissures and pockets in the sides where they are undisturbed by the churning of the tools. In uncased holes, cavings from the overburden would of course lower the percentage of copper, and on the other hand, it has been found that after the hole has passed through a sulphide body, the samples may still indicate good ore. Under such conditions, casing changes the grade of samples materially.

Moreover, it is so easy for a careless sampler to neglect his work, especially at night. An unwashed trough may collect much concentrate; an uncleaned divider may clog and not split the sludge properly. Allowing the solids in a sample to settle and decanting off most of the water before placing the tub over a fire, is a common and legitimate practice—but too often much solid matter is allowed to float out with the water.

However, regarded not as a means of developing ore-bodies, but as a means of prospecting for them, determining their boundaries and obtaining a fairly close idea as to their tenor, the churn drilling machine is certainly a rapid, efficient and comparatively cheap instrument.

The drills are owned and operated by the mining and development companies, and no contract work has as yet been attempted in the territory.

The accompanying cost data are based on an assumed average life of four years per machine. A drilling machine with tools sufficient to operate for that length of time would cost about $6,000.

The minimum amount of road required per hole is about 300 ft. When holes are drilled at 400 ft., 600 ft., or greater intervals, the item of roads becomes correspondingly greater. On the fairly steep slopes (20°) encountered in the Miami district, $.75 is an average cost per foot of road.

Cost of Drilling

Item	Cost per ft. of hole	
Labor		
2 Drillers @ $6.00 per day......	0.48	
2 Helpers @ $4.80 per day.....	0.38	
1 Sampler @ $4.00 per day.....	0.16	
1 Foreman @ $6.00 per day (2 machines)	0.12	
	$1.14	$1.14
Roads		
Labor @ $2.00 per day........	0.50	
Foreman @ $4.00 per day......	0.05	
Powder, caps and fuse.........	0.03	
Tools, etc....................	0.01	
	0.59	0.59
Coal, coke, oils, etc.....................		0.27
Water		0.10
Teaming		0.10
Assaying, office and incidentals, etc.......		0.16
Interest @ 5 per cent and depreciation		0.20
Total cost per ft. of hole............		$2.57

The monthly average of the cost per foot of hole drilled varies with one company from $2.00 to $3.00. In another instance, where holes are drilled further apart and the drilling is poorer, the cost per foot has run as high as $5.00. When drilling is the only means of development being used on a property, the cost of camp maintenance and incidentals considerably swells the cost account. It would hardly be fair, however, to charge these items up to drilling when a comparison with other districts is being made.

BOSTON MIAMI DEVELOPMENT COMPANY
DAILY CHURN DRILL REPORT

Hole No. 7 Co-ordinate 3,000N; 200W Date Feb. 10, 1910 Shift A. M,
Drill No. 2 Size of Bit $7\frac{5}{8}''$ Driller Schoffner Helper Morrison
Water—Distance from Surface when first Bailer of last Sample of Shift was hoisted 175 feet
Faults and Clay Seams. Depth below Surface......feet. Width of Fault Material......feet
Casing. Size $7\frac{5}{8}''$ Depth 140 ft.

EMPLOYMENT OF TIME

Actual Drilling Hours 9 Moving and Sitting Up Hours......
Repair Hours on Engine 1 Casing 2
Other Delays..

SAMPLES

Depth	Character of Rock		Was Specimen Saved	Minerals	Number of Bailings	Sampl'g Appli'ce		Caving			Is Sample Reliable? if not, state reason under General Remarks	True Depth	Length of Sample	Remarks
	1. Silicified Schist 2. Black Schist 3. GranitePorphyry Other Rocks	Color Hardness Leached		A Chalcocite B Pyrite C Metallic Copper D Iron Oxides E Copper Carbonates F Chalcopyrite		Split Divider	Tub	No	Yes, Slightly	Yes, Considera'y		139		
145	3 + Qtz	Gray	No	Little D	Dry	$\frac{1}{32}$	...	✓			No	144	5	
150	"	"	"	D, Trace E	"	"	....	✓			Yes	150	6	
155	"	"	"	" "	"	"	....	✓			"	155	5	
160	"	"	Yes	Much A, B	"	"	....	✓			"	159	4	
165	"	"	No	" "	"	"	....	✓			"	166	7	
170	"	"	"	" "	"	"	....	✓			"	170	4	
175	"	"	Yes	A, B, Trace F	7	"	....	✓	✓		"	175	5	Struck Water

GENERAL REMARKS:

Sample 145 contained cavings due to casing
Depth of Hole at Beginning of Shift 139 feet Depth of Hole at End of Shift 177 feet
Tubs........... Sacks........... Envelopes........... Reports...........
....SAMPLER [SEAL]

SINCE GRADUATION

J. E. KAULFUSS, '04

It is customary that articles appearing in the ENGINEER deal with the technical description of some experiment or engineering work. However, to depart from this condition, an attempt will be made to present a theme touching more upon the life and conditions the college alumnus encounters rather than the technical features of his work. This ought to appeal to the undergraduate who is anxious to know just what may fall to him upon leaving the university. My experiences are probably those of the average.

I recall that, as we engineers assembled before the Engineering Building in June, 1908, the common question was, "Have you got a job and what is it?" At that time, all had jobs in sight but there was nothing definite for the most of us, a condition largely due to the financial crisis of the preceding February. In fact the only one I remember having a place was an electrical who had accepted an apprenticeship at $45.00 per month. But we were young, free, and full of hopes and ambitions, which I trust have been or are being realized.

For several weeks following, I was busily engaged applying for work everywhere and waiting for an offer. And, upon August 1st, I accepted a position in the government service on the Upper Mississippi River Improvement as Receiver of Materials at $60.00 per month and expenses. My duties, though requiring care and accuracy, were not very arduous and included those of clerk, timekeeper, recorder, transitman and rodman. The season's work lay between Winona and Richmond, Minnesota. Our outfit consisted of a 120 x 20 work barge, a hopper, and a two-story U. S. quarterboat about 40x16; its lower floor contained a kitchen, dining-room, men's room, bunk-room for the cook and his helper, and an office for the timekeeper, while the upper floor was reserved for bunks for the laborers. My quarters were excellent and the meals were fine. We worked eight hours per day except on Saturdays, when four hours constituted the day's work. We were engaged in the construction of wing dams and shore protection along the river, which was done by weighting down mats of 20-foot bundles of willow brush with limestone rocks at the ratio of about one cubic yard of rock to two of brush. And as soon as one piece of work was completed, we were towed elsewhere by U. S. steamboats. For outdoor work, good exercise, meals, and quarters, the position was excellent, but it did not include much experience along engineering lines, yet I will always fondly remember the many pleasant hours with the old-time loggers and "river-rats" in our crew, playing cards and swapping stories being their chief pastime.

This construction work ceased on November 1st, when I was placed in charge of a party to make a hydrographic survey of the Mississippi River from Winona south about 10 miles. Our party numbered eight, a recorder or sounder, two rodmen, two oarsmen, a cook, his helper, and myself. As the work progressed, the quarter-boat was towed from place to place by a United States steamboat, which also brought our supplies. The survey consisted of (1) establishing sounding stations determining lines from 300 to 500 feet apart, and perpendicular to the channel of the river; (2) locating the same, also the shore line, islands, dams, rip-rap, sloughs, creeks, sandbars, etc.; and (3) sounding upon the above lines. The sounding stations consisted of whitewashed laths nailed on poles or trees, forming the Roman numerals x, ii, iv, vi, viii, and repeated on the right bank, and i, iii, v, vii, ix, and repeated on the left bank. The stadia method was used, the party having a transitman, recorder, rear rodman, head rodman, a third rodman on the opposite side of the river, and an oarsman. In sounding, we used a large skiff with three oarsmen, the sounder in the bow and the recorder in the stern. The sixth man remained on shore at one end of the line, and by means of a flag, waved us up or down onto line. For sounding we had a 16-foot rod and 30-lead line. Beginning at one end of the line, we rowed as directly across the stream and at as uniform a speed as possible, sounding being taken every 15 seconds, the readings and kind of bottom recorded. We experienced very disagreeable weather during the survey, much wind, cold spells, rain and snow. In the sounding particularly, we were much discomforted by shipping considerable water. But, in spite of this, we made good progress, completing about one mile per day. A sudden cold wave about the middle of November resulted in a hurry-up order to stop the survey, when we were towed up to Fountain City, the United States winter quarters. This completed services with the government after a very satisfactory season, and I was out of a job, having been unable to find other work to step into immediately afterward.

After much discouragement and many unsuccessful applications, I accepted a position as rodman at $45.00 per month and board, with the Conrad Investment Co., at Conrad, Montana. This company proposes the irrigation of about 130,000 acres of present arid land in the northwestern part of Montana. At this writing a large earth dam has been constructed forming a reservoir 25 miles in circumference, upon the edge of which the new town of Valier has been built. The land is now open for settlement, and a 30-mile railroad has been built from Conrad to Dupuyer. The water supply comes from Dupuyer and Birch Creeks. Although a great deal has been done so far, it is probable several years additional will be required before the project is completed.

A 1200-mile journey via the C. B. & Q., and the G. N. Rys. through the northern parts of Minnesota, North Dakota, and Montana brought me to my destination. Upon one's first trip in the West, the traveler is filled with awe and amazement with the magnitude of our land. For hours and hours he speeds along over the plains, seeing nothing protruding from the surface except an occasional shack or fence. There are no trees, no shrubs, no hills; nothing but grass and level land. Towns are scarce and consist, in general, of several saloons, a general merchandise store with the post-office in connection, a real estate office, a fuel and lumber office, a warehouse, a few dwellings, and the depot. Streets there are none. When leaving Wisconsin, there had been about 18 inches of snow on the level, but, upon reaching Montana, the ground was bare except in the gullies. The air is dry and clear, making distances very deceptive. The West probably owes much of its energy and progress to the effect of its climate and topography, since one can not keep from being inspired with the land. Everything is no new and so wonderful. The country is so full of ambitious young men full of hope and inspiration, and there is no better place for the average young man to go than to one of these western states to develop its resources and prosper with it.

In reaching the West, there are a few things that are quickly impressed upon the newcomer's mind. First, that it is not as "wild and woolly" as he had imagined, and, second, that everything costs more than at home, for instance, hair-cut 50 cents, and a shave 25 cents. Third, he finds that everyone is busy and astir. Conrad seemed to be especially so and on boom, new buildings springing up on every hand. For about two days after my arrival there, I was busy buying supplies and walking up and down the few streets. Finally, on the third afternoon, there came an order to pack my bed and luggage aboard a freight team bound for the dam, the field headquarters about 16 miles from town. I soon found myself, with another rodman and his worldly belongings, perched on top of a high load of potatoes, a mode of travel not very comfortable or pleasant. We expected to put up at Jones' Ranch that night, nine miles from Conrad. The early part of the trip we were entertained by the freighter with yarns of cowboys, Indians, bears, weather, wind, and what not, but his stock soon ran out, when there was nothing for us to do but look around and hang on. Luckily, an auto owned by the company bound for the dam overtook us and the rest of the way was made at neck-breaking speed, cross-country, bringing us to the camp shortly before supper. And glad we were to have arrived so well.

The camp contained an office, cook-shack, blacksmith shop, stables, warehouse, and sleeping quarters. We underwent the usual cross-examination by the field-chief, after which we sat around and "looked wise." Imagine the relief then, when the surveying party returned, to find with the rest, Wilbur Holcomb, a high school and varsity classmate of mine. There is nothing like a friend among strange people and in a strange land. Our many questions to each other were interrupted by the supper horn, when we filed into a smoky, bare, ill-lit room with long tables and benches. The granite plates and cups were slimy; the knives and forks covered with rust and dishwater; we had greasy "spuds" (potatoes), tough "bull" (beef), sour "punk," soggy cake, black coffee and rank "ole." The conditions here were very poor, and I am pleased to say that they were greatly improved shortly afterward. After the "bounteous feast," we went to our quarters, which consisted of a framework of pine boards covered with canvas. There were bunks for 12 men; we had a ground floor, and there was also a table, benches, and a stove. Here also I found everything untidy and thrown about. But I was warmly welcomed by Holcomb's friends, after which he and I spoke of Wisconsin as only Wisconsin men can, while the others smoked, sang, told stories, and gambled. For my part, however, I relished their company as little as the supper. My bedding was left behind, so I was furnished with a few dirty, musty blankets, and spent the remainder of the night trying to keep warm. So far I had not been very favorably impressed with my job, and could not see the advantages of a college education, but I felt I was "in" for it, and "in" I would stay.

For the next two days I was forced to lie about camp, there being no work for me just then. It was lonesome since there was no work being done at camp, and I spent my time as best I might, cleaning up, splitting wood, reading, etc. The weather was excellent, the air clear and dry. Way off to the west about 30 miles were the Rockies covered with snow, but in all other directions, as far as one could see, there was nothing but rolling prairie, not a tree, bush, house, or even a fence post in sight. And, though it was all so new and interesting, I was often homesick, and many a time I wished I were back in good old Wisconsin. However, the following Sunday morning, a transitman and two of us rodman with our rods and lugguage were driven nine miles farther inland to make our quarters at the Home Ranch.

The Home Ranch consisting of a log ranchhouse, barn, granaries, sheds and corrals lay on the edge of a rushing mountain stream, Dupuyer Creek, along which grew the only trees (poplars), and brush for miles around. No trees have ever "looked as good" to me as these. Our quarters were better here than at the dam, and the food was better in all ways. We found a gang of tough laborers quartered here, whose chief occupation after work seemed to be boozing, spitting tobacco juice, swapping stories and playing cards. We bunked with the cowboys whom we found to be very amiable, honest, and considerate of others. Open-handed generosity is their rule and democracy is at its highest among them.

Our work lay in running levels, cross-sectioning, and locating ditches, and topography. It was fine work on these rolling prairies. The wind came up and died down daily with the rising and setting of the sun. The scenery was excellent; the air clear and dry; and, while letters from home told of extreme cold, we spent every day outdoors without ears covered, coats buttoned or hands gloved. We had no cloudy days; the snow was gone, and the ground thawed every day. And, all in all, the work was very interesting and absorbing. Occasionally we sighted a distant coyote or jack rabbit, and several mornings we experienced the sight of the mirages of the West. Through this phenomenon we saw mountains presumably in Canada miles away, and even the town of Conrad. This is only one of the many instances of the novelty and interest of our western states.

I was just becoming used to the country in these few weeks when I accepted my present position, requiring me to leave at the instant. This meant a nine mile hike to the dam, and from there sixteen miles by moonlight cross-country on horseback. I must confess having had the usual tenderfoot's experience of being thrown from the saddle and for a week or more following, every bone and muscle ache fearfully. Yet much of this was forgotten in the thought of being back in good old Wisconsin again.

The La Crosse Water Power Co., with offices in La Crosse, Wisconsin, is engaged in building dams on the Black River, in Clark and Jackson counties for power purposes. Two years ago a dam 490 feet long, 50 feet high, canal, and power plant were built at Hatfield, and last year a smaller dam was constructed six miles up river for storage purposes. Other dams are being considered, and the company is also to build an interurban line from La Crosse to Winona, Minn. This company will probably prove to be one of the biggest power development concerns in Wisconsin.

My position is that of transitman. Our work involves hydrography, topography, levels, resurveys, locations, construction work, all kinds of office work, designs, reports, estimates, etc., covering almost the entire field of civil engineering. In this respect, the job is very valuable for it affords a variety of experience. Associated with me is a graduate of Trinity College. Mr. W. S. Woods, of La Crosse, our chief engineer, is a Wisconsin alumnus. The quarters and food have been good for the most part. For the past four months we have been camped in a 16 x 20 tent. The parties are two, of five men each, two rodmen, two axemen, and a transitman. We are engaged in making a topographical survey of a proposed reservoir. Our tent is fitted with a floor, three double-deck bunks, drafting table, desk, chairs, etc., and we have been very comfortably housed all winter whatever the weather. From time to time, we move camp as the work progresses, our boarding places being at nearby farm houses. Beyond long, hard hikes of from 8 to 16 miles a day and breaking trails through deep snow and brush, we cannot complain of the work, and I consider this winter camp in the woods as very profitable and interesting. The time passes quickly as we are working all day and platting or figuring at night. The young engineer will never regret spending a winter such as this, though the work is often difficult and tedious.

We find all of our work interesting no matter what or where it may be. In fact this is one of the most alluring features of our profession, since one never knows what new associations and surroundings he may have in the future. Probably it is also to the graduate's advantage not to remain with one firm or on one class of work too long in order that he may gain experience in different fields and in different places. There seems to be no ground to believe that the field of engineering is overcrowded. Few of us have found it so. But while our jobs have many decided advantages, these are attended by many conditions not so pleasant or agreeable. We are not always protected from the cold, the heat, insects, or vermin; we do not always find that our work is over at six o'clock in the evening, but often we are required to work until two, three, or even four in the morning; we do not always sleep between sheets, under clean blankets, or on springs, our grub is not always like mother used to make; we mend our own tears and rips, sew on our own buttons, do our own washing, and are our own doctors in case of sickness; we do not always get our mail regularly, see the daily newspapers, or take in a good show or other entertainment, especially on a job like this one. But, in spite of these and many other discomforts, I do not believe that any one ever truly regrets the choice of an engineering profession. For, as we see how some project or piece of work is nearing its completion, we look upon its growth as fondly as though it were our own achievement. There is pleasure in the knowledge that Wisconsin's graduates are welcomed and much in demand. Probably, too, we alumni take no greater pride or find no more satisfaction in anything else other than the frequent evidence of the eminence and prestige not only of our College of Engineering but, particularly, of America's greatest state institution, the University of Wisconsin.

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EDITORIALS

At the time of going to press, the junior class is away on the annual inspection trip. As usual, there are two parties, one in the east and one in the west.

The eastern party will visit the Milwaukee plant of the Allis-Chalmers Co. and the Michigan Central tunnels under the Detroit river at Detroit before leaving for Niagara Falls. At Niagara Falls, the electricals, mechanicals and miners visit the various industrial plants, and the civils inspect the different types of bridges over the Niagara River. From Niagara Falls the party goes to Buffalo and Pittsburg, where other plants are visited, and then return to Garry, at which place they will meet the western party. At Gary both parties will visit the United States Steel Company's steel mills and the Universal Portland Cement plant, which concludes the trip.

The western party will visit points of interest in Milwaukee, Chicago, Gary, Buffington, and Lockport.

On March 11th a lecture was given by Prof. L. V. Ludy, in the auditorium of the Engineering building, on Laboratory Tests of Automobiles. Mr. Ludy gave a brief description of the method of testing at the laboratory of the Purdue University. The cars used were stock cars and did not come from the makers, but were borrowed from private individuals. He gave first the tests on gasoline cars, then the tests on the steam cars and finally the comparison of the two.

On account of the very rapid building up of the automobile industry many of the first cars were not designed for especial efficiency but rather to supply the demand. This fact was shown in a most startling manner by some of the data given. The gasoline cars were run under ordinary conditions and also with the pressure of compression reduced. Of the ten cars tested the Chalmers Detroit showed up the best. It was rated as a thirty horse-power machine and gave a brake horse-power of twenty-two. Nearly all of the others gave a much lower brake horse-power, so that the average brake horse-power for the ten makes was less than fifty per cent of the rated horse-power. The amount of gasoline used varied from one to three-tenths of a gallon per mile.

The White steamer car showed up very well beside the gasoline cars and gave some remarkable results. Boiler pressures of 400 and 600 lbs. per square inch were tried. The machine was rated at thirty horse-power but gave a brake horse-power of forty-one and seven-tenths or thirty per cent more than the rated power. The gasoline used was slightly more than that used by the better class of the gasoline car but the absence of any jar in the steam car would tend to re-reduce the repair item and still make the operating expense of the steam car less than the gasoline car.

The eleventh annual convention of the American Railway Engineering and Maintenance of Way Association, in Chicago during the week of March 14th to 17th, was, all things considered, the most successful one yet held. Professor F. E. Turneaure, who has had charge of the impact tests, which have been carried on for the past three summers, gave his report and was tendered a vote of thanks by the association. The following are some of the important committee reports made: Signals and Interlocking, Electricity, Iron and Steel Structures, Wooden Bridges and Trestles, Rail, Economics of Railway Location, and Conservation of cross-ties by means of Protection from Mechanical Wear.

Several of the senior engineers attended the meetings.

The Engineers' Ministrel Show scored a hit again this year as it has always done in the past.

Forty-one musicians entertained the audience in the first act with their late songs and jokes. Interspersed with this gaiety was the more serious strain, consisting of solos by Nadeau, Leuders, Halseth, Fraser and Traxler.

Slight of hand performances by Lee Stuart and Walter Esau, and a few selections by a quartet, accompanied by four members of the Mandolin club, composed the second act.

"Who's Boss," a one-act farce, written by Henry Traxler, occupied the third act.

The idea of making the WISCONSIN ENGINEER a monthly instead of a quarterly, has been suggested by several of the faculty and alumni, and, if the staff can be assured of the united support of the students and alumni, they stand ready to carry it out. The ENGINEER is the only student publication which is not at least monthly, and is handicapped in many ways on this account, when it comes to getting advertising and subscriptions. The staff after looking into the matter, have come to the conclusion that they can give its readers nine numbers instead of four at the same price and make each number more interesting than those now published.

We would like to hear what the alumni think about this scheme, and would be glad to receive any suggestions or criticisms which they may have to offer.

On Tuesday evening, March 1st, the members of the mining classes met at Prof. E. C. Holden's house for the purpose of forming a mining club, which will eventually becoms a Student Junior Society of the American Institute of Mining Engineers. With Prof. Holden, elected temporary chairman, and W. G. Pearsall, temporary secretary, this club was formed. After a lengthy discussion of the problems confronting such an organization, and after considering the good fellowship to be derived by a closer relation among the different men of the course, the club was tentatively formed by electing a constitution committee.

On Wednesday night, March 16th, a meeting was called in room 214 Engineering building. The following officers were elected:

President—H. Lee Welsh.

Secretary and Treasurer—W. G. Pearsall.

Mucker—F. Meinecke.

First Assistant Mucker—B. S. Reid.

At the same meeting the honorary members elected were Prof. E. C. Holden and Prof. F. T. Havard.

It was arranged to hold the regular meetings on every other Tuesday night. A certain per cent of the membership is to be elected from those not regularly enrolled in the Mining Department, but taking work in some of its special lines.

Since the Juniors, during the summer, are working in mining camps and are required to make a report on the mining methods of a mine in their district, they will be well prepared to give talks before the club during their Senior year.

On Tuesday evening, March 29th, the following subjects were presented:

Lead and Zinc Mining in the Galena District of Northern Illinois, by J. G. Trewartha.

Lead Mining and Milling in Southeastern Missouri, by H. Lee Welsh.

The club welcomes all those interested in the discussion of its problems.

CAMPUS NOTES

The Haresfoot Club has planned to take an extensive tour this spring. The following is the itinerary:

April 8–9, Fuller Opera House, Madison.

April 14, Mandall Hall, University of Chicago, Chicago.

April 15, Walker Opera House, Champaign, Ill.

April 16, Pabst Theater, Milwaukee.

The basketball season, since Jan. 22d, can best be recounted as follows:

Jan. 22d, Wisconsin was defeated by Purdue by a score of 29 to 17.

Jan. 28th, Wisconsin was defeated by Chicago, 16 to 14. The game was a closely fought one and was decided in the last thirty seconds of play.

Jan. 29th, luck was against Wisconsin when, after outclassing Indiana throughout the game, they should loose in the last few minutes of play. The final score was 13 to 11 in Indiana's favor.

Feb. 5th, Wisconsin defeated Minnesota by a score of 24 to 14.

Feb. 25th, in one of the fastest games of the season, Wisconsin lost to Minnesota, 16 to 9.

Feb. 26th, Wisconsin defeated Northwestern by a score of 39 to 11.

March 5th, in the best game of the season on the home floor, Wisconsin trimmed Chicago by a score of 11 to 10.

March 7th, Wisconsin defeated Indiana by a score of 33 to 7.

March 9th to 12th. For three days nineteen high school basketball teams, representing seven states, battled with each other for the middlewestern championship. The work of the Appleton team, which won both the state and middlewestern championship, was excellent and, as the scores showed, completely outclassed their opponents. The tournament showed up the wealth of basketball material of the state, which should make up our coming University teams.

March 12th, in the last game of the season, Wisconsin decisively defeated Purdue by a score of 39 to 14.

Jan. 29th, the Glee, Mandolin, and Banjo clubs gave a concert at Platteville. They were assisted by Red Parker, who presented a scene, "On the Sidelines," of a football game.

Dr. F. Byron Robinson, '78, Prof. of Gynaecology and Abdominal Survey in the Illinois Medical School, has presented the Medical school with a medical library of 1,100 volumes.

Jan. 24th, the Governor of West Virginia, President and Board of Regents of that university, visited Wisconsin. They were particularly interested in the shops and laboratory departments, and gave some little time to the workings of the University Extension Department.

James G. Lathrop has been selected by the regents to fill the position of track coach. Mr. Lathrop was formerly track coach at Harvard, and comes to the university very highly recommended by eastern coaches.

A comprehensive work on Conservatism of National Resources is to be presented to the public from the pen of President Charles R. Van Hise. President Van Hise is giving a series of illustrated lectures this year on the Conservation of Resources.

The new Biology building will be located between University Hall and South Hall at the end of the Court of Honor. The previously determined location in the ravine between the University and Observatory Hill did not meet the general approval, and a revision of the plans was made by Architect Peabody.

Dr. J. S. Evans will fill the new position of medical advisor at the university. Dr. Evans comes to the university highly recommended and will act as an advisor to all students who are ill, convalescing, or expect to be sick. He will also have some instructing work in the Medical School.

The Student Court, which was proposed by the Student Conference, is now a reality. The following men have been elected to serve for the remainder of the year: J. W. Wilce, M. F. Appel, R. R. Birchard, P. J. Murphy, W. H. Witt, and G. W. Blanchard, seniors; and W. A. Buchen, B. P. Stiles and C. O. Bickelhaupt, juniors. Their first case was held March 7th, at which time they suspended two students for six weeks.

The Junior Class Play, "Three Queens and a Joker," was creditably staged by the junior class. Feb. 19th. The play was written by Kenneth F. Burgess, and was a satire on the Prom.

The Ten-Day Farmers' Course was a record breaker this year. The attendance reached 1,650, of which 407 were women.

A letter has been received by Mr. Shibata, in which the Japanese baseball team of Keio University propose to come to the United States to play ball with the American universities, if their expenses are guaranteed.

The Maennerchor of Milwaukee rendered an excellent concert at the gymnasium, Saturday Feb. 26th.

An opportunity was given to the students, March 3d to 6th, to hear J. R. Mott, a noted Y. M. C. A. speaker, on some of the live problems of the day. Mr. Mott has traveled all over the world, and for the last fifteen years has been engaged in studying and lecturing upon the problems which confront the students.

A reorganization of the business of the University of Wisconsin, with provision for a manager to have general supervision over the business side of the institution, was provided for by the regents in the March meeting. This will relieve the president of looking after these details, and fix the responsibility of all business matters upon one man.

Prof. Paul S. Reinsch, of the political science department, has been appointed by President Taft as one of the delegates of the United States to attend the Pan-American congress in Buenos Ayres, Argentina, July to September, 1910.

A complete inspection of the sanitary conditions of the boarding houses is to be made by Miss E. Bradee, university nurse, under the supervision of the hygiene committee. This is a long step towards the improvement of rooming conditions in Madison.

Lathrop Hall, the new gym for women, will be dedicated on April 1st. Mrs. Anna Garland Spencer, of New York, will deliver the address.

A somewhat amusing situation was manifested at our famous Engineers' Minstrels in a clever manner when Mr. Moss, alias Miss Johnson, in a Gibson-like attire, representing the ever interesting and bewitching stenographer, tripped lightly and gracefully to her desk, where she proceeded to manipulate the keyboard at a most startling rate of speed. Her shy and coy demeanor toward her most ardent suitor made the sketch most ludicrous.

NOTES AND PERSONALS

Mr. and Mrs. E. E. Bemis, Oshkosh, have announced the engagement of their daughter, Miss Florence Irene Bemis, to Carl Sweetland Reed, of New York City. The wedding will take place in the spring. Miss Bemis is a graduate of the University of Wisconsin, 1906, and was prominent socially during her four-year course. Mr. Reed also is a Wisconsin graduate, having finished the mechanical engineering course in 1905.

F. H. Ripley, '09, is now employed by the Columbus Buggy Co., in the engine department. His present address is 234 Jefferson Ave., Columbus, Ohio.

Cornell University has recently established an employment bureau and expect to help the students and alumni in obtaining positions. The plan is to register any alumni or students who wish positions, and as there is a demand for men, to select from those registered, the ones especially fitted for the positions. This should play an important part in placing seniors especially and should fill a long felt want.

The Westinghouse Machine Co. of East Pittsburg, Pa., has issued a pamphlet describing their engineer apprenticeship course. This course requires about two years time or 5,480 hours.

Lynn F. Cowan, a member of the graduate school of engineers, has accepted a position with the Chicago, Milwaukee and St. Paul Railroad, in the engineering department. Mr. Cowan is a graduate of the Iowa State University and last semester took post graduate at the Wisconsin University.

J. N. Roherty has accepted a position in the engineering department of the Oliver Iron Mining Co. at Coleraine, Minn. Mr. Roherty received his degree of B. S. C. E. in February, 1910.

ALUMNI NEWS

William A. Baehr, C. E., holds forth as Consulting Engineer in the Commercial National Bank Building, Chicago.

Paul D. Bremer is in railway work with the C. & A. R. R. His address is Racine, Wis.

One Wisconsin engineer with an enviable record is George H. Burgess, C. E., '95. He is Chief Engineer of the Delaware and Hudson Co., and of the Greenwich and Johnsonville Railway, and also Consulting Engineer to the Quebec, Montreal & Southern Ry. He resides at Albany, New York.

Louis A. Buons, C. E., '05, is Resident Engineer on the Borge Canal, Rome, N. Y. His address is Watertown, N. Y.

S. L. Clark, '07, is superintendent of setting the East Wing of the State Capitol. He is in the employ of the Grant Marble Co., Milwaukee.

C. A. Keller, '99, is with the Chicago Edison Co.

F. A. Kennedy, G. E., '06, is Chief Engineer of the Shinango Furnace Co., Hibbing, Minn.

W. M. Kennedy, '96, is President of the Highland Mining Co., Highland, Wis.

Harold E. Ketchum, '08, is superintendent of the concrete work, Milwaukee Traction Co.

D. A. Keyes, '06, is with the Chicago Telephone Co.

William O. Krahn is now a draftsman with the American Bridge Co., Milwaukee, Wis.

Harry A. Severson, '01, is secretary of the Barber-Colman Co., Rockford, Ill.

Harold Seaman, E. E., '00, who wrote the University Bulletin (Eng. Ser., Vol. 1, No. 10), the Effect of Frequency on the Steadiness of Light Emitted from an Incandescent Lamp, is Engineer with the Electric Storage Battery Co., Cleveland, Ohio.

Irving Seaman, E. E., '03, is with the Electric Storage Battery Co., Marquette Bldg., Chicago, Ill.

E. R. Shorey, C. E., '08, is Mining Engineer with the Vinegar Hill Zinc Co., Galena, Ill.

James M. Shoett, '89, is Estimating Engineer for the Noreke-Richards Iron Work, Indianapolis, Ind.

P. H. Connolly, '85, holds, the position of City Engineer of Racine, Wisconsin.

S. P. Connor, '98, is Assistant Manager of the Sub-Contracting Department of the George A. Fuller Co., 949 Broadway, New York City.

J. S. Hodge, '04, is Superintendent of the Granite Falls (Washington) Electric Co.

F. S. Hobast, '86, is a Superintendent of the Fairbanks-Morse Co., Beloit, Wis.

C. A. Hoefer, '05, is connected with the Hoefer Manufacturing Co., Freeport, Ill.

E. G. Hoefer, '05, is Instructor in Descriptive Geometry in the State University of Iowa.

A U. Hoefer, '06, is in the employ of the Chicago Telephone Co., Chicago, Ill.

J. J. Hogan, '99, is with the Western Electric Co., at Austin, Ill.

J. E. Kaulfuss, '08, is with the La Crosse Water Power Co., at Hatfield, Wis.

E. M. Kayser, '00, holds a position with the Pennsylvania R. R. in New York City. He is connected with the tunnel work which that company is doing in connection with its subway system.

G. R. Keachie, '03, does contracting work in Madison, Wis.

A. E. Keller, '07, is in the employ of the Laclede Gas Co.. St. Louis, Mo.

C. A. Johnson, '91, is Manager of the Gisholt Co., Madison.

P. B. Johnson, C. E., '07, is Asst. Eng. Erecting Dept., American Bridge Co., New York. His home address is 626 N. Henry St., Madison.

G. H. Jones, '97, is with the Chicago Edison Co.

Emil L. Leasman, C. E., '07, is with the Corn Products Refining Co., Chicago.

W. N. Jones, '05, is located at the City Water Works, Cincinnati, O.

Norman Lee, E. E , '04, lives at 11 Rue Scribe, care of American Express, Paris, France.

E. F. Legg, E. E., '01, is Engineer of the Central Station Works, Long Branch, N. J.

O. B. Jorstad, C. E., '04, is with the Westinghouse Elec. & Mfg. Co., at Wilkinsburg, Pa.

P. F. Joyce, '93, is employed in Washington, D. C., as draftsman for the Isthmian Canal Commission.

O. M. Leich, E. E., '98, is at Rochester, N. Y., with the Stromberg Elec. Telephone Mfg. Co.

E. Jacobson, '06, is located at St. Louis, with the Laclede Gas Co.

C. M. Larson, C. E., '05, formerly Assistant Engineer on the National Railway of Mexico, now has his office at 900 Railway Exchange, Chicago, as Real Estate Engineer for the C. & A. R. R., T. St. L. & W. R. R., M. & St. L. R. R., and Iowa Central R. R.

B. W. James, '97, is a Consulting Eleetrical and Mechanical Engineer, Seattle, Wash.

O. Laurgard, C. E., '03, is Assistant Engineer, U. S. L. S., Washington, D. C.

Geo. H. Lantz, C. E., '08, is Assistant City Engineer, Missoula, Mont.

O. B. James, '91, is in the hardware business, Richland Center, Wis.

G. J. Jeinsta, '06, is in the employ of the Chicago Telephone Co., Chicago.

F. H. Lawrence, C. E., '06, is in the Engineer Department, Chicago Telephone Co.

L. P. Jessard, C. E., '08, is Assistant Field Inspector, Wisconsin Rate and Tax Commission. He lives in Superior, Wis.

F. W. Lawrence, C. E., '06, is Assistant Sales Manager, A. O. Smith & Co., Milwaukee, manufacturers of automobile parts.

J. F. Icke, '00, is City Engineer of Madison.

W. S. Lacher, C. E., '07, is foreman of the Drafting Room, B. & B. Dept., C., M. & St. P. Ry. The offices are in the Railway Exchange Building, Chicago.

H. S. Imbush, '05, is in the employ of the Western Electric Co., Chicago.

O. F. Lademan, '97, is with the Kinlock Telephone Co., St. Louis.

W. H. Imbush, '05, is with the Wisconsin Telephone Co. His home address is 176 Martin St., Milwaukee.

T. J. Irving, '05, is in the Construction Dept. of the C. & N. W. Ry. He lives in Watertown, Wis.

C. Lapham, '81, is Division Engineer on the C., M. & St. P. Ry., and lives in Milwaukee.

E. R. Jacobs, '05, is located at Aurora, Ill.

F. V. Larkin, '06, is at Provo, Utah, with the Telluride Power Co.

Albert Larsen, M. E., '05, is a graduate apprentice with the Allis-Chalmers Co., Milwaukee.

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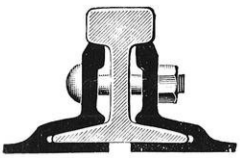

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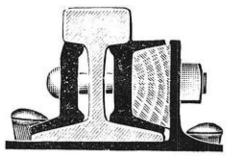

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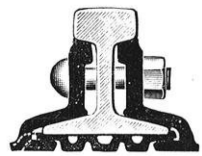

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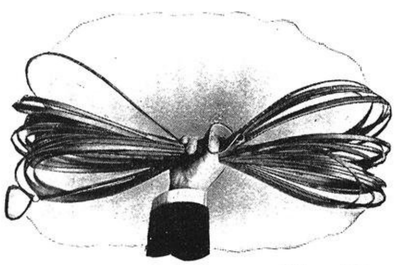

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