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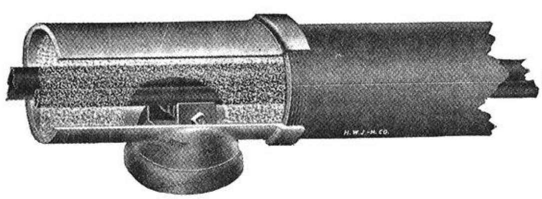

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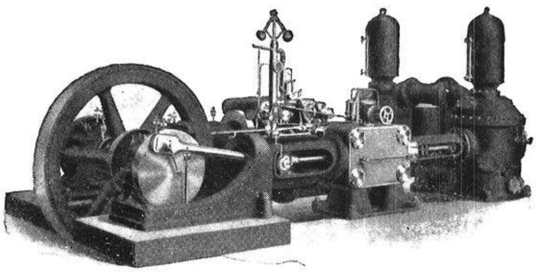

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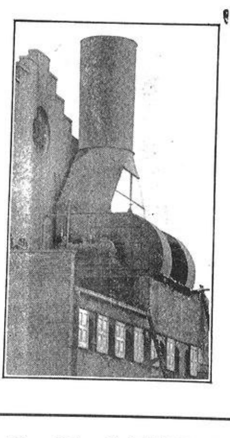

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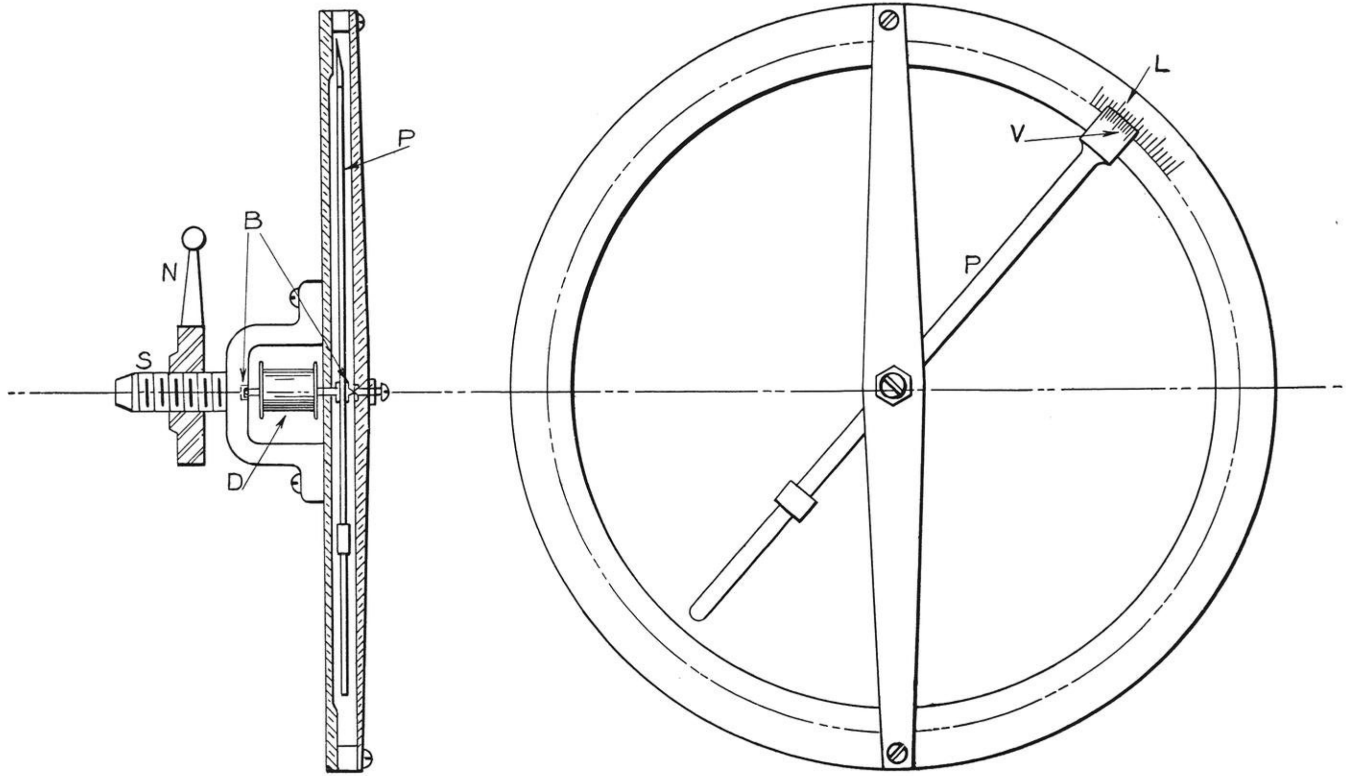

Fig. 1

THE WISCONSIN ENGINEER

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A UNIVERSAL INSTRUMENT FOR MEASURING DEFORMATIONS OF MATERIALS.

H. F. MOORE, Asst. Professor of Mechanics, U. W.

In 1903, Messrs. Adams and Halm, while studying reinforced concrete beams in the University of Wisconsin Laboratory for Testing Materials, found it necessary to devise an apparatus for the measurement of actual elongations and compressions along the longitudinal fibers of beams.

Fine measurements (to one one-thousandth inch) were required, and, as several measurements as nearly simultaneous as possible were to be made over long horizontal distances, the micrometer with electric contact was not convenient. A method was tried in which deformation was measured by the motion of a pointer over a dial, a drum 1 inch in circumference being on the same axle as the pointer, and the drum being rotated by a silk thread passing over it. This method was not successful owing to the great change in reading of dial caused by a slight change in the moisture in the air near the silk thread—breathing on the thread causing a large change in dial reading. The idea then occurred to the experimenters to replace the thread with a fine silk covered copper wire, the silk insulation giving a firm frictional hold on the drum, and copper core giving constancy of length of wire. This idea put into practice was successful, and the apparatus used at that time is still in use for making determinations of the position of the neutral axis in beams.

Their apparatus is fully described in their thesis and will not be again described here; however, an instrument based

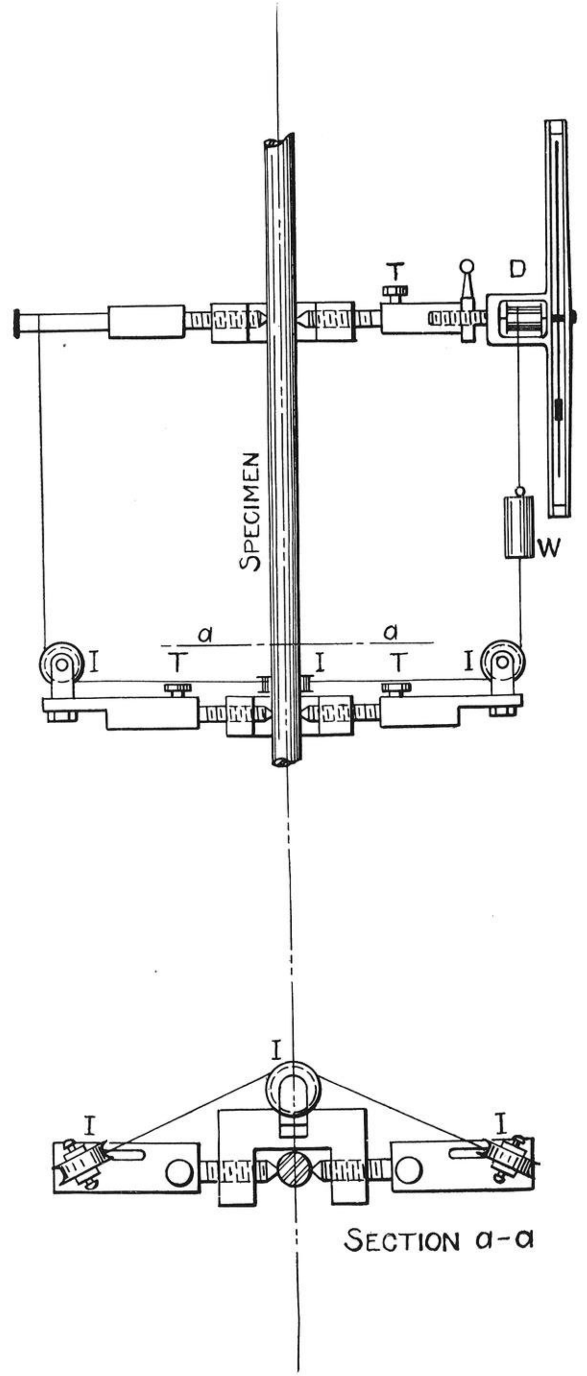


Fig. 2

on the same idea, but applicable to a somewhat wider range of tests, has been designed in the U. W. Testing Laboratory and has been in successful use for several months. This apparatus has been thought worthy of description.

The essential part of the apparatus is shown in Fig. 1. The drum D and pointer P are fastened to an axle revolving in hardened steel pivot bearings B. Over and round the drum passes tbe fine insulated copper wire (No. 36 wire being usually used). The drum being 1 inch in circumference, and the dial L being divided into 1,000 parts, evidently readings can be made directly to one one-thousandth inch, while by means of a vernier V, readings can be made to one ten-thousandth inch of deformation. The moving parts are very carefully balanced.

The whole apparatus can be fastened to clamps or surfaces by means of the screw S which allows some axial adjustment of the whole apparatus, and the dial can be clamped in any position by means of the lock nut N. In attaching or removing the apparatus no disturbance of the adjustment of the axle in its bearings is necessary.

Fig. 2 shows the apparatus used as an extensometer, the form of clamp shown being specially designed for attachment to the rods of reinforced concrete beams. The dial is screwed into a block which in turn is attached to a pointed screw, clamps being fastened to the specimen at two points by means of pointed screws. The fine copper wire is kept taut by weight W and passes round drum D, then down to lower clamp and over idler pulleys I I I and up again to the other side of the upper clamp from that from which it started. The outside idler pulleys are adjustable as to distance from specimen and as to angle through which they are turned about a vertical axis. The axles of the outside idler pulleys can be kept horizontal, irrespective of the turning of the screws, by loosening the thumbscrews TT and turning the blocks.

The axles of all idler pulleys run in hardened steel pivot bearings.

The apparatus reads twice the elongation of the specimen.

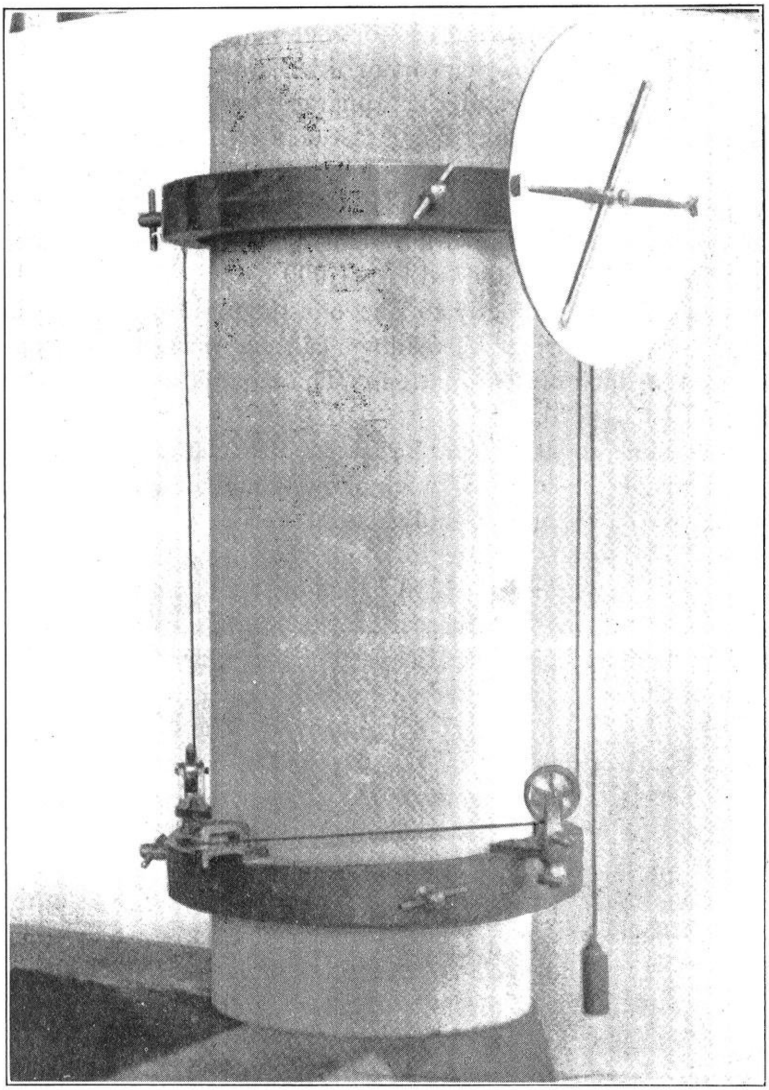


Fig. 3

Fig. 3 is from a photograph of the apparatus used as a compressometer on a 6-inch concrete cylinder. The circular clamps with three pointed screws in each are attached to the cylinder at any given distance apart, and the fine copper wire led from one side of the upper clamp down to the lower clamp, round three idler pulleys to the other side of the cylinder, and then up to the drum of the dial apparatus, which is fastened to the upper clamp, round the drum and finally to the weight which keeps the wire taut.

As in the extensometer, the movement of the pointer over the dial reads twice the deformation.

Fig. 4 shows the adaptation of the dial to measuring deflection in a cross bending test, a stick of timber being shown as the specimen.

Over the supports of the specimen there are attached to the specimen on each side pins Z Z, these being attached at the neutral axis. Side pieces R R are attached to the beam by two of these pins at one end and rest on the two other pins at the other end—thus permitting sliding. To the center of the beam, or at any other point where it is desired to measure deflection, is attached a clamp C carrying idler pulleys I I. From a pin attached to the right hand side piece (see cross section through "b") extends the fine copper wire down to the clamp, over the idlers I I, and up to the left hand side piece, where it passes over a third pulley to and thence around the drum of the dial apparatus, which apparatus may be screwed at any convenient position on the left hand side piece. As in the other cases, the wire is kept taut by means of a weight W, and the reading of the dial gives twice the deformation.

An arrangement of the dial to indicate deformation in a torsion test could be readily made by attaching an arm to one end of a torsion specimen, the free end of the arm to extend to the other end of the specimen, and to carry a dial; then attaching one end of the fine copper wire to the specimen, and winding the wire once around the specimen, carrying the wire to and around the drum of the dial apparatus to

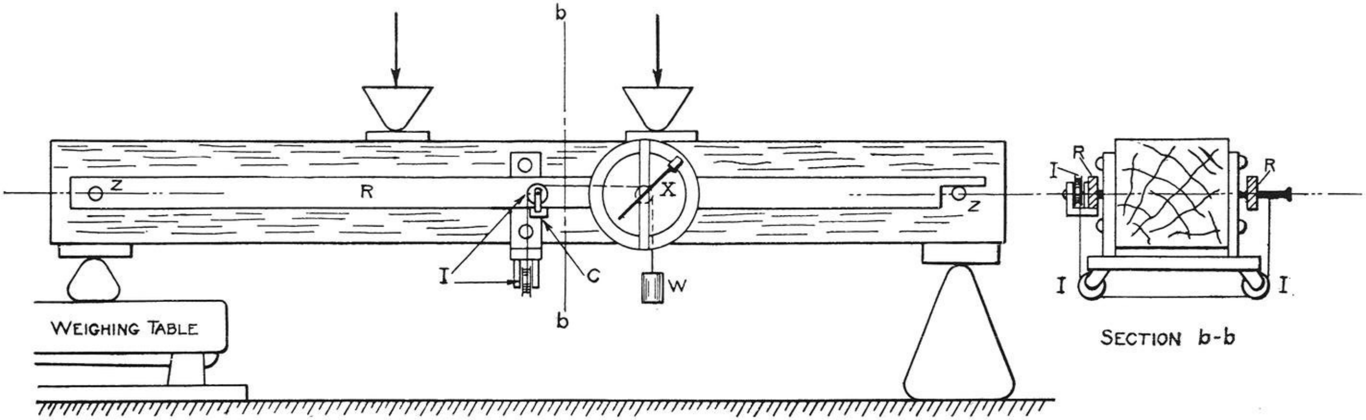

b
Z
R
Z
I
C
W
X
b
WEIGHING TABLE
R
R
I
I
I
SECTION b-b

Fig. 4

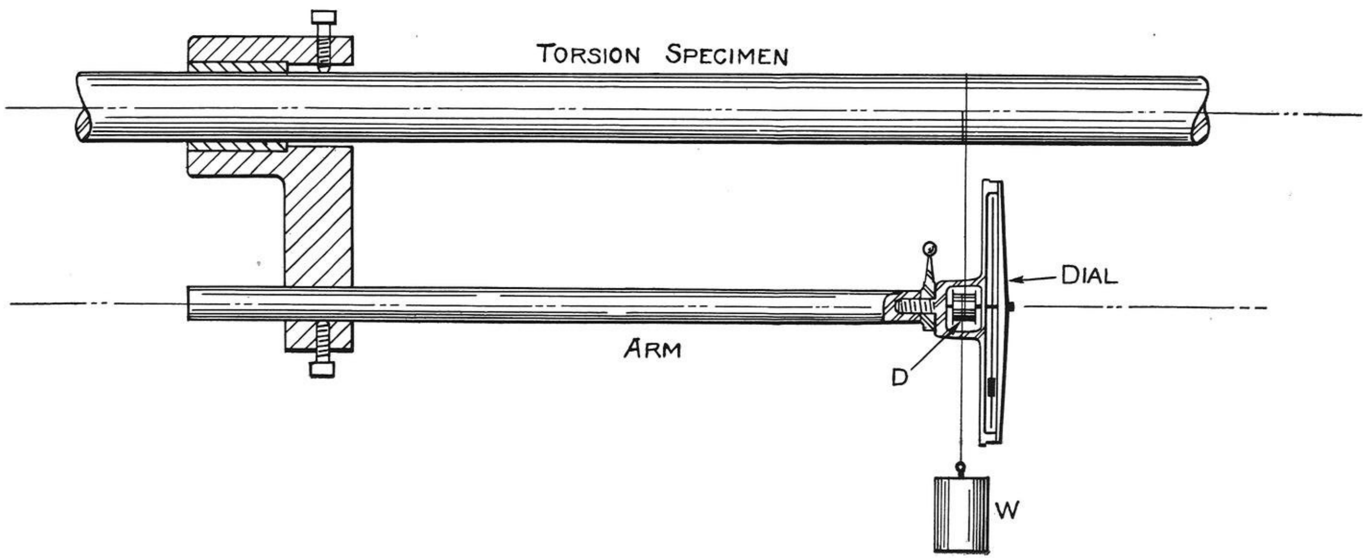

TORSION SPECIMEN
DIAL
ARM
D
W

Fig. 5

a weight. The motion of the pointer over the dial would then indicate the actual detrusion over the length covered by the arm. (Fig. 5.)

The apparatus has been used to indicate deformation between parts of the web of a built-up steel beam, the dials being screwed to angle plates, which in turn were bolted to the web.

A limitation of the use of the apparatus, which it shares with all friction wheel measuring devices, is its tendency to slip under shock. The moving parts are made as light as possible, but, of course, they have some mass, and under any considerable accelerating force the friction of silk insulation on the brass drum is not sufficient to prevent slipping. This limitation has caused no difficulty in static tests in several months of fairly hard service in the U. W. Testing Laboratory.

The dial may be calibrated by moving a marked tag connected to the wire leading from the drum over any integral number of inches measured by any standard scale, and noting the deviation of the pointer from zero at the end of such movement. A correction factor can be thus obtained to obviate any error in the size of drum or any errors due to thickness of wire.

The principal of the apparatus has been tested by practical service in the U. W. laboratory for some four years, and it seems thoroughly sound. The form of apparatus described above has been in use for the past five months, has been used to measure the very small extension of a tensile specimen of steel within the elastic limit, and the large deflection of a timber beam, and has given good satisfaction in all cases.

The apparatus was built in the Mechanicians' shop of the College of Engineering, and the satisfactory results obtained with it are due in no small degree to the excellent workmanship of its parts.

The advantages of this form of apparatus are that it is self-indicating, that no handling of parts is required during an entire test, that the fine copper wires make a most convenient connection between different parts of the specimen, and it is adaptable to a wide range of tests.

APPLICATION OF ELECTRICITY TO AGRICULTURE.

A. R. SAWYER, '95,
Professor of Physics and Electrical Engineering, Michigan Agricultural College.

The writer will treat this title under the following four heads in order to get a comprehensive view of the subject.

1st: The illumination of the farmer's house and other buildings.

2nd: The use of electricity in power operation on the farm.

3rd: The extension of the telephone service to the farmer.

4th: Use of electricity and electric light in assisting the growth of vegetables.

Very little has been accomplished in the application of electricity to agricultural operation in comparison with what remains to be done, or compared with what it is desirable to accomplish. Electricity has entered into every phase of our modern life but in this particular domain it has been the slowest to make itself felt. Of course the reason has been that it is difficult to apply electricity to these places and not because of a lack of a field of usefulness. To the writer it seems very certain that much will be accomplished in the near future.

In regard to the first use of electricity mentioned, namely, the illumination of the farmer's house, it is true that in the aggregate there are many wealthy farmers who have an isolated plant which generates electricity for lighting and power purposes, for example, Ex-Vice-President Levi P. Morton's residence in New York state, and others. In a previous number of the WISCONSIN ENGINEER the writer described the plant of Jas. B. Haggin, Lexington, Ky. These, however, are not of particular interest in this article, as these plants were designed without regard to cost and are within the reach of but few, and we are concerned with the examples of what can be done by the large proportion of our farmers. Yet we can get many suggestions from these plants as to the difficulties to be met in farm plants. At the present time, one of the most serious is to get sufficiently trained help to operate the plant.

The plant recently described in *The Electrical World*, (Aug. 18, 1906,) comes nearer our needs in illustrating what can be done along this line, as that was designed with the intention of operating on a paying basis. It serves further to illustrate what may be done where water power is available near the farm, or better, if near a collection of farm houses.

This plant was designed and largely built by a young man raised on a farm who had taken an engineering course. The introduction of farming engineering into agricultural courses is materially assisting in bringing about the right psychological condition, when more of these small water power plants for farmers' use will be developed. There are certainly many such opportunities just waiting for the person who knows how to take advantage of them and whose tastes are along this line. Almost every graduate in the engineering course, immediately on graduating, looks for employment with some company engaged in his line of work. On the other hand (in Michigan, for example) if a young man, whose people own considerable farm property, takes an engineering course and his mind naturally reverts to making some use on the home place of what he has learned, or possibly conditions at home are such that it is necessary for him to return and take charge of the farm, it is quite possible that he will take a step in this direction. Such a case as this may seem rare and extreme, but my experience the last few years has led me to believe it is a very common occurrence.

Now, such a young man is in a stituation to look around and take steps for developing any water power that is available for bringing an electrical current into use in the neighborhood.

Another recent development which is going to assist very materially in making it possible for the farmer to light his house and buildings is the fact that companies are now formed to develope large water power plants and tie them together by means of high potential wires, or even tie them to steam plants where coal is cheap. And thus our country is fast being covered by a net work of high potential wires, which of course makes it possible for the transformer to be connected on at almost any point. A farmer neighborhood can be organized to buy current and distribute it just as farmers organize to put up telephone lines.

In *The Electrical World* recently was briefly described the efforts of the Aurora, Elgin & Chicago Railroad Co. to distribute power to farmers in the neighborhood of their road, which is a very material step along this same line.

The third feature which is going to materially assist in this development is the fact that colleges are now offering scientific courses to prepare young men for agricultural work, or work on the farm, and the farmer is having it called to his attention that he must apply considerable scientific principles in his farming. In other words, farming is approaching a science and the farmer finds he must apply these principles if he wishes to get the most out of his farm with the least outlay of labor. This, coupled with the fact that manual labor on the farm is now very apt to be too expensive to permit of hiring the necessary help, would tend to call the attention of the farmer to the fact that electrical power can be used to take the place of manual labor to a considerable degree. Of course, under these circumstances, this is closely allied with the second division, namely, that of the application of electricity for power purposes.

At present, it is very common to find that the farmer has bought a five or ten horse-power gas engine and uses it to saw wood, separate cream, make butter, cut up feed and other such purposes, and he is finding it is also possible to have a dynamo and battery for lighting the building, and doubtless it will occur to him that, if the generator is of sufficient capacity, all these power operations can be performed much better by a motor, as the application of the power need not be in the same building as the engine; in other words, it becomes a much more flexible arrangement.

Now of course when the farmer buys a gas engine and uses a generator, it will be of a very limited capacity and he will not likely undertake any very large power operations with that plant, but with power available in larger quantities from a nearby water plant, or high potential wires that go in the neighborhood, they will readily find it not only possible but advisable to use power on a much larger scale. Of course, everyone naturally has in mind the uses of power for plowing as one of the power applications of the farm. Probably most of our readers are familiar with the fact that the traction engine has been used to a considerable extent both in this country and in Europe for plowing, and when the farmer has power available in large quanities, it is not at all unreasonable to expect a motor may be used to supplant the clumsy traction engine. Just how the details of this will be worked out would be foolish for the writer to undertake to state. Such things come only through the combined efforts of an army of people working at it as opportunity comes to them, and it is difficult of course to predict just what form that will take.

So, to recapitulate a trifle, it seems that since the farmer is having his attention directed toward the application of scientific principles to the farm, and since manual labor on the farm is very expensive and the young men on the farm are not staying, but prefer to go to the city and become motormen, work in a livery stable or any place rather than stay on the farm, and since the time is rapidly approaching now when power in large quantities will be available, it seems certain that this development which has long been looked forward to is on the verge of realization.

In regard to the extension of telephone service to the farmer, it would be a mere waste of time for me to describe what has been accomplished along this line, as probably all the readers of this paper are familiar with what has been accomplished and the development that has taken place because of it. There is room, however, for one improvement in this matter which is gradually coming about in the nature of a refinement; that is in regard to the party line service. It certainly is not desirable to have from two to fifteen phones on a party line and have every bell ring every time anyone on the line is called up. It not only annoys the subscribers unnecessarily, but produces considerable temptation to listen in on every possible conversation. With the advent of the selective party line, in which only the bell of the one called rings, and with the still further improvement which I understand the Automatic Electric people of Chicago advertise with the possibility of preventing others from listening in, a much to be desired improvement in the telephone service to farmers will be brought about.

The amount of space I have devoted to this question of the telephone service is not comparable with the importance of that service to agricultural work, but it seems to me it is without the scope of this article to dwell on it further.

In regard to the last division of the subject; namely, the use of electricity and electric light in assisting the growth of vegetables, in the aggregate a considerable has been done along this line, although the commercial importance of it has not been very great. Perhaps more has been done in a commercial way in Europe than in America. The writer has known of various theses and other experimental work being done with a view to determining whether a slight current of electricity or an electric light can be used to hasten the growth or development of growing plants of any kind, but, although in many cases experiments seem to indicate encouraging results, the writer is not aware that very much use has been made of it in this country.

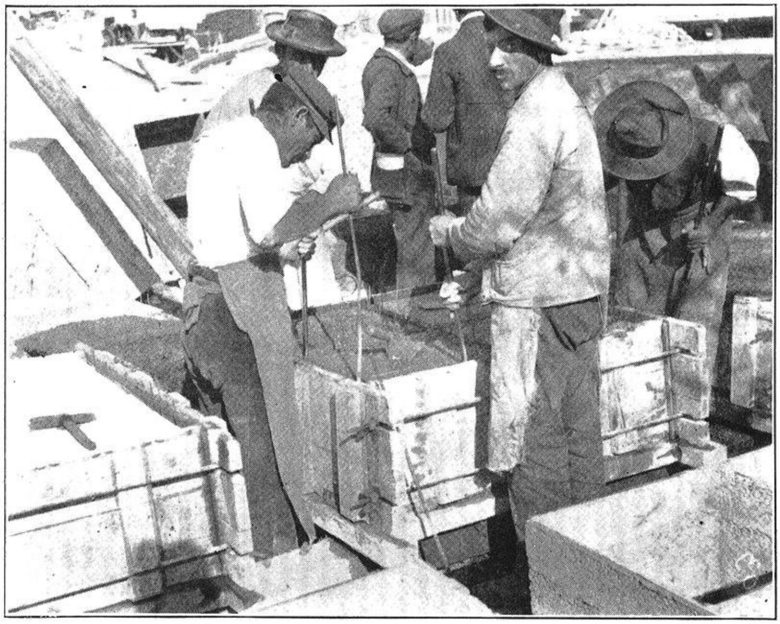
THE INFLUENCE OF A FEW LOCAL ECONOMICAL CONSIDERATIONS ON THE DESIGN AND EXECUTION OF REINFORCED CONCRETE WORK.

RUDOLPH B. HARTMAN, '01.

From time immemorial, were a competent structural architect or engineer to be given a commission to furnish designs for any one of the thousands of types of structures called for by the necessities of our industrial world, the solution would invariably have been more or less directly based first, on the requirements of the special case in hand, of which in the United States those strictly and almost solely economical would have generally completely overshadowed all others; second, on an almost fixed amount of money to be expended for the proposed structure which too often was very much too small, especially from the designer's point of view; third, on the limit of time set for completion up to occupation of the structure, which limit was and is today almost always overrun because of unavoidable delays, unless the second item above is made more agreeable to the designer and he is told "Cost is no object;" fourth, on the season and weather in which the structure is to be built, taking uncertain chances with which has cost many a designer as well as contractor dearly; fifth, on the local normal conditions of the building market; and sixth, on the local special or abnormal conditions of the building market.

This article will assume that a reinforced concrete structure meets all of these conditions squarely (the writer thoroughly believing it does) and will confine itself simply to a discussion of some of the phases of the fifth and sixth items just mentioned. Much might and shouid be said of items three and four, especially of temperature on speed of erection, and of cost of false work shoring, disregard of correct principies of which has caused many a sad lesson to designer, contractor and owner, as well as loss of life, in some failures of reinforced concrete work, but this article itself has its limit.

To be able to fully understand that which follows it will be of value to have clearly before the mind some or most of the local economical elements of reinforced concrete work; they are, item No. 1, actual and comparative cost and grade

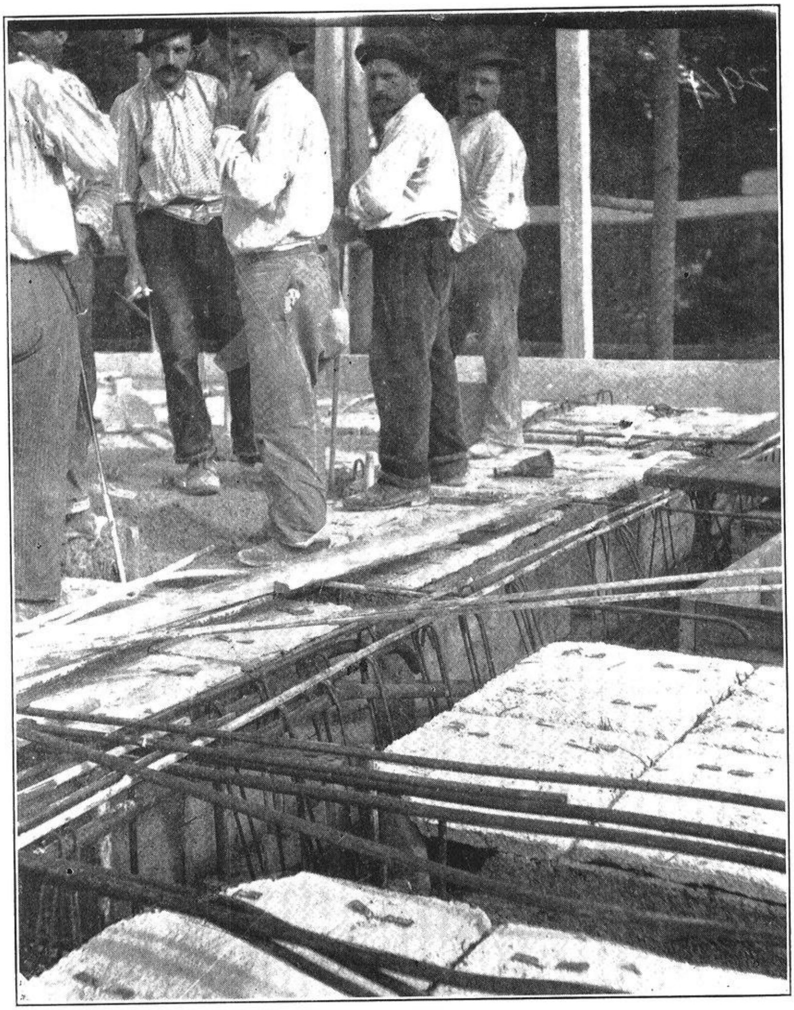


No. 1

of sand and screenings or other substitutes for sand; No. 2, actual and comparative cost and grade of gravel and stone or substitutes for gravel and stone; No. 3, actual and comparative cost and grade of cement; No. 4, actual and comparative cost and grade of wood and iron for false work purposes; No. 5, actual and comparative cost and grade of steel for reinforcement; No. 6, bearing value for soils of foundations; No. 7, whether or not dry and damp proof structures are wanted; No. 8, arrangement of columns as to clearance between same; No. 9, minimum and maximum head room in structures; No. 10, minimum and maximum size of columns;

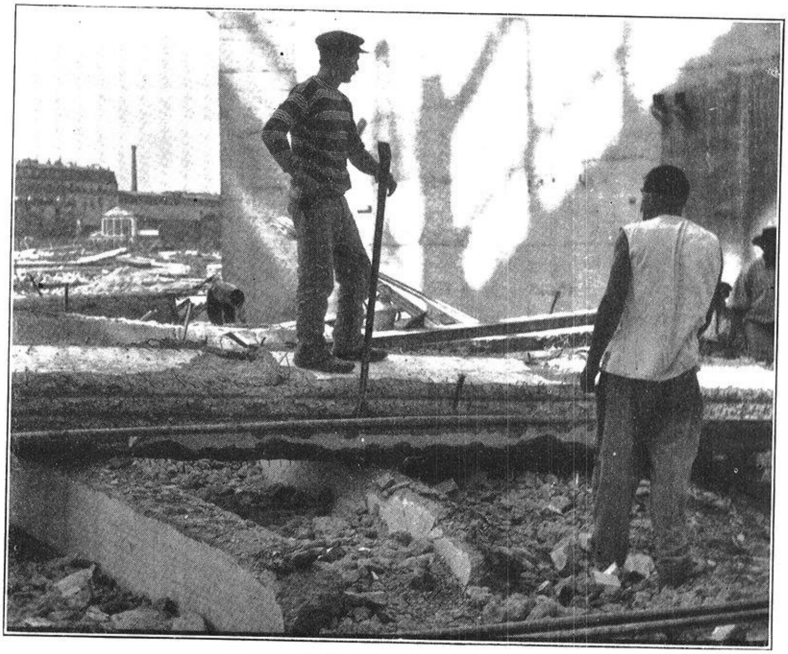
No. 11, minimum and maximum size of girders and beams; No. 12, outside appearance and finish of structure; No. 13, inside appearance and finish of structure; No. 14, static loading or impact or vibratory loading; No. 15, amount of loading; No. 16, ratio of regular working load to capacity, or specified working load per square foot; No. 17, whether a practical expert and specialist or a general architect and builder designs; No. 18, whether a specialist contractor or general contractor or builder executes and builds under these designs; No. 19, the amount and quality of direct supervision; No. 20, the amount and quality of labor within reach; No. 21, the amount and quality of labor saving machinery and tools within reach; No. 22, extent to which fireproofing is desired; No. 23, extent to which sanitation is desired; No. 24, extent to which maintenance cost is desired avoided; No. 25, extent to which vibration should be avoided; No. 26, extent to which acoustic properties should be considered; No. 27, methods for cleaning the structure for other than sanitary purposes; No. 28, arbitrary and uneconomical desires of owners; No. 29, whether or not the owners furnish material; No. 30, whether or not the owners furnish labor; No. 31, whether or not the designer has control over the execution of the work; No. 32, whether or not more than one designer work independently on the structure; No. 33, whether or not more than one contractor or builder work independently on the structure; No. 34, whether or not local building laws interfere with the foregoing items, *i. e.*, uneconomical considerations by arbitrary ordinances, whether due to lack of bringing existing ordinances up to date, or by arbitrary interpretation of the ordinances by officials in charge; etc., etc.

With these and other consideration in mind we have under local conditions the influence of location of the structure as to continent, section of continent, country, section of country, state, section of state, city, section of city and the site itself. Of these the larger divisions as to continent and country play a vital part only when comparing designs of such divisions



No. 2

with each other, such as those of Europe *vs.* those of the United States or those of our northern states with their cold winters *vs.* those of our southern states which rarely or never feel a frost, and each of these sections with the belt of states between them in which at times almost daily variations above and below the freezing point of water take place (the cities of Milwaukee and Chicago are from this standpoint far worse situated for economical reinforced concrete work than are Minneapolis and St. Paul, or Winnepeg, Quebec, Toronto and



No. 3

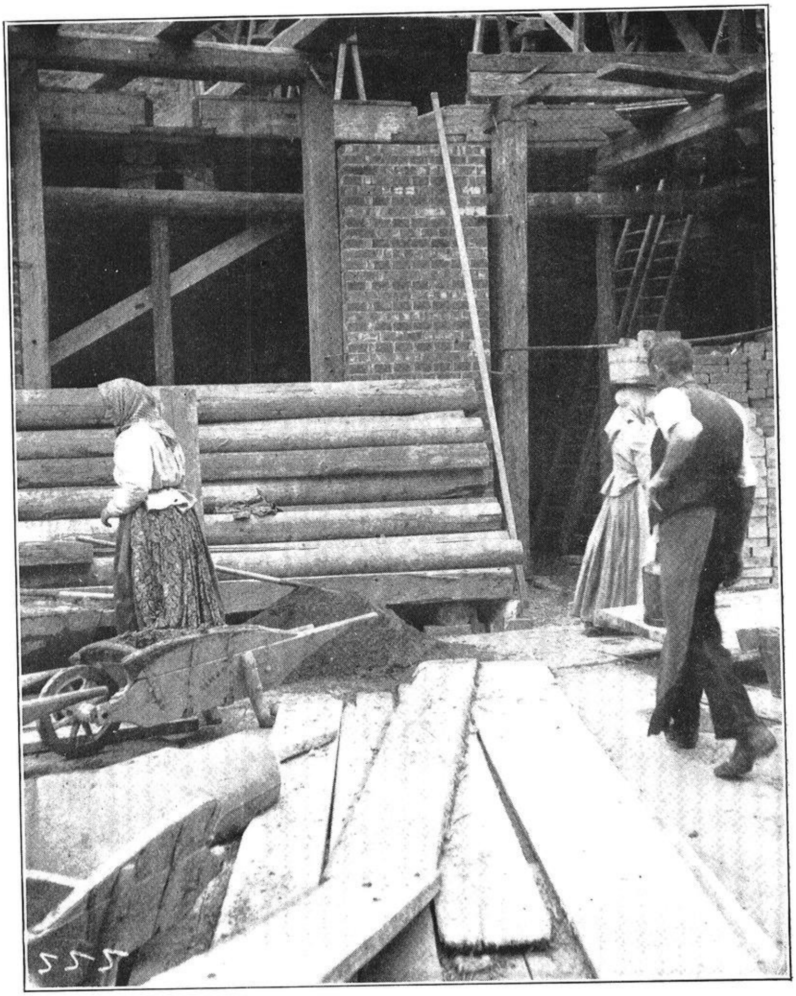
Montreal, Canada). These larger sections carry with themselves also all the differences as to general supply of the materials needed for a given purpose and as to the character and cost of labor and supervision necessary to work up the same.

Proceeding now to take up the items in order it may be stated that this article will consider purely structural features almost solely. Under item 1, the decision in a given case as to the sand to be employed depends invariably on the sand to be had. Should same be a first class structural concrete sand then item 2 will next be considered. Should, howevcr, the sand be of a poorer grade, *i. e.*, very fine or too dirty, or the dirt of the wrong composition, or sand of too even a run of grain, either fine or coarse, the proper allowances would have to be made at once for depreciation of strength of the resulting concrete made up from same. With first class sand giving 100 per cent efficiency, passable fine sand

No. 4

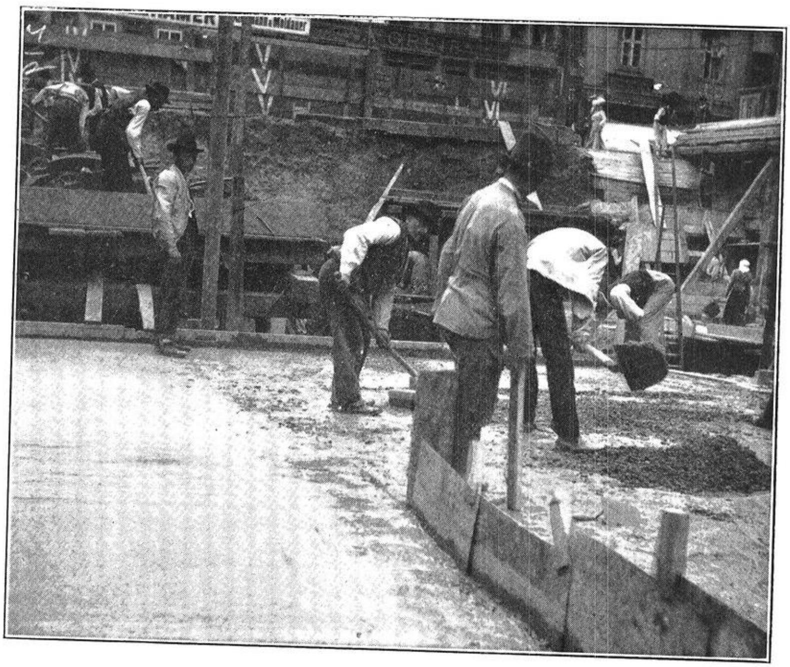
might give no more than 20 per cent efficiency, and dirty sand less than 0 per cent efficiency. The remedy in too fine passable sand would be costly and means from 25 per cent up to 100 per cent more cement than when first class sand is used. Should no sand be obtainable lime stone or other stone screenings might pass, but should never be used except under the direction of a competent specialist or expert, and then only after the extra amount of cement needed to bring the screenings up to the standard of first class sand has been determined and is used. Screenings are often far more deleterious than fine sand. Actual failures in reinforced concrete work are traceable and have been traced to fine sand and screenings. The allowance of dirty sand in reinforced concrete work should only be possible after a competent specialist has passed on the same. The great range of character and amount of dirt in sand makes it impossible to state a fixed standard and experienced judgment only can pass on same.

Item 2 is similar to item 1 in some ways. Again the obtainable material rules. If this material be clean gravel and of first class size, screened or unscreened, whether it be of lime stone, granite, trap, or other base, it will be considered first class for concrete work and given 100 per cent efficiency rating. While some dirt might be allowed in gravel or stone the same as in sand, again the judgment of a specialist is imperatively necessary; but in general a clean gravel is far more to be desired than is a clean sand, and only in very exceptional places and cases should dirty gravel or stone be allowed. There is a type of gravel continually being made at Milwaukee, consisting of blast furnace slag from the Illinois Steel Co.'s plant at Bay View, being run into Lake Michigan (which by the way nightly forms a red hot lava stream on a small scale) which, through the resulting milling, crushing, grinding and washing action as well as aging it receives, is ranked by the writer above any other material for concrete purposes obtainable at Milwaukee. Crushed lime stone as the sole base for concrete as far as the stone part is concerned is ranked by the writer at no more than 75 per cent efficiency. Crushed trap rock unquestionably ranks above lime stone, but because of its sharp corners cannot be considered the equal of the slag gravel mentioned above for reinforced concrete purposes, although the writer has not used any of the trap rock. A mixture of good gravel and crushed lime stone for the stone part in concrete is ranked by the writer from 75 to 100 per cent effi-



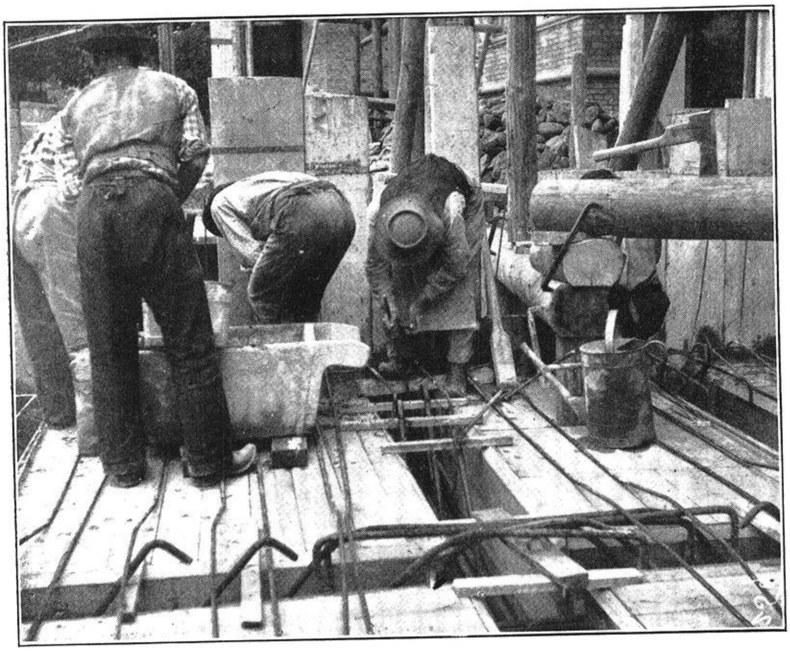
No. 5

ciency depending on the proportions of each in the mixture. Should the local crushed stone be sandy, or clayey, or soft, it could easily deteriorate the resulting concrete to 25 per cent efficiency and less. One of the reasons why gravel, even though of lime stone base, is preferable to crushed stone is because same is unquestionably harder than a soft crushed stone could be, since the gravel has been thoroughly submitted to grinding and crushing actions before being deposited. As to



No. 6

conditions of good sand and poor gravel and *vice versa*, the latter makes a stronger and better concrete all around than the former, this following the statement just made regarding dirt in stone. Substitutes for gravel and stone are poor at best. Brick bats are a poor excuse for stone unless the bats come from a hard pressed or paving brick, which is improbable. Yet with proper allowances they may be used. Cinders for concrete are generally to be avoided since for strength they are a very poor substitute for gravel or stone. However, if their use is neccssary they can be reliably used after being carefully selected by an expert who controls their use, because certain grades of cinders are totally unfit for concrete purposes from a chemical standpoint. Often plain poor ashes of no structural value whatever are used as cinders in concrete construction. At other times a very sulphurous cinder is used which has in time by reason of chemical action disin-

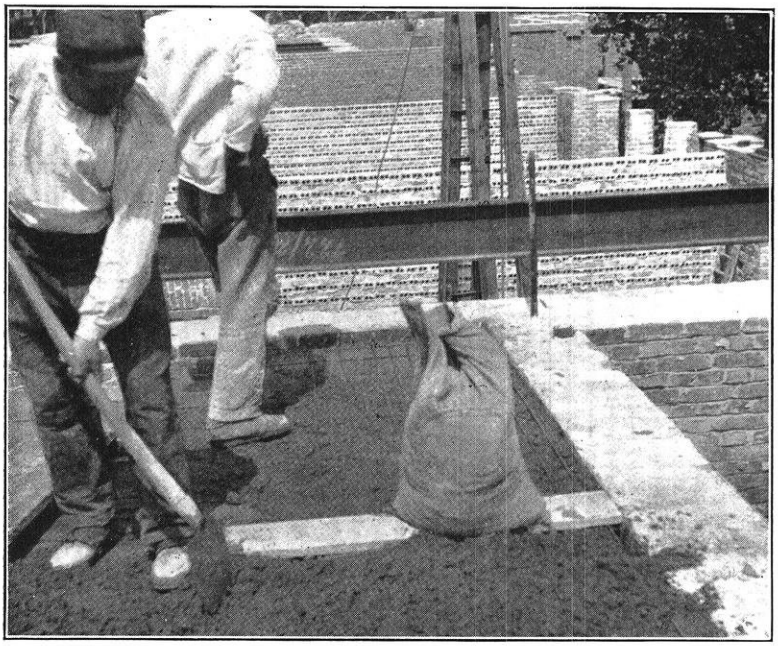


No. 7

tegrated concrete. The San Francisco fire showed up a large amount of cinder concrete work in its poor value, very much of same being nothing more than dirt after the fire passed through, and, undoubtedly, much of this was dirt before the fire struck it.

As to item 3, a good Portland Cement thoroughly tested *before using* fulfills all the requirements structurally. Natural cements have their place even today, and the day may return when they will again largely be used structurally in reinforced concrete work, but the conditions accompanying their use are in some matters different from those affecting Portland Cement, so they will not be referred to here.

As to concrete, therefore, to resume, the local supply generally will govern. If concrete, mixed 1 part Portland Cement, $2\frac{1}{4}$ parts sand to $4\frac{1}{2}$ parts gravel or stone with first class material throughout, be given a ranking of 100 per cent



No. 8

efficiency, then local conditions will determine whether a concrete must be mixed 1:1 $\frac{1}{2}$:3, 1:1 $\frac{3}{4}$:3 $\frac{1}{2}$ or 1:2:4, in order to develop 100 per cent efficiency, or it may be entirely impossible to develop this 100 per cent efficiency, and so in certain districts it would be impossible to make columns, beams, slabs, etc., anywhere near as small in section and area as in other districts if we adhere strictly to a standard reinforced concete design. A good water is assumed obtainable throughout this article, although bad water has often been the cause of failures of concrete and cement work and deserves special consideration given the subject. The judgment of a specialist would be necessary if no water but bad water be obtainable.

It should be borne in mind that, in many places and parts of structures, concrete of efficiency 50 per cent or 75 per cent would be more economical to use than higher grade con-

No. 9

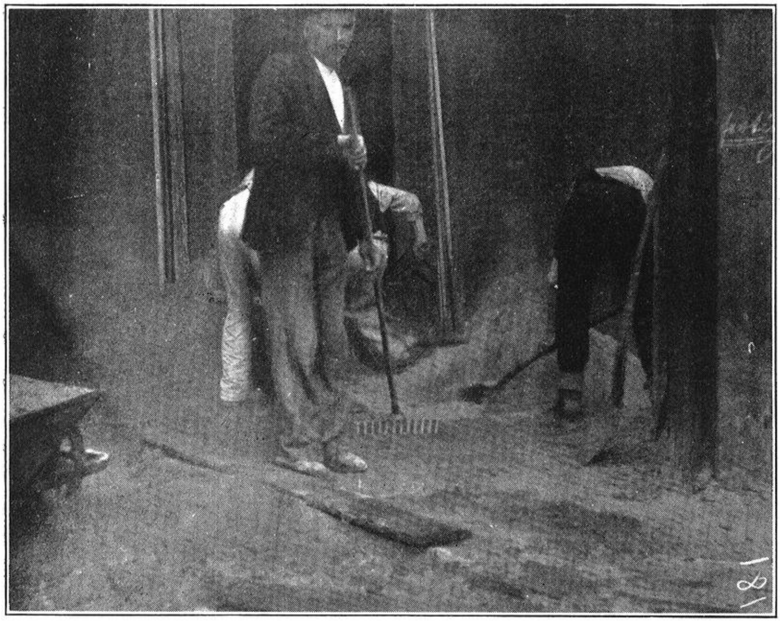
crete, but resulting concrete sections in these cases must be increased necessarily 100 per cent or $33\frac{1}{3}$ per cent in area over the areas of 100 per cent efficiency concrete. However, a considerable change as an increase in area of concrete in reinforced concrete work will necessitate a similar considerable change or increase in the amount of steel for reinforcement to be mentioned later, without compensating gain in strength and is generally a source of greater cost of structure eventually. Best practice from the standpoint of economy requires a minimum of all materials properly placed. The conclusion which is reached regarding sand, gravel and stone, and cement for a reinforced concrete structure is, therefore, easily seen to be *get a competent engineer to pass on same and to proportion same.*

As to item No. 4, the limits of this paper do not allow of saying much on a subject which would require an article by

No. 10

itself. However, it should be noted that from the standpoint of economy all over the world wood for false work forms still holds the day.

Item 5, as to steel reinforcement, is generally considered the sum total of all reinforced concrete designing. In reality, while it is very important, directly and indirectly affecting the cost of a structure to perhaps two or three times its own direct cost, it still is only a part of the design, and a designer may be well grounded here and yet be thoroughly unsuccessful as a designer. In general the local market will be a stock market, *i. e.*, all steel in the shape of round, square, or flat bars will be obtainable at hardware dealers in certain fixed sizes and lengths. By waiting a short time the nearest rolling mill or wholesale supply house could get any sizes and lengths to the site. Correct lengths as needed, if time allows, will save very much all around in cost by allowing the



No. 11

design to approach the nearest to 100 per cent efficiency in sizes of beams, columns, floor slabs and amounts of steel needed in any of them. Round steel should be preferred for various reasons. Square steel is ranked by the writer at about 75 per cent of the round steel value, considering area for area. Flat steel in which the thickness is not more than one-fourth of the width is ranked about 50 per cent of round steel value. The reasons for this are mainly contained in the phrases "Sharp corners," "Poor grip shape" and results from actual tests. Deformed bars of all kinds are not only not advocated by the writer but are considered a nuisance in many ways. Every one of them have either sharp corners which tend invariably to split the concrete in which they are imbedded, or they have air and water bubble pockets which allow a poor bond and adhesive value and form starting places for rusting, or they have wasteful attachments or projections of metal which increase the cost without compen-

No. 12

sating increase in value of metal sections, or they have two or all of these objections. A slight jar on any of the deformed bars while the setting concrete is still semi-plastic produces an entire and continuous series of no contact surfaces, as beautifully shown in a sample on exhibition at the last Cement Users' Convention, in Chicago, in January, this year, even when this sample was made of extremely rich concrete. Smooth round rods if disturbed similarly do not disturb the semi-plastic setting concrete as to shape materially, and thus are not subject to this bad feature attending the use of deformed bars.

Tests for so called adhesion or grip in comparatively large chunks with regard to the size of rods imbedded in same with small length imbedded are practically worthless in judging reinforced concrete work. There is absolutely no comparison between five $\frac{1}{2}''$ rods imbedded in the lower 4 inches of an 8 x 8 beam and one $\frac{1}{2}''$ rod imbedded in the center of an 8 x 8

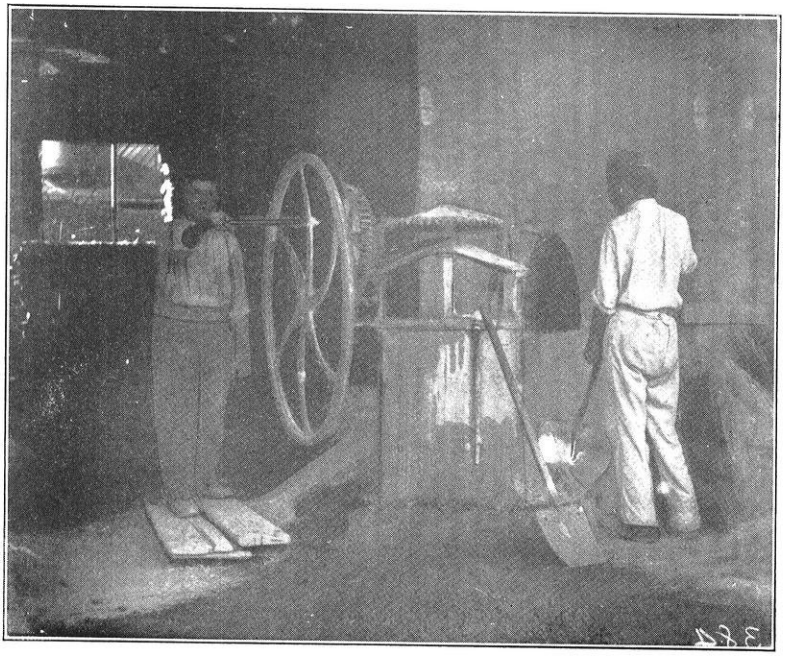


Fig. 13

chunk, and there is further no comparison whatever in the sticking properties of these five $\frac{1}{2}''$ rods in a beam 10 to 15 feet long as compared with the sticking properties of one $\frac{1}{2}''$ rod imbedded in the center of an 8 x 8 chunk 8 inches or even 30 inches long from which the $\frac{1}{2}''$ rod is to be pulled. No European engineers today in spite of American deformed bars will conscientiously use anything but smooth round rods except it be to their personal interest in other matters to use something of a deformed variety. Reasoned from the basis of correct principle of design they all agree on smooth round rods (it should be noted here that the American deformed bar reinforced concrete engineer has had a European prototype, but he has not been a success). Furthermore the plain rods are always the most economical and locally especially so. If stock steel be used a general rule in good practice is to use 10 per cent to 15 per cent more steel than where the steel is

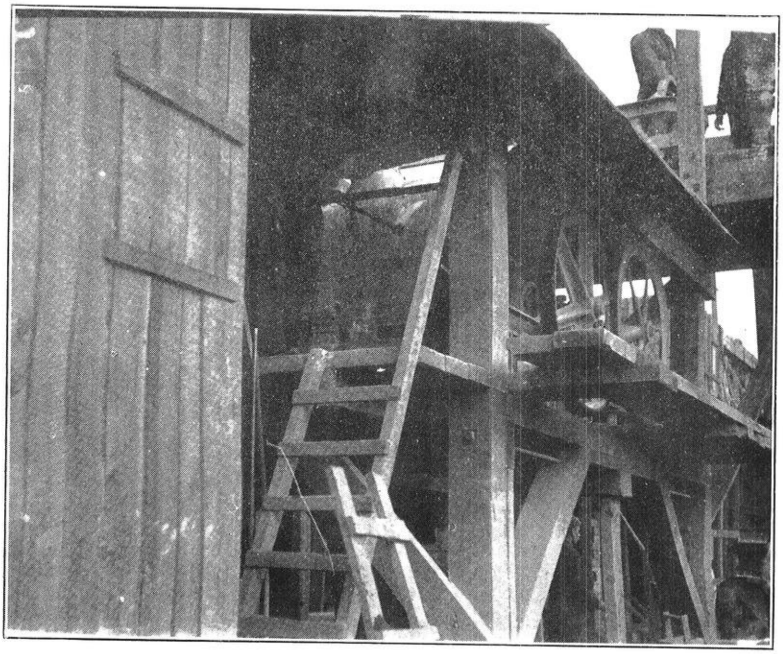
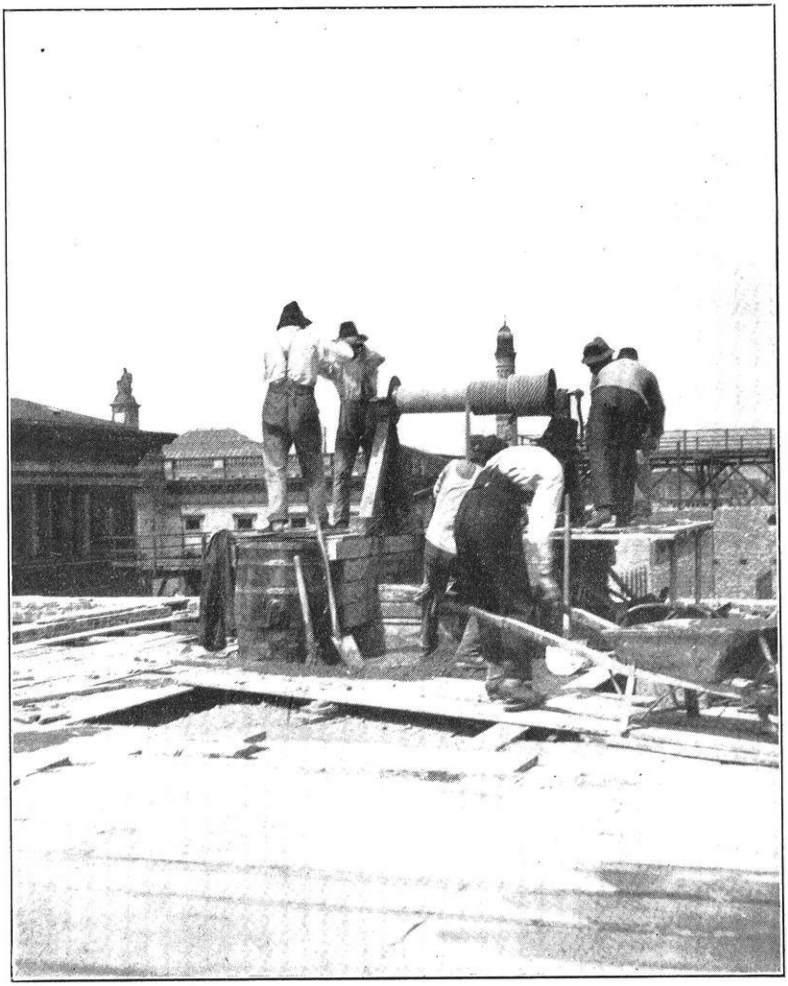


Fig. 14

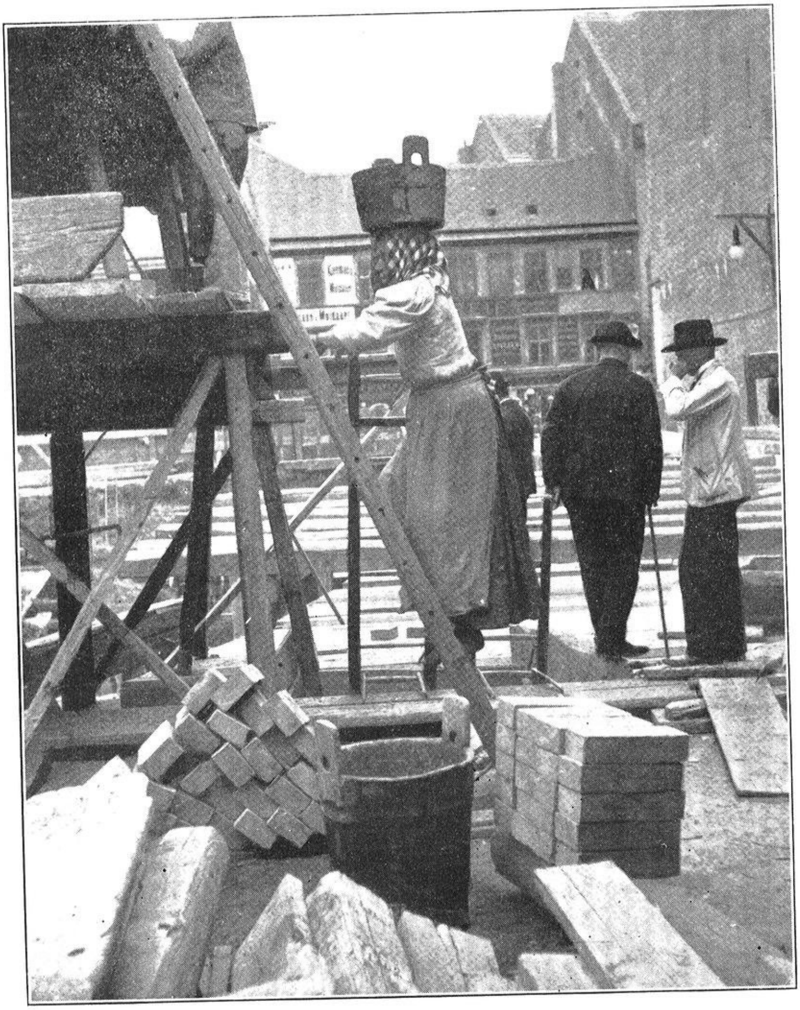
of correct length as required, and furthermore to allow sufficiently for lapping bonds. In case a poorer concrete than grade efficiency 100 per cent. is used, a good rule is to add enough extra steel above that required in concrete of 100 per cent efficiency to get the per cent of steel to concrete half way up to that called for with 100 per cent efficiency concrete. This naturally assumes that a proper increase in area has been made in the poorer concrete section over that of the



No. 15

100 per cent efficiency concrete area. In beam, girder and slab construction the steel should be placed with carrying rods partly straight, and partly bent at ends at varying distances if possible, thoroughly cantilevered into adjacent spans and *sufficient* stirrups of round steel of correct design added to prevent any oblique so called "sheer failure" and to vitally increase the resistance of the structure against impact and vibratory stresses. That the arrangement, spacing, number and character of oblique reinforcement provided by a deformed bar after the pattern in which such members are sheered up from metal, rolled as a part of the carrying rod, does not prevent the evil effects from impact and vibratory stresses, which properly designed stirrups will do, was shown this last year ,1906, in concrete failures in California, Rochester, Milwaukee, etc. If a poor grade of concrete is used a good rule is to add additional stirrups in per cent equal to the per cent the concrete is below 100 per cent efficiency concrete. To show the value of stirrups properly designed and inserted, even under static loads, if all straight carrying rods represent 100 per cent strength under static breaking loads, about 117 per cent represents the strength when approximately 50 per cent of these rods are bent up at varying distances from the ends, and about 137 per cent represents the strength with the addition of properly placed stirrups of correct design, as shown by tests made in 1906 at the University of Wisconsin Laboratories, which tests will be reported in a bulletin to be issued soon.

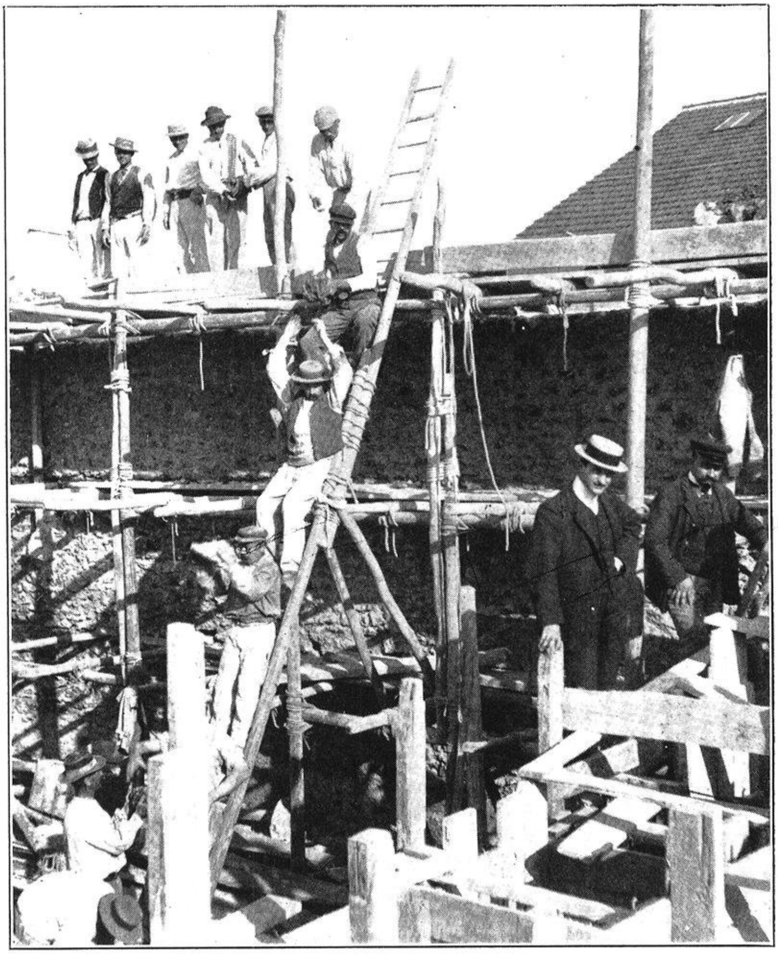
In all shock tests or accidents, or under vibratory loads, or under use *anywhere near the figured capacity* of the structure, the immense value of properly inserted stirrups of correct design in reinforced concrete is distinctly and vitally understood by European engineers. Stirrups of proper design lend themselves to variations in size of beams and number of carrying rods, as well as to the additional duties of supporting these while placing concrete, and of tying beams into slabs, besides their value as oblique rupture preventatives and shock resisters to such an extent that they really form the



No. 16

most economical part of what is called the standard European reinforced concrete construction today. With slight modifications facilitating their use under American labor conditions, the writer has incorporated same into his own system of construction which he consequently calls a perfected European system, one which has almost fifty years of experimental data to substantiate its claims "to be standard" as against the thousand and one latter day abortions continually being thrown on the market, especially the American market, which do not even have the right to claim originality and are foisted upon the public as panaceas for all the ills of reinforced concrete construction. In all column and wall construction continuity of reinforcement should be provided. High carbon steel should only be used in very exceptional cases, and in 95 per cent of cases where it might be advocated at first thought, mature reflection will convince the designer that he should have stuck to his soft or medium steel. High carbon steel in reinforced concrete is of no more value than in structural shaped steel, although the identical reasons do not apply. Steel should never be worked higher under continuous static loads than 12,000 pounds per square inch of carrying rods area. The suspension idea should not in any shape or manner be embodied in reinforced concrete design. It is a delusion and a snare and was thoroughly exploded in France, the rest of Europe and even in this country by the cable and wire systems. Most wire systems are suspension systems (if anywhere near economical) and are failures always if so used. If wire systems are used they compare directly with rod systems, but are of no greater value than the area of metal they furnish over the area furnished by the rod system. However, if they do this, since wires per pound cost more than rods per pound, they prove themselves to be uneconomical compared to rod systems.

A new phase of the suspension idea in a slightly different dress is being worked out under the so-called "Mushroom-System" advocated for economy in false work construction mainly, but this economy is certainly very debatable and in



No. 17

the writer's opinion a falacy in a purely reinforced concrete building. In buildings with very heavy outside masonry walls it has its greatest right to this claim, but this type of construction as to entire building is uneconomical in itself. Besides, shrinkage stresses, eccentric loads, use of structure up to anywhere near its capacity, unsymmetrical floor panels, outside floor panels, openings in floor, differential pier settlements, etc., all play havoc with the mushroon construction. In 1900 at Paris, the French prototype of the mushroom system received its death blow by demonstrating its fundamental weaknesses by a big failure.

The above rules allow economically a high percentage of reinforcement or of steel in concrete, which in turn allows the nearest approach to 100 per cent efficiency in combined design and the minimizing of concrete material and labor, especially *under working loads*, because steel should be stressed *low* under working loads. This minimizing as stated above spells economy.

With the above remarks on reinforcing and local influence of same reciprocally on concrete in the saving of cement, sand, gravel and labor, and with adherence to the above rules freshly in mind, an application to item 6 will illustrate the value of same a little more clearly. On good soil, structurally, the foundation problem is solved with little trouble. On poor soil a "float foundation" of reinforced concrete properly reinforced and provided with stirrups properly placed and of correct design adapts itself locally at once. There is only one possible objection to same, and that is in such places where eventually within the life of the structure the soil around the same is excavated below the bottom level of the float foundation. Even then a retaining wall built below the float foundation at the time of excavation will serve to continue indefinitely the value of this float foundation. In *all other cases* of any magnitude whatever the reinforced concrete float foundation is the solution and saves dollar upon dollar as against piling. *Without stirrups* a correctly designed float foundation is economically impossible, and little or no saving as compared to piling results.

No. 18

Items 7, 8 and 9 can be passed by for the present article.

Item 10 demands that if concrete of 100 per cent efficiency in columns be used and worked at 600 pounds to 650 pounds per square inch, that, for concrete in a location where it can be made economically of only 50 per cent efficiency, 300 pounds per square inch working load be used. A good rule in columns is to make all columns from 2 to 4 inches wider when crushed stone is used as against hazel-nut gravel. The reason is obvious to all who have tried to make sound reinforced concrete columns out of crushed stone. If normal lime stone screenings with normal mixture of concrete are used, the 300 pounds per square inch should be the working stress, especially if there is any speed at all in the erection of the structure. Similar deductions apply to beams and girders, item 11, except the working stresses be changed to 750 pounds per square inch or 850 pounds per square inch for 100 per cent efficiency concrete. For both items 10 and 11, if stock steel be used and spliced or lapped joints occur, add two to four inches to sizes of 100 per cent efficiency concrete and further addition for concrete of lower efficiency, according to the percentage said concrete is below 100 per cent efficiency concrete.

If outside appearance is of considerable importance, item 12, cover up the concrete work entirely with a veneer of some kind, or allow simply a few beams as belt courses to appear. For the cheaper grades of structures, as mills and shops, etc., it is more economical to allow all beams and columns to so appear.

For inside appearance, item 13, if contraction cracks are unsightly, wait until they appear before plastering or finishing. This will generally include as long a wait as possible until the concrete in the structure is thoroughly dried out. It is far preferable to allow contraction cracks to come than to try and attempt to stop all of them by wasteful reinforcing. The day has gone by when such cracks frighten anybody at all familiar with reinforced concrete construction. However, a competent *engineer and specialist* should pass judgment as to whether or not any cracks in question are contraction cracks or not, and as to whether the reinforcement in the structure has been so placed that these contraction cracks do not affect the strength of the structure. In the writer's opinion the appearance of certain contraction cracks are a source of satisfaction and give rise to adjustments in the structure which are thereby definitely determined and which increase the security of the construction. Reinforced concrete work makes a better appearance unfinished, except a little painting, than plastered, if it is plastered too fresh. Also in reinforced concrete construction it should be remembered that here as in all things, but especially here, "haste makes waste."

Item 14, on kind of loading, would require a paper in itself. Let it suffice to say that stirrups, or some equivalent of stirrups (which equivalent the writer does not know or cannot see) are necessary for all loadings other than static loading, and even here in static loading as stated before a big increase in strength is noticed. Deformed bars are an absolute fallacy as a vibratory and shock resisting medium. One of the best representative reinforced concrete engineers of the east, a man of reputation, experience and judgment and a *user of a deformed rod* stated a short time ago in a prominent publication that in those floors where he had no transverse reinforcement, if said floors were subjected to actual working loads near the calculated working load, that diagonal failure gradually took place. This statement explains the erroneous position of another deformed bar construction company when they show pictures in their catalogue of a by them called "failure of smooth bars" in a floor built for heavy working loads. The writer ventures the opinion that the *same failure will take place in the same way by using said company's own deformed bar*, provided said deformed bars are placed exactly in the same way and of exactly the same weight as the smooth bars are placed and worked under identical conditions. Europe, and lately this country, are full of examples of smooth round steel reinforced floors and bridges bearing up under severe vibratory and shock loadings. However, it should be remembered that, impact and shock stresses being about twice as dangerous in any construction as static stresses, the steel should be calculated never to be worked much higher than one-half the static limit. If this is lived up to *no failures* from shock or impact stresses can or will take place. The catalogue mentioned above *does not show a failure of steel* in its picture reproduced there, but a failure of *concrete.* Stirrups have saved building after building from tumbling all together because of their shock resisting power. The examples are legion in Europe.

The specified loading, item 15, should be partly based on the kind of loading and, therefore, same becomes an economic factor of vital importance. It should also thoroughly consider the fact brought out in item 16.

In this item 16, an element enters into design which is generally taken advantage of by unscrupulous designers and builders (it is too bad that such are at times engaged on responsible work). Specifications should state especially, if the designer himself is not the builder, the per cent of specified loading, same being generally in pounds per square foot on floor area, which should go to slabs, beams, girders, columns, etc. This item consequently becomes of very great economic value, and invariably local conditions govern the same.

Under item 17 we face the question, "Can an expert or specialist earn his own cost to an owner?" In all conservative safe business dealings the concensus of opinion on this question would answer same at once by saying, "*Why, certainly,*" In the writer's opinion in reinforced concrete work the efficient, and, therefore, thoroughly practical specialist can always affect a saving to the owner of at the very least ten per cent of the value of the structure besides his own pay. This will depend, however, on the grade of execution of his design said specialist can expect from those who are to carry out his plans. If the specialist is also the contractor and builder the *maximum saving* is reached. However, a farther saving will result when we change over to another method of building, and that is, when the specialist works either for a percentage of cost or a fixed commission, this last being the best and most economical way of them all. It is understood, of course, that the structure in question fulfills all the requirements of the owner indefinitely, said requirements being those which the specialist agrees to fulfill. A general architect or builder must needs hire a specialist if economical results are to follow his efforts, but in this case invariably the specialist is hampered by such architects and builders, and the maximum of economy is frustrated. A general architect or builder who has no first class specialist in reinforced concrete work *may* possibly put up a building *cheaper* than a specialist can, but the result is bound to be a poor, unsatisfactory job which cannot very long be worked up anywhere near its capacity or its first value, as against a thoroughly useful and workable structure, good indefinitely, built by a specialist. Furthermore a general architect and builder is bound to have very often small and large failures accompanying his erection as against *no* failures whatever for the real specialist. The strengths of the two resulting products can hardly be compared, nor can their uniformity of strength be compared. A general architect and builder will allow far more unskilled help to dictate what is to be used and done than would a specialist, who would dictate himself. The vital personal difference is that the general architect and builder feels little or no responsibility and believes it good policy to shift the little he does feel as part of a general good fellowship plan, while the specialist thoroughly feels and knows his reputation is at stake, and lives up to his convictions.

A specialist contractor, item 18, is far preferable to the general contractor for the same reasons. The benefits derived from the general contractor would be best conserved in building a reinforced concrete structure if the specialist contractor should also do the general contracting work, which would amount to saying that that type of general contractor who learned contracting as a specialist reinforced concrete contractor would be the solution for the best economical results in reinforced concrete construction.

As to direct supervision enforced, item 19, this is generally a farce in America, *unless specialists control.* Herein lies the greatest and vital difference between European and American work. The writer knows of one structure going up at the present time which is practically under the sole responsibility, in actual fact, of one man, and that man receiving less than $5.00 a day and being nothing more than a foreman of less than three years experience in the work for which he is responsible. In this case the owners either do not know they are playing with fire or they are fool-hardy enough to take their very uncertain chances with a very uncertain wind-up to their venture. Similarly situated propositions have proved unsatisfactory failures and have killed working men. The workmen or laboring men are practically the same in Europe as in America, facts for which will be presented shortly. In fact, the writer thoroughly believes American foremen can get more work out of their men than European foremen ever would dream of getting. This is simply as to "hustling the men," but the American foreman is a thoroughly discontented creature; he must be "either the whole thing" himself, or he waxes extremely independent the minute his pay is advanced (which generally is more or less of a necessity in our growing, expanding communities, whether his work deserves it or not) and, thinking himself indispensable, he becomes inefficient, lax, and thoughtless, and, to his great astonishment, is suddenly "fired." This astonishment is so great and he has so little analytical power that he repeats the same action the next time, if there should be a next time. Or in this land of promise and ambitious fulfilment, if he be really in a way efficient and smart in his position, he invariably sets up in business for himself, after which, generally proving himself unsuccessful, he is, however, no longer a working man and generally has ruined himself for good as an efficient man on reinforced concrete work because he has learned too little of some things and too much of other things for his own good. The practice of general contractors and builders to get hold of a foreman trained by a specialist and then to give him "carte blanche" sometimes results in a temporary economy to the general contractor and possibly the owner, but eventually results in the complete discomfiture of the general contractor and greater discomfiture of the owner. The general contractor and builder forgot to take the specialist who trained said foreman *along with the foreman.* A competent specialist should control at *all times! All other* ways of building reinforced concrete structure are extremely dangerous.

As to the quality of labor, item 20, it makes very little difference where the structure is to be built, as far as concrete laborers are concerned and as long as a sufficient number of such laborers can be obtained. Figures 1 and 2 show the brothers and fathers of our Italian friends on railroad work in this country, and yet this picture was taken by the writer in southern Germany on a very important reinforced concrete job. Fig. 3 shows a Parisian type of laboring man in primitive garb. Fig. 4 also shows Parisian workmen. Figs. 5 and 6 show Viennese workmen and work women. Fig. 7 shows Swiss workmen. Figures 8 and 9 show Berlin workmen and Figure 10 shows Manchester workmen. On this English job shown in the last picture, amounting to $625,000.00 in cost, a French foreman, who could not speak English, was in charge! And yet no accidents of any kind came from this system, but the French foreman *was under French specialists*, thus proving the contention of the writer that it is the specialist who guards the safety and economy of design and erection, for in no way other than by the use of this French foreman could the specialists keep absolute control of the structure in the process of erection. The labor question as to quality is the same abroad as here. However, the cheapness of European labor in the provinces and small towns allows of less attention to the labor item of cost, yet in Berlin, Paris and London, labor is about the same in price as in Chicago and Milwaukee. The fact that counts is that direct control must *be in the specialist himself*, if economy and reliability shall result. The foreman must know thoroughly and feel that the specialist is in direct control if trustworthy work is done. As to the false work workers, they, being generally carpenters, are governed mainly by the well understood conditions surrounding these mechanics in all places and thus need not be mentioned here. Furthermore, since union conditions govern these to some extent, the influence of organized labor has up to the present been exerted, in any telling way whatever, only on the carpenter part of reinforced concrete work.

Regarding concrete machinery, item 21, Americans are far ahead of Europeans, as they generally are when labor saving machinery is needed. Economy demands quick work in as large units as possible. Wheelbarrows or rather carts in America are lately being manufactured to carry six cubic feet of "sloppy concrete" which, with the weight of the cart itself amounts to half a ton handled by one man, and this half a ton is handled with less work than it took formerly to wheel three to four hundred pounds of sand or gravel by the ancient standard wheelbarrow. Difficulty is met with by the contractor in transferring men from wheeling these carts to wheeling sand and gravel with the regular wheelbarrow, although the man in question handles only one-third the weight in the latter case as compared with the former. Good concrete mixers increase the output of concrete five and ten times over the maximum possible with hand mixing and it is far better mixed concrete and it is in shape to be far more economically handled. The writer would say in this connection that batch mixers only should be allowed to mix reinforced concrete work. Hoists to accommodate the changed conditions are continually being built and improved upon. To contrast American methods of mixing, handling and hoisting concrete with European methods turn to Figure 11, a German mixing outfit from Berlin, the city which has grown even faster than Chicago, to Figure 12, an Austrian outfit from Vienna, to Figure 13, a French outfit from Paris, one and a half times as large a city as Chicago, or to Figure 14, an English outfit from Manchester. These are mixing affairs and are used on very large and important work and are representatives of the countries in which they were taken. Also, see the Berlin hoist, Figure 15, the Viennese hoist, Figure 16, the Paris hoist, Figure 17, and the English derrick bucket hoist, Figure 18, the latter consisting of a self movable locomotive and derrick with a simple old fashioned cylindrical bucket, unfortunately not shown in the picture, which had to be reversed to empty same. It should be stated, however, that this, the only attempt at modern machinery seen by the writer in a tour in 1903, whose object was especially to study reinforced concrete construction, was of a French make. *No local conditions* should possibly interfere with the requirements of first class machinery if the proposed reinforced concrete construction has any magnitude whatever. Here at least standardization can be had.

This article will pass by items 22 to 28, although here also whole papers might be presented.

Under item 29, when the owner furnishes material the writer believes a great source of evil and an uneconomical condition in reinforced concrete work is found. This evil is one which cannot entirely be eradicated, even if the owner has the help of a competent specialist, unless the specialist is given entire "carte blanche," which is improbable; however, with the addition of furnishing of labor, item 30, and paying the specialist, who in this case *designs and builds*, a percentage or a fixed price for his work, the ideal and thoroughly practical form of building is presented. In this latter case satisfaction to all results, the desideratum of all good people. This last is also by far the most economical to both the owner and specialist and is receiving the commendation and growth as well as recognition it deserves. It may be abused, but never by a thoroughly reliable and reputable as well as conciencious specialist. Local conditions are by this method entirely under the control of one competent specialist. The owner is safe guarded and the specialist is safe guarded, it being necessary that both should so be taken care of. The only known way an owner can attempt to get a cheaper structure for a given purpose than by this method is to give the work to an incompetent contractor who is forced to lose money through his incompetency at figuring; but in reinforced concrete work this incompetency is invariably accompanied with incompetency to build, which is invariably accompanied, consequently, by poor, weak and unsatisfactory work, as well as disastrous failures, proving such a proceeding to be a boomerang to the owner.

Items 31, 32 and 33 are conditions which invariably cause loss to all concerned and should by all means be avoided in reinforced concrete work. They are unquestionably the faults of meddling owners who imagine they know another's business better than they do their own, but who also pay dearly for their imagination. In this case it is right that they should pay, but the losses to others concerned cannot be equalized. The writer would warn all specialists to steer clear of all such owners, as they will most assuredly get the worst of it, but if this avoidance is impossible, to be absolutely certain that responsibility for bad conditions resulting, and even for loss of life should a failure result, is placed where such responsibility belongs.

Item 34 need hardly be touched here, although it contains food for much pertinent inquiry.

There is, therefore, really and rightly a special set of laws or rules to be followed by each locality in our country, our section of country, our city and our particular site, and for particular circumstances in the solution of a structural problem in reinforced concrete, if we are to arrive at thoroughly reliable, as well as economical results. These must be painstakingly worked out, as far as practical, by each locality; and after sufficient trial adopted and incorporated into local building ordinances or practices; always, however, securing to builders the rights for the introduction of new methods and the use of new materials in a conservative way in some manner similar to those of the New York and Philadelphia building codes. Because of these many complex considerations surrounding reinforced concrete building it is practically impossible to get any one set of laws and rules to govern all situations, and therefore, here as in all things, mature ripe judgment to plan and design, coupled with the energy of youth to carry out rigidly and with economy this plan and design, form the basic elements to success and are and must remain the foundation stones upon which the success of a reinforced concrete designer and builder must rest. But the necessity of years of training in the knowledge of the materials he uses, the talent and even genius to fashion the same into the ever new and varying forms demanded of him, and above all a full and thorough realization of the true economic value of the items considered in this paper, with many similar unmentioned items, and with *power to apply all these* are essentially vital to him who would be a reinforced concrete engineer. Such an engineer truly must be reinforced in the complex ways he attains and be concrete in the simple way he gives!

THE TECHNICAL GRADUATE AND THE MANUFACTURING COMPANY.

Mr. Chas. F. Scott, consulting engineer of the Westinghouse Electric & Manufacturing company, addressed the engineering students on the afternoon of November 9th on "The Relations of the Technical Graduate to the Large Manufacturing Company." Mr. Scott described in an informal talk many of the operations of a company, such as the one with which he is connected, pointing out the departments and the kinds of work in which technically trained men are engaged, and discussed the qualifications which are valuable and essential in such positions. He then suggested several ways in which the training in college could be made more effective in preparing for subsequent activities.

In his opening remarks he referred to the rapid changes which are taking place at the present time.

The changes which have occurred in the life-time of the young men present surpass in many features those which have occurred during many centuries. The rate of progress, moreover, is an accelerating rate. The value of the manufactured products of the United States has doubled in less than twenty years.

This is significant of a new order of things.

Engineering is not only the basis of this material change, but it is also the underlying condition which has brought about the new political and economic and social evolution.

These facts are well known. They have come to be regarded as almost commonplace. It is important, however, that we realize their significance in order that we may better understand the present tendencies and anticipate the qualifications which the future engineer should possess.

Two institutions have grown up within the past few years, with which we are very intimately concerned. These are the technical school and the large manufacturing company.

In engineering education the ideals, the methods and the facilities are all new. The engineering graduate is a new product. He is a new factor in the world's work.

Educational methods are not fixed and definite. They are vastly different from those of a generation ago, and I apprehend that the engineering educational methods of the near future may be quite different from those of today.

Closely related to this development in engineering education is that of the manufacturing company. In electrical engineering, in particular, the growth of the school and of the industry have had a close relationship. Each has been, to a greater or less degree, dependent upon and aided by the other.

In the days of our fathers, manufacturing was carried on in a small way, usually one man was at the head of a given business, personally familiar with and directing its various departments. He devised processes, directed the manufacture and was his own sales agent. Modern manufacturing, however, is of a different kind. The various functions formerly performed by one man require the co-operation of many men in a single organization. Each is an expert and altogether they act as a powerful unit.

Thus, co-operation—or the corporation—has become the modern method. It is the method, moreover, by which modern engineering is conducted. Enterprises, except those which are small or of a particular kind, cannot be conducted by a single individual. The co-laboration of many men is required for larger undertakings. Hence, the necessity of the engineer being able to work efficiently with others.

The large electrical manufacturing company is typical of modern manufacturing and business methods. It may be noted that the products of the electric companies, which are now produced in values exceeding a hundred million dollars a year, would have had no market, as they would have been practically useless, thirty years ago.

The work of these companies, in general, is broad in its scope; it includes invention, development, design, manufacture and erection, as well as the sales and financial departments. To carry on this work, such companies are divided into many departments.

Technical men find their field in those departments which are concerned with engineering, either directly or indirectly, and, furthermore, the engineering training is found in many cases to be an excellent preparation for those engaged in more purely executive work.

There was an oldtime idea that the theoretically trained young man was completely equipped for doing engineering work and that he was at fault if he was not immediately prepared to produce efficient results. This view, however, is based upon several misconceptions. First of all is the relation between knowledge and experience. One may know his theory and his formulae, but engineering problems are not abstract—they are concrete. They deal not merely with forces, but with materials. One must know the constants of his materials and the uses of the products. These come from experience.

The designer of apparatus must not only know the theoretical principles which are involved, but he must know the various qualities, electrical and mechanical, of the various materials which he must use. He must be familiar with the methods of using these materials and the manufacturing facilities which will insure cheap and rapid production. He must be familiar with the conditions of service, so that he may design apparatus which will not only meet reliably the electrical and mechanical requirements of normal operation, but which will safely withstand the emergency conditions which are liable to arise. His apparatus must be adapted to the class of men who will use it. It must work properly with the other apparatus in the system in which it is to be placed. It must, in short, meet commercial conditions in a manner which will prove acceptable to those who purchase it. A gain of a per cent in efficiency or in regulation is of minor consequence if a machine has bad bearings which overheat. It follows, therefore, that even the designer, he who has probably more to do with theory than those in other departments, has to be familiar with many other points besides his theory. Experience, creative imagination, foresight as to the effects of new combinations and new forms, good judgment, integrity, not only with people but in dealing with facts, tact and the ability to get along comfortably and efficiently with other people, together with a goodly measure of all-around common sense, are qualities which must supplement the knowledge of formulae in order to effect the best results.

Those who are engaged in testing departments, in inspection, in erection, as well as in the various departments of commercial engineering and sales, require in a large measure the same breadth of view and qualities which have just been enumerated.

The manufacturing companies have recognized that the man immediately from college requires a further training. He needs experience, a new point of view. Engineering apprenticeship courses are therefore arranged, in which he may gain familiarity with manufacturing and testing operations and also what is of scarcely less importance, an immediate knowledge and acquaintance with the working together of many men in a great organization.

Young men in college are devoting their energies to preparation for their life work. It behooves them to expend their efforts as efficiently as is possible. They will do well first of all to learn fundamental principles, to gain theory, not merely in the abstract, but, through their laboratory work, to gain a concrete physical understanding of these principles. A knowledge of specific things, such as particular kinds of apparatus or the characteristics of special materials used in manufacturing processes, are of less consequence. Practice changes; principles do not.

The student must not emphasize knowledge as distinguished from training. Training, which enables him to use his knowledge, is of first consequence. The man who is trained in observation, whose logical and reasoning powers are alert, who is able thereby to efficiently apply the knowledge which he has, will probably be much more effective and successful than his companion who may know more but can do less. A skillful workman with poor tools can accomplish more than a mediocre workman with the best of tools. Many of those who select college graduates look for the successful leaders in student organizations rather than those who head their classes. The man who combines both kinds of leadership gives especial promise.

Many students do not get this broader view of their work. They do not apply engineering methods to themselves. Each man may well consider himself as a machine, as something with which to produce results. He should study how he may produce the best results with the least effort. Many are already quite proficient insofar as the "least effort" is concerned. The real problem, however, is with reasonable effort to produce maximum output. It is probable that some who have seemingly expended but little effort have learned to work with greater efficiency than the plodders who have received better classroom reports but with a vastly greater expenditure of effort. The man who has learned to handle himself and to work efficiently has a vast advantage when he does apply himself. This is one reason why college grades do not give a true indication of future careers.

If students can take this larger, broader and more serious view of their work, giving attention to the understanding of principles rather than the knowledge of facts, and recognizing that training in the use of their powers is of scarcely less importance than the acquisition of these powers, then the college graduate will become a more successful man both from his own standpoint and that of usefulness to others.

A PRODUCER GAS INSTALLATION IN THE MECHANICAL LABORATORY.

PROF. A. W. RICHTER, '89.

A little more than one hundred years ago, the immortal Watt and a few associates were struggling with problems resulting in the development of the modern type of the steam engine. In the face of these great achievements, we sometimes forget the important work accomplished by one of Watt's workmen in that other great field of power production, namely, the development of the gas industry. James Murdock, Watt's most trusted foreman, was the first to successfully manufacture coal gas for commercial purposes, and finally succeeded in lighting his home and offices with the new light. In 1802 the front of the Soho Manufacturing establishment was brilliantly illuminated with gas, the occasion being the general illumination in celebration of the Peace of Amiens.

Since the early beginnings scientists and others have been continuously at work in an attempt to utilize gas for power purposes, but nothing of importance was accomplished until the Otto engine was placed upon the market, since which comparatively recent date improvements have been continuous. During the past few years, much attention has been paid to the utilization of producer gas in the production of power, and, in the course of development, we have now entered the producer gas age.

The University of Wisconsin has just installed two types of producers which are to be operated in connection with a producer gas engine. These producers will be used for instructional purposes as well as for investigation. Many problems relating to producer gas derived from different fuels remain to be solved, and some of these are under consideration at the present time. The apparatus will also be used for the instruction of students, who will be taught the manipulation of the apparatus, and who will also determine the cost of operation as compared to other methods of power production.

The thermal efficiency of the producer is about 85 per cent. This high efficiency, together with the high thermal efficiency of the gas engine, when compared with the older steam engine, permits an enormous saving in the fuel supply of the world.

Since the producer with its producer gas engine will deliver a horse power hour with the consumption of about one pound of coal, and since the steam engine usually consumes from three to eight pounds of coal per horse power hour in order to produce the same results, it can at once be seen that the saving which will accompany the introduction of the gas producer will be enormous, a very important matter in the economical use of our fuel supply.

Eventually we may see producers in general use and using every available fuel from the city garbage and other refuse to anthracite coal. The importance of the subject cannot be over-estimated. The fuel question and the question of available fuel supply is of prime importance. Though scientists may differ as to the amount of available coal, certain it is that, at the present rate consumption, the supply will be exhausted in a comparatively short time.

The gas producer is a means of retarding this enormous use of coal and extending the time when the natural fuel supply of the world will be exhausted.

The accompanying figures show one of the installations in the Mechanical Laboratory of the University. A, Fig. 1, is the producer proper. It is cylindrical, lined with fire brick. Near the bottom is a grate with an ash bin underneath. Near the top of the producer is a shallow vessel filled with water and so situated that the hot gases coming from the fuel bed pass around it and vaporize the water. B is a coal hopper for the introduction of the fuel. F is an air fan which is operated by hand when starting the producer. The scrubber, C, is filled with coke.

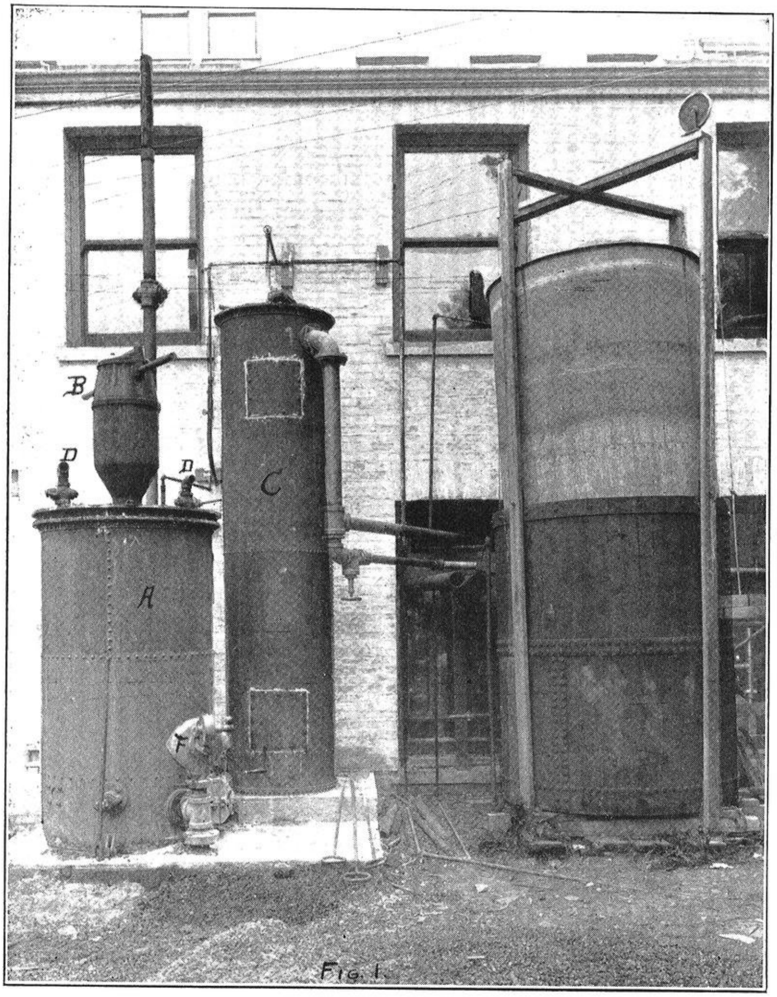


Fig. 1.

The operation of the producer is as follows: Immediately above the grate there will be a bed of ash and above this ash zone there is maintained a deep bed of highly incandescent fuel. Air entering at D D passes over the surface of the heated water, carrying the water vapor with it to the grate. When this air comes in contact with the highly heated carbon, the oxygen of the air combines with it and forms carbonic acid, which gas in passing through the upper layers of highly heated fuel takes on more carbon, resulting in the final formation of carbonic oxide, which is a combustible gas. When the carbon unites with the oxygen of the air, forming the carbonic oxide as spoken of above, heat is liberated and is used to decompose the steam carried by the air. This decomposition results in the formation of hydrogen and oxygen; the oxygen coming in contact with the highly incandescent fuel forms an additional amount of carbonic oxide in the manner mentioned above. The hydrogen is thus allowed to pass off as such with the other gases. This gas now passes to the bottom of the scrubber, and, in passing to the top of the scrubber, it is met by water which has been sprayed upon coke. The gas is thus washed, cooling it and removing the tar, ash and other injurious matter, making it suitable for engine use.

The combustible portion of producer gas thus consists of carbonic oxide and hydrogen and usually a very small percentage of hydrocarbons. As these combustibles are mixed with the large percentage of nitrogen present in the entering air and also a small percentage of free oxygen and carbonic acid, the heating value is low, usually from 125 to 150 British Thermal Units per cubic foot. Following is the composition of a sample of producer gas which was produced from a hard coal.

CO_2 — 4.9%
O — 0.6%
CO — 20.2%
CH_4 — 0.5%
H — 18.6%
N — 55.2%

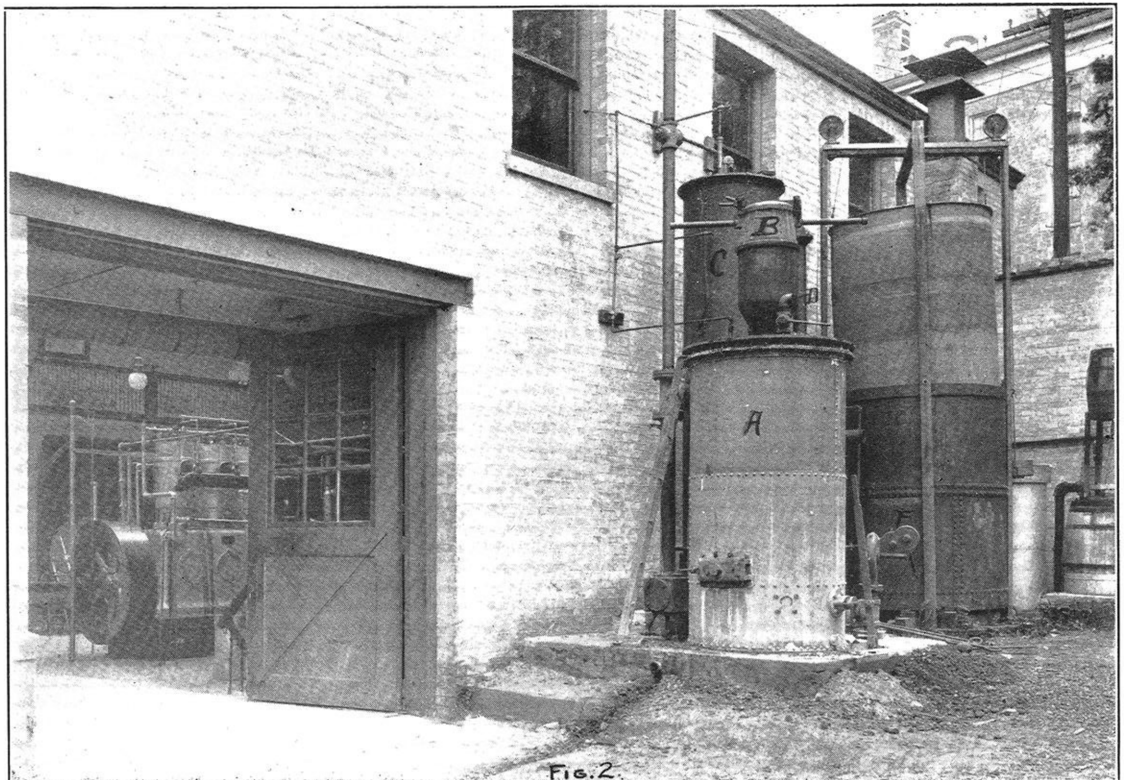


Fig. 2.

Gas and air is drawn into the engine cylinder by the engine itself, is here compressed and then ignited by an electric spark. The engine is of the single cylinder throttling type, of twenty-one horse power capacity. Its operation is similar to that of other gas engines. A higher compression is carried in the cylinder, due to the lean nature of the gas. Since the engine draws the air through the producer, as required for its operation, it is evident that the gas is produced as required by the engine, and its formation consequently stops when the engine stops, eliminating large "stand by" losses.

In Fig. 2 can be seen one of the several gas engines located in the Mechanical Laboratory, permitting an extended study of the subject. At the present time the department is investigating methods of drying wet fuels, making them available for producer and other uses.

IRON MINING IN THE BIRMINGHAM DISTRICT.

EDWIN M. BALL, Asst., Eng. Corps, Mining Dept., Tenn. Coal, Iron & R. R. Co.

In the vicinity of Birmingham, Alabama, in what is known as Red Mountain, are found the Clinton or Red Ores, the most important iron ores in the state of Alabama. It is the purpose of this paper to briefly outline the present methods of mining deposits of this ore by the different companies, but more especially the Tennessee Coal and Iron Company. This company is the largest operator in the district, whose mines are ably managed and splendidly equipped with modern machinery.

The Clinton Ores are Hematites and belong to the Clinton formation of the Silurian. They outcrop principally on the crest of Red Mountain and dip towards the southeast at angles varying from five to thirty-five degrees, the dip increasing as one goes toward the southwest. The seams now worked vary from three to twenty feet in thickness. There are two varieties of Clinton ore, soft red ore and hard red ore. In general the soft ores extend from the outcrops for a distance of about three hundred feet on the dip. This soft ore has at one time had practically the same chemical composition as the present hard ores. This soft ore is the hard ore with the lime removed by the action of circulating waters. Its average chemical composition is as follows: Silica or insoluble matter 27 per cent; metallic iron 46 per cent; water 7 per cent; phosphorus 0.30 per cent to 0.40 per cent and a little lime. The hard ore is sometimes found at the outcrop, but most frequently it lies under a heavy covering, and is the continuation of the soft ore in the direction of the dip. The hard ores contain a greater percentage of lime than the soft ores, and are poorer in iron as a consequence. The average chemical composition of hard ore is as follows: Silica

13.4 per cent; metallic iron 37 per cent; lime 16.20 per cent; alumina 3.18 per cent; phosphorus 37 per cent; sulphur .07 per cent; carbonic acid 12.24 per cent; water 0.50 per cent.

The ore body occurs between a foot and hanging wall of slate. There are two seams of ore separated by a thin parting of shale. The two seams occur at the northeast end of the district, but at the southwest end, near Bessemer, Alabama, the upper seam alone exists. At this point it has a greater thickness than at any other portion of the district. The lower seam in general is high in silica, and is not generally used for iron making. Where the ore outcrops, the surface burden has been removed and the ore is mined from open-cut workings. The general method is to load it by hand into tram cars, which are lowered and dumped into railroad cars. Where the surface burden is thick the ore is mined from slopes sunk on the dip of the vein, and generally at right angles to the strike. The slopes are driven large enough to give nine feet by ten feet in the clear. Headings are turned on both sides at right angles to the slope every fifty-five feet, measured on the slope. Where the slope passes through the soft ore, it is well timbered, as the slate roof can not be held by other means. After the hard ore is reached very little timbering is required. In sinking the slope, the general procedure is to drive beneath the ore a distance of nine feet, leaving the ore as the roof or hanging wall. This permits of the headings being driven in the ore and gives sufficient height at the slope for a tipple dump. The headings are driven twenty feet wide to a distance of seventy-five feet from the slope; at this point a man-way or upset is made to the heading above. From this point on, the headings are carried thirty feet wide. At convenient points, upsets are made to the heading above for the purpose of ventilation. The headings are generally driven to a distance 1,200 feet each side of the slope; when driven to this point, the twenty-five foot pillar remaining between this heading and the heading above is taken out, or robbed, as locally termed. The headings nearest the mouth of the slope are the first ones to be robbed, thus the robbing continues back, step fashion, from the face of the headings toward the slope. It will be seen that by this method the robbing in the lower headings is slightly behind that in the upper headings. As the pillars are robbed the hanging wall is allowed to cave, all pillars being removed with the exception of the sixty-foot slope pillar, which is allowed to remain as long as the slope is in active operation. In mining soft ore by underground methods no air drills are required, holes for blasting being readily put in by means of augers or hand drills. In the hard ore No. 3 Rand drills are used. The ore is blasted with 40 per cent dynamite. It is then loaded by hand into steel-end dumping tram cars of two tons capacity. The ore is then run by gravity over a track laid with thirty-pound rails to the tipple at the slope. The empty cars are brought back to the face of the heading by mules. The ore is dumped from the tram cars into a twelve-ton skip. This skip travels on a track of five-foot gauge laid with sixty-pound rails, and is end-dumping, the door being closed by the bail. The skip is then hoisted to the surface and the rear end elevated; this raises the bail, allowing the door to open and the ore to discharge into a pocket. This method of dumping the skip is entirely automatic. The ore is drawn from the pocket to a No. 8 L. Gates gyratory crusher. After being crushed to a size approximating five inches it is allowed to pass into railroad cars standing on the railroad track at the tipple. In order to insure safety to miners and mules man-ways are driven on a 50 per cent grade at each slope to the back of the mountain. Underground pumping is done by means of steam pumps operated with compressed air.

The surface equipment consists of boiler houses, engine houses, machine shops, carpenter and blacksmith shops, in fact everything required for cheap and successful operation. The hoists are 30 x 60 inches Nordberg and Webster Camp and Lane first motion Corliss engines. These hoists are equipped with twelve foot drums, grooved for a $1\frac{3}{8}$-inch steel rope. Compressed air is furnished at sixty pounds pressure for air drills and pumps by a 22-inch and 36 x 48-inch duplex Nordberg two stage Corliss air compressor. Boilers used for furnishing power are 72 x 18-inches return tubular type. Coal from company mines is used as fuel and complete combustion is obtained by the Parson's system. The boiler houses are of steel construction, and the shops and engine houses are of brick. The tipple at the surface is of frame construction set on concrete piers. The crushers rest on concrete foundations of sufficient height to permit of running the ore into railroad cars by gravity.

The labor employed in the mines is both white and negro. They are a happy, care-free lot of men; make good wages and seem well content with their lot in life.

In conclusion, it is well to state, that the Tennessee Coal & Iron Company's mines are so equipped as to give a large output at a very low cost per ton.

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EDITORIAL.

THERE are no words adequate to express the deep regret felt by the faculty and students of the College of Engineering on account of the resignation of Prof. D. C. Jackson. In losing him we lose one of our strong men, the next to the oldest in seniority of appointment on our faculty, and one who has built up the Electrical Department from practically nothing to the place it now holds in this college and the rank it has attained among other schools. When Prof. Jackson came to Madison, fifteen and one-half years ago, the Electrical Department occupied a small corner of the basement of Science Hall. The equipment was small, the facilities for instruction were inadequate, and men to teach the different preliminary branches were lacking. Prof. Jackson took hold of the work, systematized it, taught some of the elementary branches himself, wrote lectures and delivered them on the subjects which were not treated in any text-book, and by the hardest of hard work on his own part put the Electrical Department on a firm foundation. Since then, under his leadership, the department has grown rapidly, in fact, much more rapidly than any other department, and now holds a place in the front rank of engineering schools.

Prof. Jackson has been more than the teacher, he has tried to make himself the personal friend of every student with whom he has come in touch. He has always been ready to advise a man, both on the theoretical and the practical side of the questions which arise. His wide experience in both lines makes his suggestions doubly valuable, and many an alumnus has cause to remember with gratitude the advice received during his senior year and at graduation time.

However, we are not the ones to wish to hold Prof. Jackson here when the opportunity for his advancement comes. What is our loss is another's gain, and we congratulate the Massachusetts Institute of Technology on being able to secure so able a man for the head of their Department of Electrical Engineering.

Our best wishes for his continued success will go with Prof. Jackson, and we shall follow his future career with the greatest interest.

THE Senior Engineers, believing that variety is the spice of life, have decided to have an innovation this year and will therefore produce a high class vaudeville entertainment sometime this spring. This takes the place of the minstrel show which has been given for several years past. Great enthusiasm is being shown and a rousing success is already assured. J. D. Sargent has been appointed General Chairman, and the work is being pushed rapidly. Anyone who has unknown talent along this line, and who is too modest to see the management about it himself, should have his friends call the matter to the attention of the committee. There is a great demand for places, but only the best performers are wanted, and every one should make a try for the cast.

THE Engineering faculty are planning a series of talks for the under-classmen, these talks to be given by the various members of the faculty as opportunity offers during the coming months. The purpose of this movement is to give the members of the lower classes an opportunity to learn something about what an engineer really is, what responsibilities are put upon him and what problems he is very likely to be called upon to solve. It is a sad fact that too many of the young men who start in as students in some one of the engineering courses have no conception of what it really means to be a first class engineer. To a great many the word merely calls to mind the man who rides in the locomotive cab, to others comes the thought of the man in greasy overalls who has charge of the construction work in some large manufacturing plant. They do not seem to think of the man behind all these things, the man who is working with his brain rather than his hands, the man who is the real engineer. It is about this man that Dean Turneaure and the other members of the faculty wish to speak to the students, and every freshman and sophomore should make it a point not to miss any of these talks.

ON Thursday evening, Dec. 13th, the Senior Engineers held a smoker at Keeley's Hall. The purpose of this event was to give the Seniors an opportunity to become better acquainted among themselves, and also to have them meet the Faculty on some footing other than that of the classroom.

Some one hundred, including a majority of the Engineering faculty, were there, and every one reported a good time. Plans were talked over for the vaudeville entertainment, and speeches were made booming this and also encouraging good fellowship among the members of '07.

WE are in receipt of the first issue of *The Engineering Quarterly*, a magazine which the students of the University of Missouri have launched into the stream of engineering publications. This first issue contains a number of excellent articles, and, if the standard is maintained, there is no doubt but that the success of the magazine will be assured.

THE ENGINEER extends congratulations to the editorial staff of *The Engineering Quarterly* for the favorable impression made by their first issue, and our best wishes go with them for continued prosperity.

ALUMNI NOTES.

E. B. Schildhauer, '97, formerly Chief Draftsman of the Chicago Edison Co., has been appointed Electrical Engineer in charge of the electrical apparatus for the Panama Canal, with headquarters at Washington, D. C.

Mr. E. S. Moles, '05, was married during the holidays to Miss Ora Mason, and is now at home at 301 Murray St., Madison, Wis.

Mr. E. L. Williamson, '00, is now with the Riverside Trust Co., at Riverside, Cal.

W. P. Hirschberg, '01, formerly with the Cambria Steel Co., is now with the Indiana Steel Co., at Gary, Ind.

M. R. Bump, '02, has left the Denver Gas & Electric Co., and is now with Henry L. Doherty at 60 Wall St., New York City.

G. H. Haley, '05, is now leveler on the New York State Barge Canal, with headquarters at 62 Philips St., Albany, N. Y.

W. B. Alexander, '97, has been promoted from Asst. Master Mechanic to Asst. Division Engineer of the C. M. & St. P. Ry.

E. L. Barber, '04, has taken a position as instructor in Electrical Engineering at Washington University, St. Louis, Mo.

P. A. Bertram, '95, is now General Manager of the Jefferson City Light & Power Co. at Jefferson City, Mo.

P. A. Biefield, '94, who has been teaching in Germany, is now Professor of Mathematics at Buchel College, Akron, Ohio.

P. S. Biegler, '05, has given up his position as draftsman with the Chicago Edison Co., and is now an instructor in Electrical Engineering at the Iowa State College, Ames, Iowa.

W. M. Brennan, '94, is now located at Owen, Wis., and is Division Engineer of the O. & N. Ry.

F. W. Buerstatte, '01, is now with the Whiting Foundry Equipment Co., at Chicago Heights, Ill.

W. C. Burdick, '03, is now Civil Engineer with the Falk Manufacturing Co., Milwaukee, Wis.

G. H. Burgess, '95, is now Assistant Engineer with the Erie Ry., and is located at 12 James St., Montclair, N. Y.

B. E. Buttles, '00, is now with the Denver Gas & Electric Co., at Denver, Col.

J. S. Carey, '88, is now in Chicago, with the United Box & Paper Co.

C. M. Cole, '02, is located at Goshen, N. Y., with the New York State Engineering Department.

R. T. Craigo, '05, has gone from St. Joseph, Mo., to Denver, Col., where he has a position with the Denver Gas & Electric Co.

H. R. Crandall, '98, has severed his connection with the Hendee-Bamford-Crandall Co. and is now in the Engineering Department of the Wisconsin Telephone Co., at Milwaukee.

McClellan Dodge, '84, has gone from Eau Claire, Wis., to Mangham, La., where he is President and Engineer of the Richland Centre Lumber Co.

C. C. Douglas, '03, is now located at 4203 Maryland St., St. Louis, Mo.

E. A. Ekern, '03, is now in the Engineering Department of the Telluride Power Co., at Provo, Utah.

E. T. Eriksen, '89, is now Civil Engineer of the Sanitary Department of Chicago.

E. J. Fisher has left the U. S. R. S., and is now with the D. L. & W. Ry., at Hoboken, N. J.

F. W. Fratt, '82, is now Chief Engineer of the M. K. & T. Terminal Co., at Kansas City, Mo.

J. H. Friend, '03, is now Engineer of the Electric Light and Gas Co. of Mobile, Ala.

J. C. Gapen, '03, is now Chief Inspector of the North Shore Electric Co., with headquarters at Oak Park, Ill.

L. W. Golder, '95, is now Secretary of the Metal Specialties Mfg. Co., of Chicago.

B. W. James, '97, has located at Seattle, Wash., as an Electrical and Mechanical Engineer.

R. T. Logeman, '99, is now Chief Draftsman in the Bridge Dept. of the G. N. Ry., and is located at St. Paul.

W. R. Mott, '03, is now an Electro-Chemical Engineer at Niagara Falls, N. Y.

E. B. Mueller, '03, is now Asst. Engineer of the Tacoma Light and Power Co. at Tacoma, Wash.

W. C. Parmley, '87, has opened offices as a Consulting Engineer in New York City.

W. J. Richards, '93, is now Electrical Engineer of the Allis-Chalmers Co. at Norwood, Ohio.

A. B. Saunders, '02, is now at Los Angeles, Cal. as Engineer with the Pacific Electric Co.

H. H. Scott, '96, is now located at 60 Wall St., New York City, with Henry L. Doherty.

S. T. Smith, '00, is now at Los Angeles, Cal. in the real estate business.

W. F. Tubesing, '05, is now with the Ferro Concrete Construction Co. at Cincinnati, Ohio.

S. G. Van Ness, '96, is now Manager of the Merchants' Light and Power Co., Memphis, Tenn.

M. T. Warner, '95, is now Engineer of the Repair Dept., National Elevator Co., New York City.

L. B. Weed, '00, is now Superintendent of the Sunrise Mines at Sunrise, Wyoming.

The engagement of Miss Mabel Davidson, daughter of Gov. Davidson and Mr. Frederick C. Inbush, '06, of Milwaukee has been announced, the wedding to take place April 2d.

On Friday, Jan. 27, '07, Miss Jessie Morse and Mr. Forbes Cronk, '05, were married at Madison, Wis. Mr. Cronk is located at Coleraine, Minn.

BOOK REVIEWS.

Boiler Waters, by William Wallace Christie. D. Van Nostrand Co. 1906. 8vo. cloth, illustrated, $3.

This book is devoted primarily to a discussion of the impurities existing in feed water, the results which follow, and various methods of reducing or eliminating the troubles which they cause. The first chapter is devoted to the analysis of waters, including the results of many tests, with descriptions of testing apparatus, chemicals needed and methods of making tests for many of the impurities. Chapters on boiler scale and corrosion follow, and include many exhibits, with discussions on remarkable cases. A chapter on feed and blow-off pipes devotes considerable attention to methods of blowing off and of making feed connections. The causes of priming and foaming are next taken up, and the results of the latest study and experiments given. A chapter on the hardness of water completes the first three-quarters of the book. The last chapters are devoted to feed water heaters, economizers and water softening plants. In this part of the text the principal types are explained in detail, paying particular attention to water softening plants and the results which have followed their installation. Tables of Factors of Evaporation, Properties of Steam, etc., with an index, complete the text. The editing of material taken from so many different sources and authorities has been quite a difficult task, and in a measure has interfered with the arrangement. It is, however, a most valuable contribution to boiler literature, and covers the subject-matter in a most satisfactory manner.

Practical Alternating Currents and Power Transmission, by Newton Harrison, Hendenberg Publishing Company, 1906. Illustrated.

The author has added another book to those already written which mainly interests those who have not sufficient mathematical training to enable them to make use of many of the text-books on alternating currents previously published.

Many of the definitions and explanations given seem unnecessarily involved. The numerous diagrams, however, aid materially in the aim to give the reader a good physical conception of alternating current phenomena. Proper physical conceptions must form the foundation before mathematics are useful in the further refinements of the art.

From this point of view, coupled with the fact that the book seems quite well up to date, Mr. Harrison's work may be commended as a worthy addition to the elementary books upon this subject.

Electric Wiring and Construction Tables, by Horstman & Tousley. F. J. Drake & Company. 1906. $1.50.

The above is the title of a new hand-book, intended primarily for wiring contractors and others who require data in convenient form on interior wiring. Considerable space is devoted to wiring charts, covering most of the conditions of voltage, frequency, power factor, etc., which arise in practice. These charts will no doubt be of use to many, particularly those who have not had sufficient theoretical training to deduce these results for themselves. There is, however, always much likelihood of a misuse of such tables unless one understands the derivation of such data.

The diagrams of standard cross-sections of iron conduits would seem to be not the least useful information contained in the book. The data on outside diameters of insulated wires and other data of a similar nature, which are not usually gathered together in any one hand-book, make it a useful addition to one's list of reference books relating to this line of work.

ALUMNI DIRECTORY.

We are publishing below a new alumni directory, which has received a great number of additions and corrections since the last directory was published. Anyone knowing of further additions or changes is requested to send them to the alumni editor. Addresses which are uncertain are preceded by an asterisk (*).

Abbott, Clarence E., B. S. M. E., '01; C. E., '05, Hazel Green, Wis., Mine Supt.

Adams, W. K., B. S. E. E., '03, Fort Pierre, South Dakota.

Adams, B. C., B. S. E. E., '03, 1010 Grant St., Madison, Wis., Madison Gas and Electric Co.

Adams, B. F., B. S. M. E., '02, 37th and Rockwell Sts., Chicago, Ill., Art Bedstead Co.

Adamson, Wm. H., B. S. C. E., '86, 927 24th Ave., S. Seattle, Wash., Draftsman.

Ahara, Edwin H., B. S. C. E., '92; M. E., '96, Mishawaka, Ind., Supt., Dodge Mfg. Co.

Ahara, George V., B. S. M. E., '95, 1020 Oak St., Beloit, Wis., Asst. Supt. Testing Dept., Fairbanks, Morse & Co.

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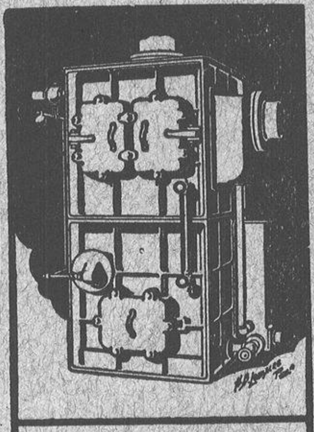

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