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SHAFT SINKING ON THE WESTERN MISSABE RANGE

A Thesis on Actual Practice for the Professional Degree in Mining by
FORBES B. CRONK
ABSTRACTED BY E. C. HOLDEN, *Professor of Mining and Metallurgy*

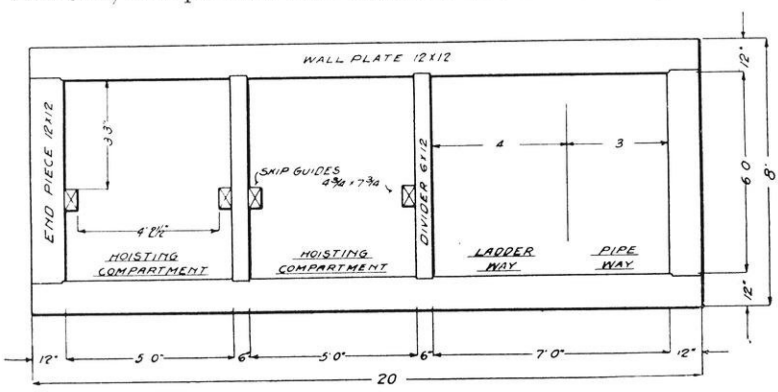
The conditions under which this shaft was sunk were favorable but sufficiently varied to make it typical of Missabe Range practice under average conditions. The shaft was sunk to replace another which had been put down six years before. The first shaft was sunk under great difficulties in new, water bearing ground, both the surface and ore being of loose, sandy character difficult to hold. The shaft was to have been 250 feet deep but at the end of a year it had only reached 185 feet when on cutting a station one side caved clear to the surface and the whole shaft was "buckled" and "corkscrewed." To save it at all seemed hopeless, but it was finally straightened out sufficiently to allow of its being piped and used for water discharge. Drifts were driven from another shaft a quarter of a mile away, making it possible finally to cut a pump station at its bottom and install pumps. No hoisting was possible.

It takes many years for caved ground to settle and in this case movement continued during all the period the shaft was in use and it was feared that at any time a sudden shift might break the water columns, flood the mine and cut off the water supply of a neighboring village. In January, 1912, it was decided necessary to sink a new shaft.

The new shaft was located in the bottom of a local drainage gulley and about 150 feet from the old one so that it could be readily connected by drifts with the pump-station. This location made it necessary to build up the shaft collar ten or twelve feet above the new surface to provide for suitable stock pile grounds.

The type of shaft selected was three compartment, vertical, timber lined, eight by twenty feet inside dimensions, the hoisting compartments each five by six feet inside, the third compartment which accommodates ladderway, steam and water pipes and electrical conduits, seven by six feet. (See Figs. 1 and 2.)

Ground was broken on March 25, 1912. The top bearers were two white pine logs thirty feet long and about two feet six in diameter, laid parallel with the short axis of the shaft, their in-



—PLAN OF SHAFT—

FIGURE 1

side faces flush with the inside of the end plates. It was intended to use these bearers in the usual manner, building them into the end construction of the saft, but on examination they were found to be partly rotten and were trussed and reinforced as shown in Fig. 3.

The first forty-five feet were sunk by means of two hand windlasses and buckets of about two cubic feet capacity because the hoisting plant was not ready. The material was favorable to rapid progress, the upper twenty-three feet being a stiff blue clay just damp enough to yield easily to the shovel, and the remaining twenty-two feet a dry sand and gravel. The collar was built up six feet above the first set, making a total of fifty-one feet in the first twelve days of two eight hour shifts each. The

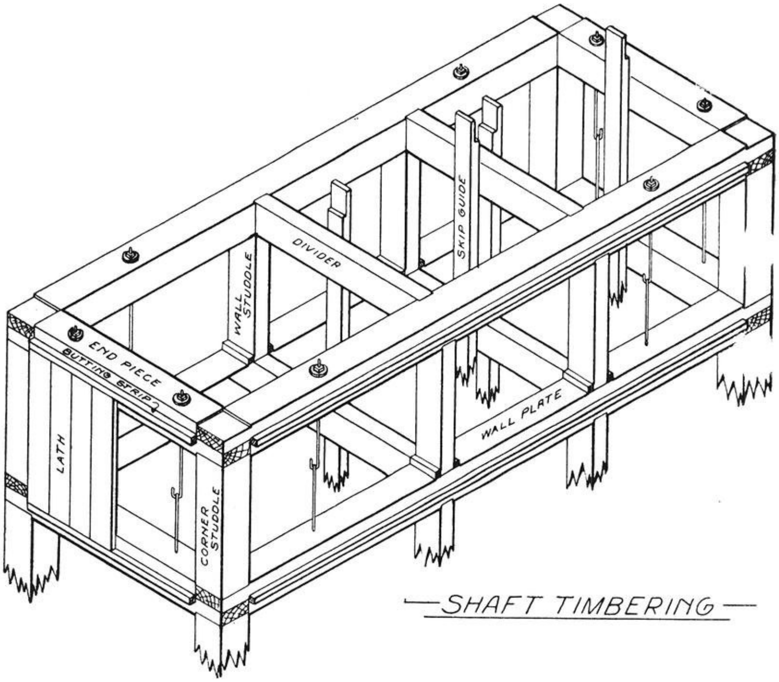


FIGURE 2

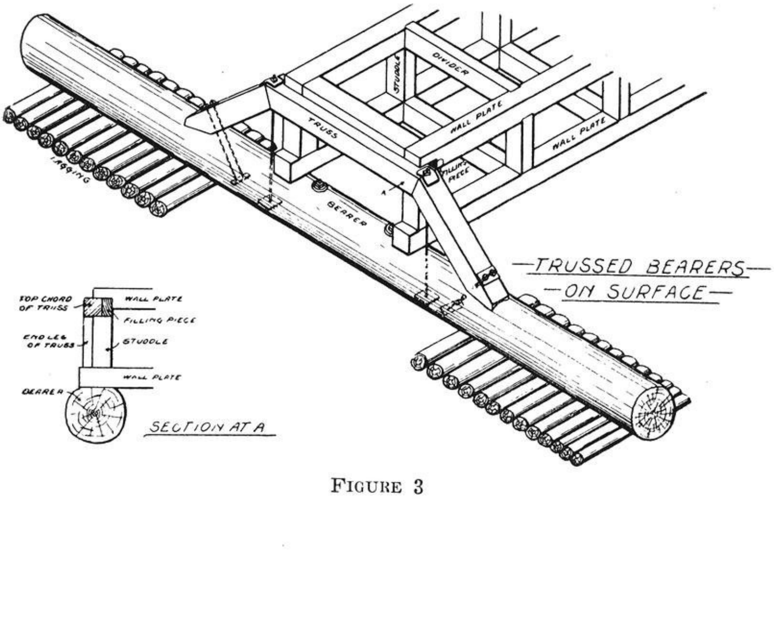


FIGURE 3

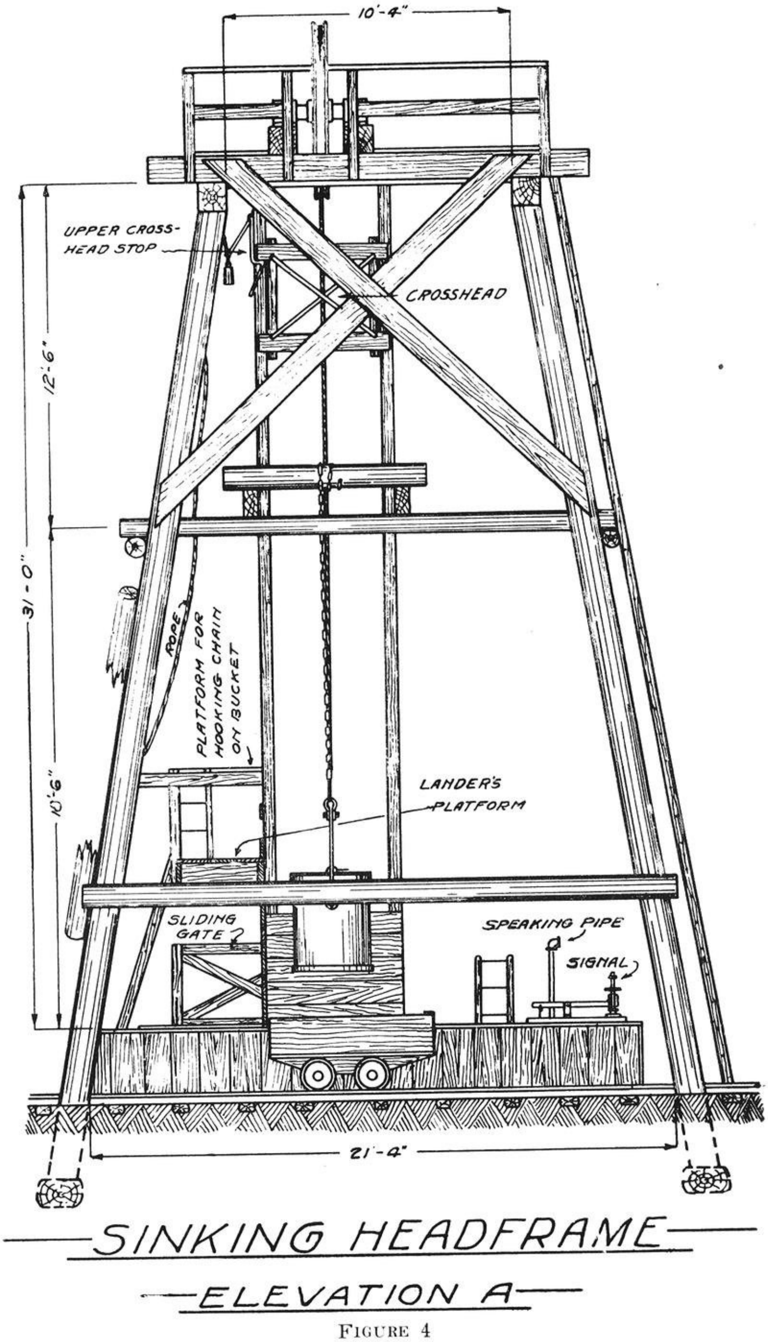
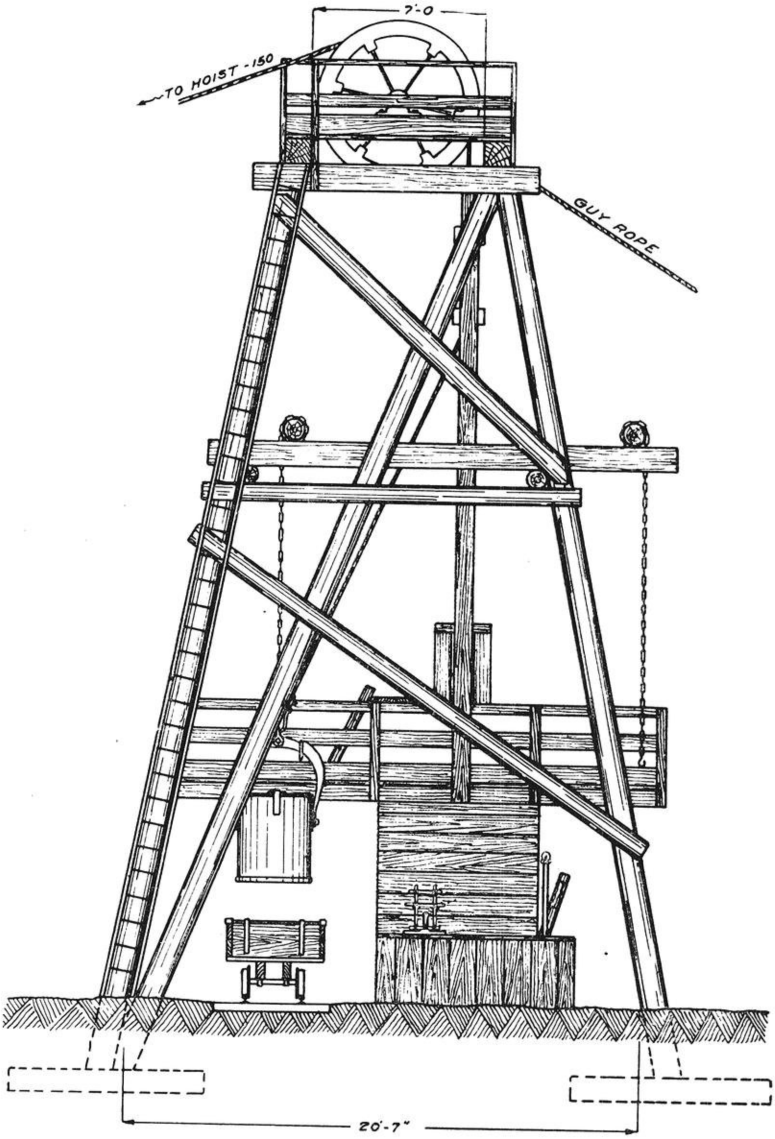

10'-4"
UPPER CROSS-HEAD STOP
CROSSHEAD
12'-6"
31'-0"
10'-6"
ROPE
PLATFORM FOR HOOKING CHAIN ON BUCKET
LANDER'S PLATFORM
SLIDING GATE
SPEAKING PIPE
SIGNAL
21'-4"
SINKING HEADFRAME
ELEVATION A

FIGURE 4



SINKING HEADFRAME

ELEVATION B

FIGURE 5

average force was a shift boss, four miners, four windlass men and one laborer.

The hoist was a Lidgerwood two cylinder reversible engine with ten by twelve inch cylinders and a forty-two by fifty-three inch drum operating in balance. This hoist was located about 150 feet from the shaft in a fireproof hoist house eighteen by

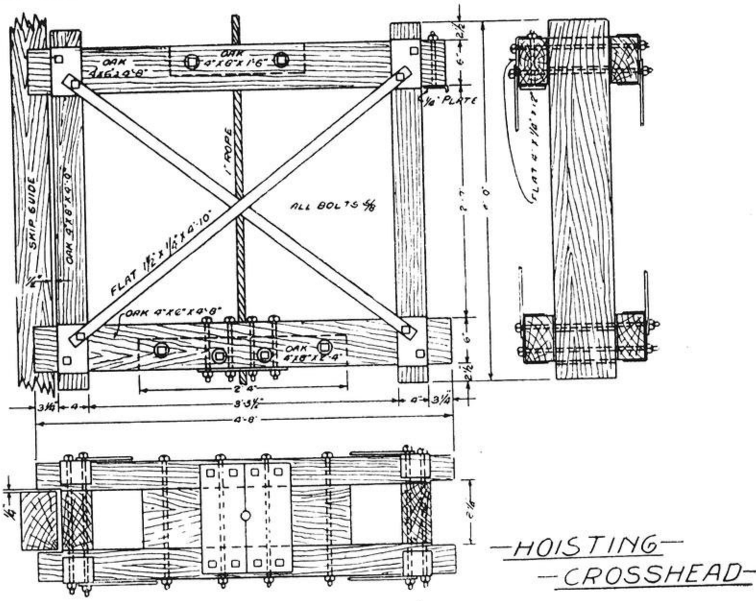
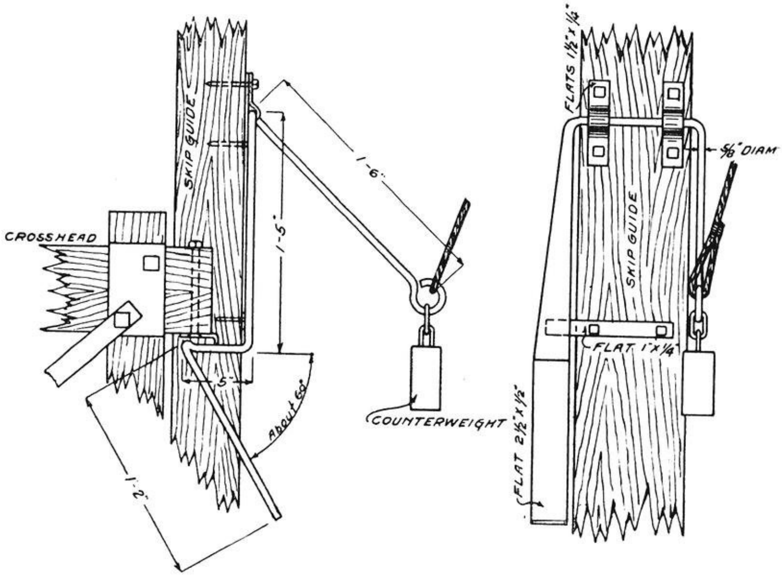


FIGURE 6

twenty feet outside. A temporary sinking head-frame was erected over the shaft according to the plans in Figs. 4 and 5. The bucket used had a capacity of twenty-five cubic feet and was of self-dumping type, built of steel plate. The bucket was used with a crosshead and corresponding top and bottom stops as illustrated in Figs. 6 and 7. Considerable trouble is sometimes met with in using crossheads of this type, due to their hanging up in the guides. In this case, however, no trouble was experienced, as the crosshead operated perfectly. For lowering tools and short pieces of timber the bucket was generally used, but for long timbers a stirrup clevis was used with a cross bolt through the hanging bolt holes of the timber.

Water level was reached at a depth of eighty-one feet through variable ground, at a rate of four feet per day, working two eight hour shifts. Where the ground was firm enough to stand without support, the excavation was done in the ordinary manner, sets being placed as fast as room was made for them without special support. In loose ground, such as dry sand and gravel, which stood only moderately well, temporary supports were nec-



—UPPER CROSSHEAD STOP—

FIGURE 7

essary. A number of steel bars, one and one-fourth inch and one and one-half inch in diameter and six or seven feet long, were worked in vertically behind the lath of the bottom set placed, their lower pointed ends projecting into the ground at the bottom of the shaft. The bars were driven down as depth was gained, their lower ends always buried in the shaft bottom and their upper ends retained behind the last set of timbers. Behind the bars, one inch supports were slipped in, and in this way sufficient room would be made for a full set of timber with four foot studdles.

While sinking was going on in the dry portion of the shaft, a drift had been driven underground from the old workings and a vertical raise put up sixty feet through ore to meet the shaft. It was intended to drain the shaft and to serve as a chute for the shaft dirt to be trammed to another shaft. The raise was stopped in a layer of hard conglomerate overlying the ore. At water level a small pump was put in and an additional seven feet gained, but with considerable difficulty. There remained

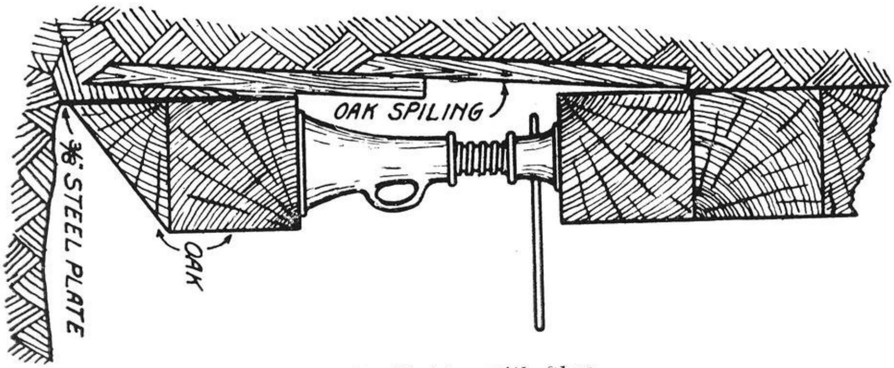


FIG. 8.—*Sinking with Shoe.*

about thirty-five feet to be sunk to connect with the raise, and it was decided to drill through the intervening ground to take care of the water. Several shifts were spent in unsuccessful attempts to drill through by hand, but the same layer of hard conglomerate that stopped the raise stopped the drills. Finally a churn drill outfit was rigged up and a three inch casing was put through with it and the desired water outlet established. Despite the successful drainage, with the shaft making about 600 gallons per minute, the ground being a mixture of sand and clay quickly disintegrating under the action of water coming down the shaft, it was very hard to work and hold the ground.

Two inch spiling was driven ahead and the method might have been successful but for the boulders present in the ground. Finally a sinking shoe was used, as shown in Fig. 8. In operation the dirt was taken away on the inside from along the shoe and the latter jacked down until sufficient room had been gained for a set of timbers. The shoe-set proved a success and the remaining ground between the bottom of the shaft and top of the raise was quickly penetrated. It was evident, however, that the design of shoe could be improved.

The set was made of the standard size of the shaft timber and thus the ground excavated did not include the space required for the lath. The open space between the shoe-set and the last placed shaft-set was unprotected, and to hold the ground it was necessary to drive short spiling. The corner construction was weak and the wall-plates of the set tended to turn over under

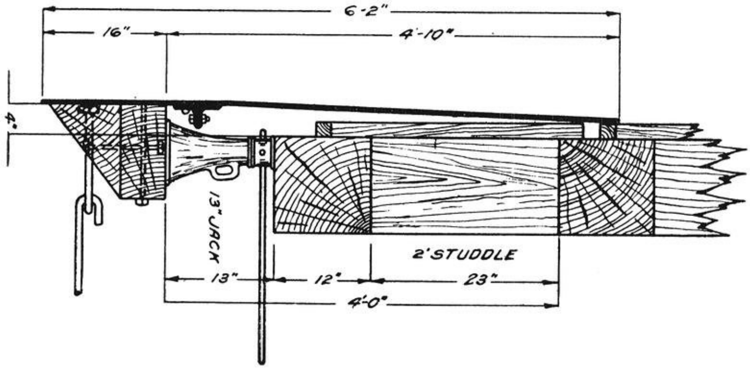


FIG. 9.—*Sinking Shoe Improved Section, in Operation.*

the pressure from the jacks. The bolting details also needed improvement. To remedy these defects an improved sinking shoe has been designed as indicated in Figs. 9 and 10. The method of operation is essentially the same but the set is much heavier; the corner construction has been strengthened; tight rods at the ends correct the tendency to overturn under jack pressure; the shoe is four inches larger all around than the regulation sets; and attached to the cutting plates are follower plates of three-eighths inch steel long enough to permit installing a full set of timber with two foot studdles. The natural inward slant of the follower plates, due to the large amount of clearance provided should reduce skin friction to a minimum.

The shale-conglomerate capping of the ore body was reached at a depth of ninety-eight feet from the collar. The shoe set was retained to a depth of 108 feet, after which it was unnecessary. Connection was made with the old workings at 175 feet and sinking continued to a total depth of 220.5 feet, the plat being cut and connection made to the old workings at 175 feet. The last sixty-three feet of shaft above the plat consisted in

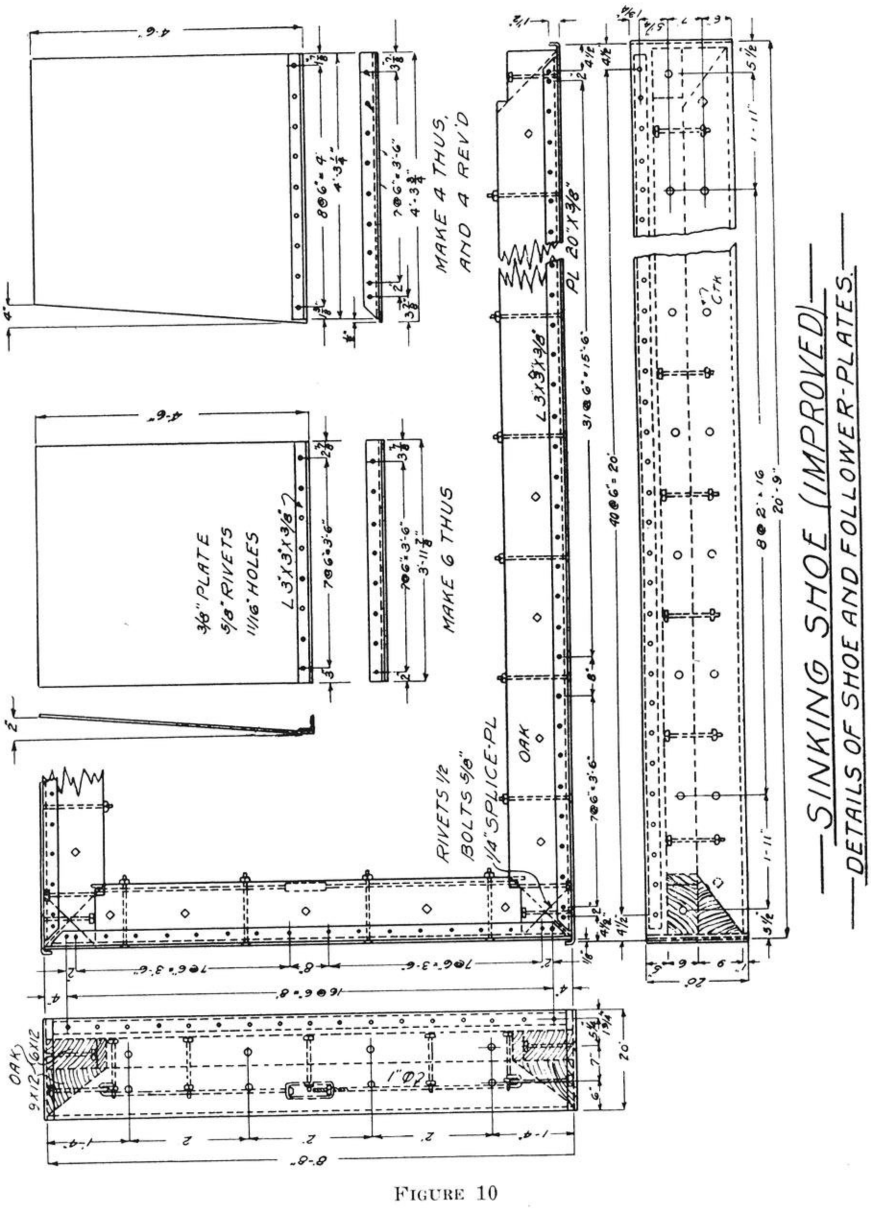

SINKING SHOE (IMPROVED)
DETAILS OF SHOE AND FOLLOWER-PLATES.
MAKE 4 THUS, AND 4 REV'D
MAKE 6 THUS
3/8" PLATE
5/8" RIVETS
11/16" HOLES
L 3"X3"X3/8"
PL 20"X3/8"
RIVETS 1/2
BOLTS 5/8
1/4" SPLICE-PL
OAK

FIGURE 10

enlargement of the raise, when the latter proved a great aid in progress. Not only was there considerable loose dirt to be removed, but by lowering the bucket into the raise until its rim was level with or slightly below the shaft bottom, shoveling operations were much facilitated. For this part of the work a rough progress of about three and nine-tenths feet per day was maintained, working three eight-hour shifts. Sinking from the water level to 108 feet, a distance of twenty-seven feet, con-

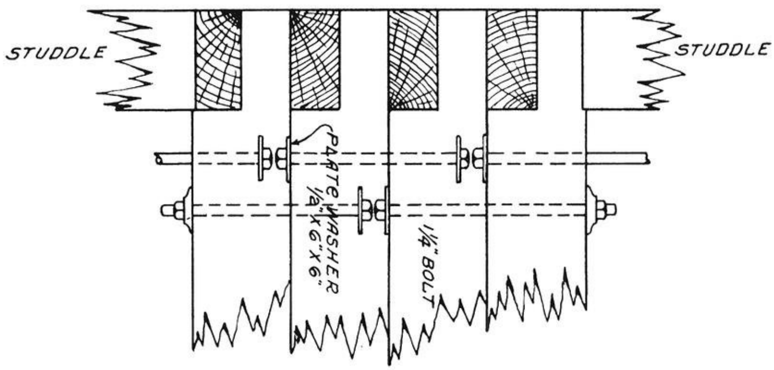


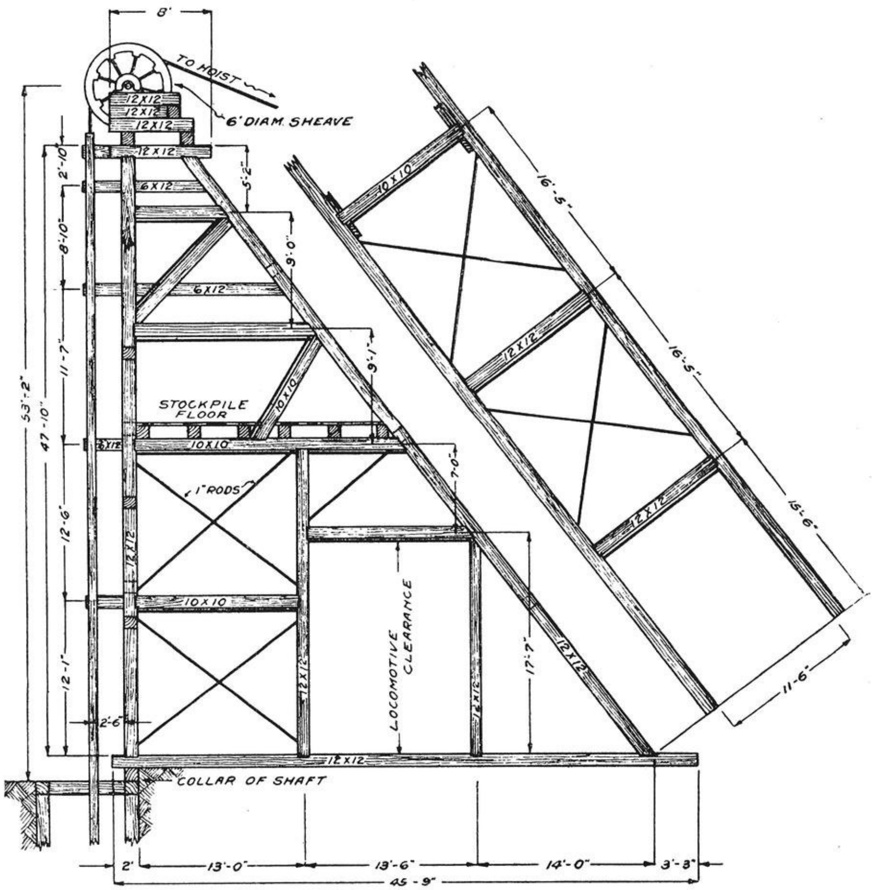
FIG. 11.—*Bols in Close Timbering.*

sumed twenty-six days, the work being so intermittent that progress rates per day would be deceptive. Three shifts of eight hours each were started when water level was reached. Three intermediate bearer-sets were used in the shaft, the long timbers being spliced because it was not thought advisable to disturb the ground to the extent necessary to get in single stick bearers.

Just above the ore capping a layer of three feet of dense, practically impervious shale was reached, which was apparently the cause of the large flow of water developed by the shaft. As the ore underneath the shale and conglomerate was of sandy and disintegrating structure, it was deemed a wise precaution to make a water seal in the shaft at this point. A set of timbers was removed just above the shale and replaced by sacks of cement mortar well rammed in place. So far as could be ascertained, the results were highly satisfactory. The shaft was lined with solid sets of close timbering from the water level through to the conglomerate capping, as illustrated in Fig. 11.

Attention is called to the fact that countersinking of bolt heads is done only on the upper side of the timbers, which avoids the use of offset wrenches for tightening nuts. This practice is subject to criticism, however, as it offers more opportunity for rust and rot than if the countersinking were done on the under side, even at the expense of some inconvenience in placing timbers.

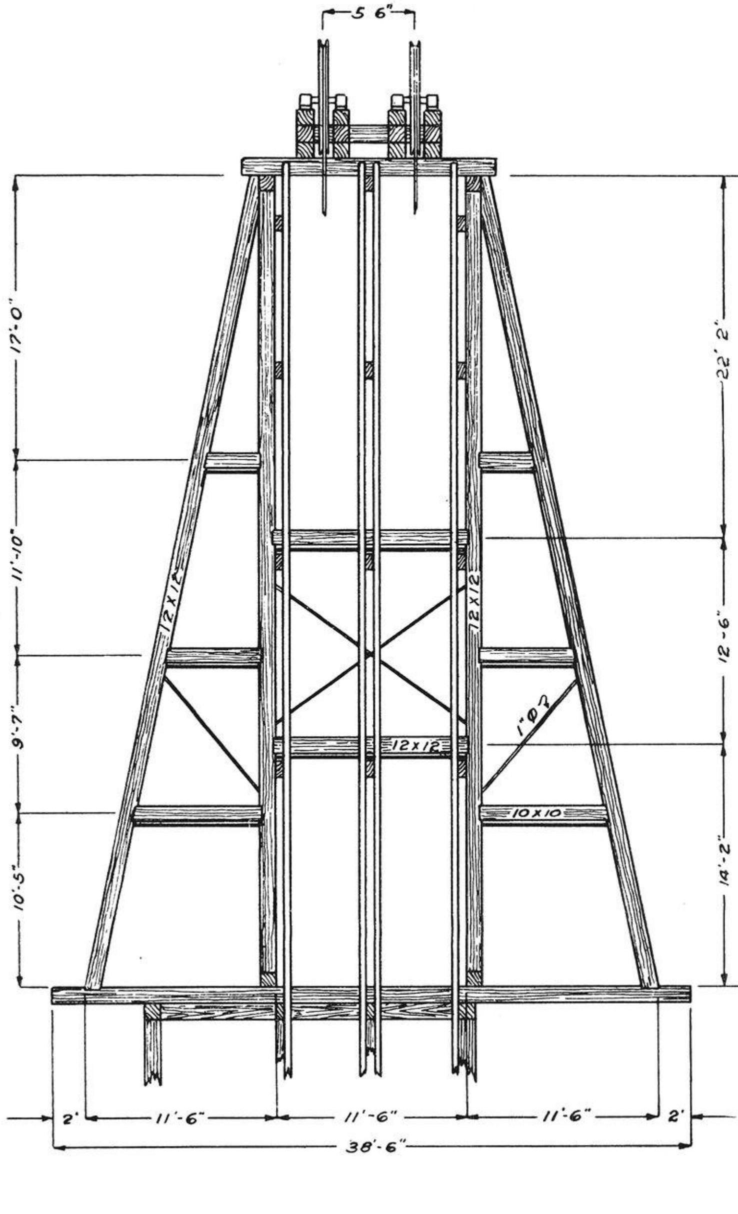
The ladderway timbering was of approved design, the ladders



—PERMANENT HEADFRAME—

—ELEVATION A—

FIGURE 12



PERMANENT HEADFRAME

ELEVATION B

FIGURE 13

extending four feet above the landings or sollars, the openings being provided with toe-boards around their edges to prevent anyone from suddenly slipping through. The landings were about fifteen feet apart, but the distances must of course conform to the spacing of sets. The ladders were built of two by four inch oak, tamarack or other hardwood stringers, and one-half inch round steel rod rungs spaced about fourteen inches centers.

On completion of the shaft the temporary headframe and bucket were discarded and replaced by scoops and the permanent headframe shown in Figs. 12 and 13. The headframe has been found exceptionally rigid and satisfactory. The skips used are one and one-half ton capacity.

We have not permission to publish detailed costs of this work, but by courtesy of the management the following general results are given:

Cost per foot for labor..............................	$27.704
Cost per foot for supplies..........................	14.786
Total cost of sinking per foot......................	42.490

This cost is of course exceptionally low and may be regarded as an example of what can be done only under favorable circumstances. Under the conditions generally met with on the Missabe range sinking costs for vertical timber-lined shafts will run from $70 to $100, per foot, the first figure being rarely realized and the latter often exceeded.

CHARTS FOR THE GRAPHICAL DETERMINATION OF ECONOMICAL SIZE OF CONDUCTOR FOR ELECTRICAL POWER TRANSMISSION

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In choosing the size of conductor to transmit a given electrical current, the engineer must give consideration to safe current, carrying capacity, the permissible limit of voltage variation and the economical size of the conductor. The safe carrying capacity is based upon the rise of temperature of the conductor, due to I^2R loss, which may be permitted without injuring insulation or setting fire to neighboring objects. This limitation does not ordinarily need to be considered in any but short lines or distribution systems.

In the case of short feeders and relatively small distribution systems, as in wiring of buildings, in transformer secondary systems, or in the distribution systems of small towns, the conductors are chosen so that a specified voltage variation at the receiving apparatus shall not be exceeded. For satisfactory electric lighting the permissible variation of voltage is smaller than for a motor load for the reason that relatively small voltage variations greatly affect the life and efficiency of incandescent lamps.

Where a method of voltage regulation is provided, as is the case in power transmission systems, the economical size of conductor rather than the voltage regulation of the system is the determining factor.

Lord Kelvin showed, many years ago, that the most economical size of conductor to transmit a certain current is one whose annual charge (interest on investment, plus depreciation and taxes) is equal to the annual value of the power lost due to the resistance of the conductor.

The economical cross section may be readily determined from the accompanying curves, one group of which relates to copper and the other to aluminum.

The ordinates of the curved lines are given in cents and indicate the value of power lost annually in one circular mil-foot

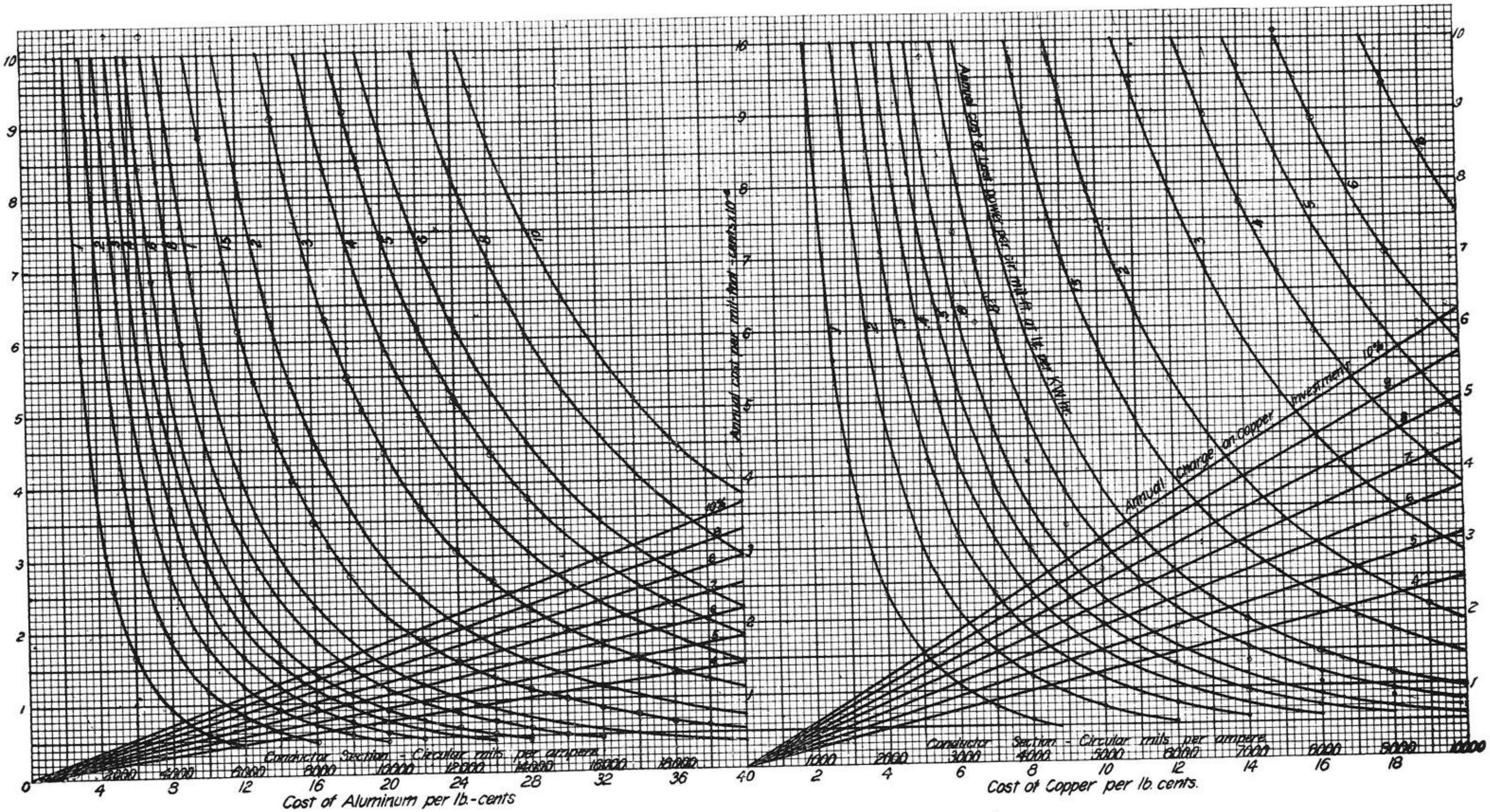
Annual cost per mil-foot - cents x 10⁻⁴
Annual cost of Lost power per cir mil-ft. at 1¢ per KW.Hr.
Annual Charge on copper investment 10%
Conductor Section - Circular mils per ampere
Cost of Aluminum per lb.-cents
Cost of Copper per lb. cents.

FIGURE 1

of conductor for each current density plotted as abscissae (expressed in circular mils per ampere) when the value of power per kw.-hr. is that given on the curve.

Each of the straight lines gives for each of several interest rates, the annual cost of interest, depreciation, taxes, etc., upon one circular mil-foot of conductor for the various costs of conductor metal per pound, as abscissae. The economical conduc-

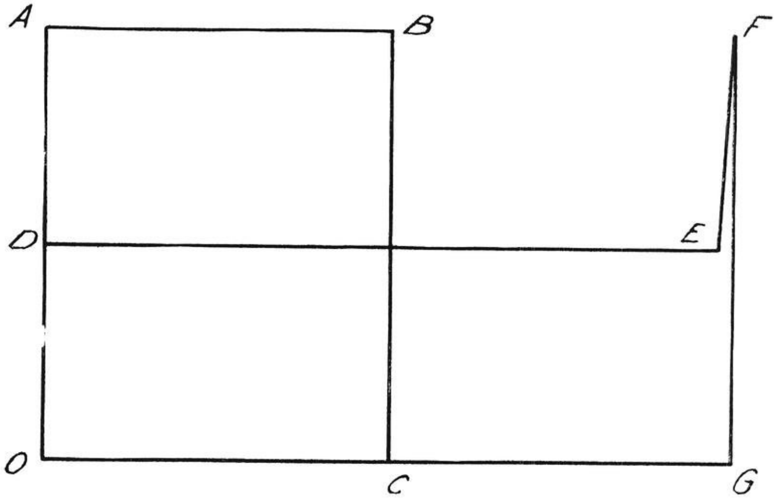

FIGURE 2

tor then is that at which the current density is such as to make the annual interest on the value of each circular mil-foot equal to the annual value of the power lost in each circular mil-foot. As a concrete example:

To determine the economical size of copper conductor when power is worth one cent per kw.-hr., copper conductor is worth sixteen cents per pound and interest, etc., equal to seven per cent., refer to the seven per cent. curve where the annual interest is found to be 3.5×10^{-6} cents when copper is sixteen cents. A horizontal line at this value intersects the curve giving the annual value of power loss in one circular mil-foot at approximately 5,250 circular mils per ampere. This then is the economical section to use. To be accurate, the value of current used in expressing current density in circular mils per ampere, should be the square root of the mean square of the current ordinates taken over a year, that is the effective value.

With constant load this annual effective value, as it may be called, would equal the average value of the current. With a varying load current, the annual effective value would be greater than the average value.

One can determine the maximum and minimum values of effective current for various load factors as follows:

Assume a load current as shown by the area OABC in Fig. 2, which has a load factor of fifty per cent. A load which has the same maximum value instantaneously and the same average value and therefore the same load factor, is outlined in the figure as ODEFG. The rate of loss in the first case will be four times that in the second case but for half the time, and, therefore, the loss for the total time period will be twice as great. The effective value of the current in the first case is then twice the average value. The form factor, which is the ratio of effective value to average value is therefore, two. In the following tables are set down the maximum possible form factors for various load factors; the minimum form factor is unity in each case.

Load Factor	Maximum Form Factor
.10	10
.20	5
.30	3.33
.40	2.5
.50	2
.60	1.66
.70	1.428
.80	1.25
.90	1.11
1.00	1.00

SOME CAUSES OF BAD CITY PAVEMENTS IN AMERICA AND THEIR REMEDY

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In Charge of Highway Engineering

The marked inferiority of American city pavements as compared with those of European cities is certain to impress even the most casual traveler. An investigation will show, however, that this inferiority is not usually due to lack of knowledge or skill in the design or construction of our pavements, but instead is the result of several unwise customs, which it is now proposed to briefly discuss.

Prominent among these faulty customs are the following:

a. The selection of the wrong type of pavement for the particular street, having in mind the most important service required of same.

b. The lack of a systematic program for paving and other street improvements and of proper standards of street and pavement widths resulting in the frequent, and often needless, opening up of pavements, both by public service and municipal authorities, and in unwise street and pavement dimensions.

c. Inadequate inspection of pavement construction.

d. The general lack of an adequate system of pavement maintenance.

Selection

Nothing could be more fundamentally wrong and more certain to produce bad pavement conditions than the selection of an unsuitable type of pavement for a given street or highway. Such a pavement will always be a source of annoyance and of abnormally high ultimate cost. The belief is altogether too common that some one type of pavement is the best pavement to be used under all circumstances. It cannot be too frequently or too emphatically stated that the best pavement for any street or road must always depend, first, upon the kind of *service* expected of it, and, second, upon the widely varying local conditions, such as the quantity, nature, and even direction of the traffic, or the character of the district served by the pavement or even the grade of the street, or the presence or non-presence of car tracks. Combined with the above local conditions, the selection of the best pavement for a particular street or highway must also depend upon certain leading characteristics of the pavement material itself, such as its durability, smoothness, noiselessness, slipperiness, first cost, etc. Failure to understand this is responsible for many poor pavements.

The best pavement, then, would be that one which would give the greatest and most needed service to the locality in question. The legitimate conclusion to draw from this is that in any large city or large country area several different types of pavement will be found necessary. A few applications of this principle will best serve to make my meaning clear. For example, if a given street has a steep grade, such considerations as smoothness, noiselessness, first cost, etc., must give way to the single quality of non-slipperiness. Again, if the street in question were on a moderate grade and in a high class residence district, or in the office building district of a large city, the factors of smoothness and noiselessness might alone properly determine the final selection. The selection of a pavement on this basis, while perhaps involving a high first cost pavement, has repeatedly fully justified itself by the added value and earning capacity conferred upon the abutting property. This added value is due solely to the great *service* afforded by the adjacent pavement. Thus the substitution of expensive creosote wood block for the rough granite block pavement in the Loop district of Chicago has so reduced the street noise as to add greatly to the renting value of adjoining offices. Still again, the construction of the several hundred miles of brick pavements on the country highways leading into the city of Cleveland, by insuring a hard, clean, durable road surface 365 days in every year, have increased the market value of the country so served many times the extra cost of the brick pavement over some cheaper competing types of pavement. The transformation so made can be best described by the saying that such a property was so many minutes instead of so many miles from the city.

Considering again the selection of a pavement for a wholesale district or one near the freight yards, calling for heavy traffic, the qualities of durability and non-slipperiness should naturally receive the greatest consideration. The financial loss to abutting merchants resulting from frequent interruptions of business due to numerous repairs or renewals of a cheap and non-durable pavement might annually greatly exceed the difference in the first cost between a cheap and a so-called expensive pavement. Not only would such a cheap pavement cost more at the end of a term of years, but in such interval would give very inferior service. Advanced communities are now governing the selection of their pavements not alone by what they pay but primarily upon what they receive for their money.

Even this brief discussion shows the fundamental necessity for using the greatest wisdom and experience in selecting a proper type of pavement. And yet how often are such wisdom and experience entirely lacking.

In view of past experience, it must be admitted that the custom of allowing the abutting property owner to decide the type of pavement for his street is wrong both in theory and practice. Such a choice is very likely to result in the rapid destruction of the pavement so selected because not suited for the traffic conditions. In the end this places an unnecessary burden upon the shoulders of the general tax payer because of the resulting high annual maintenance cost.

Property owners who never would consider themselves qualified to decide the kind and size of sewers or the water pipes in front of their homes, strange to say, appear very confident of their ability to pass on the type of pavement suited to their own street. The fact that their interest in pavement matters is generally limited to their own street, suggests that considerations for their own pocketbook alone form the basis of their expert knowledge. This is especially true where the property owner pays for the first pavement only and the city pays for all renewals and repairs. Under such circumstances the land owner is apt to select the cheapest pavement, that with smallest first cost, even though the cost of maintaining such a nonsuitable pavement be many times in excess of a reasonable charge. In some American cities excessive maintenance charges, due to this system of selection, have resulted in the practical abandonment of such pavements, so that they are soon full of holes.

Then, too, a certain type of salesmanship possessed by some agents of paving material concerns has greatly stimulated the property owners' confidence in their expert knowledge, thereby greatly complicating the situation. Not infrequently the controversies aroused by the active solicitations of such agents have prevented a wise choice of pavement, with the result of bad pavement conditions. In the long run such agents are not serving even the best interests of their own company.

The writer does not wish or intend to belittle the thoroughgoing and bona fide investigations of pavement matters by citizen organizations. In fact, under our democratic form of government such movements are a real necessity for informing the general public and thereby securing its confidence and co-operation with the plans of the city government. The writer is fully aware of the excellent results secured by this important type of team play between citizens and their chosen administrative officers. The best results in such cases, however, have been realized through the employment of experts by such citizen organizations to investigate the facts and report to the citizens their conclusions, with full statement of reasons. Some of these reports distributed in the form of bulletins have contributed greatly toward the cure of pavement evils by pointing out their proper remedy. We need more, not less, of this form of team play. The selfish practices which I am condemning are obviously so poorly calculated to serve the general welfare of the city that no one really attempts their defence. In fact, many cities select their pavements now on expert advice alone. Such cities have learned to put great weight upon the recommendations of their city engineer, based as they are upon large experience and adequate investigation. We may confidently expect that our growing vision of municipal efficiency will not much longer tolerate the old system of pavement selection by selfish interests. Can any one doubt that better roads and pavements will result?

Pavement Program

Although our common sense suggests that the most suitable pavement for each particular street should be carefully and expertly chosen, is it not at least of equal importance that all such paving improvements should proceed in accordance with some well considered plan, some comprehensive system looking to the ultimate future pavement of the entire ward and city or county? And yet how generally do our city and county officials adopt street improvement plans with little or no consideration for the work that was done the year before or the work that is to follow the year after, a "hand to mouth" system, bearing all the earmarks of our vicious ward and township systems.

A real problem should consider the welfare of the whole city or county, not only present needs but the future, so far as they can be anticipated by properly conducted studies of past and present conditions, including changing population, property values, traffic conditions, tax rate, and bond limit, etc. Not infrequently a comparative study of similar conditions in nearby and similarly situated cities will throw much light on such a study. Improvements based upon a well thought out program will insure roads which begin somewhere and go somewhere, each improvement being a new link in the finally completed chain of communication.

Again, a rational program will provide several paved avenues with the lightest grades possible for the heavy through traffic, so that delays due to congestion may be prevented,* thus at the same time conserving the life of the pavement. The amount and character of the street traffic remaining about the same, the type of pavement on such main traffic avenues would not be changed on any given street without some excellent reason. Experience has shown that when the type of pavements change much greater liability of the horses falling exists. There are other objections to the "crazy patch" system of paving, one result of which is the increased cost of maintaining some combinations.

The smaller towns and cities, through lack of scientific direction, very frequently copy the very expensive street standards of the larger cities, standards that administer well to the heavy traffic and high priced real estate of a city like Chicago but which are quite unsuited to the opposite conditions certain to obtain in the small town or city. The adoption of such stand-

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* At the Third International Road Congress the road authorities of Great Britain reported that the loss of a quarter of an hour in each day of eight hours due to street congestion in London involves a money loss to the workers of that city of about thirty million dollars annually.

ards must mean an abnormal and unnecessarily high tax upon the citizens, not only for their first construction but also for their perpetual maintenance. This prodigality in the expenditure of the city money generally will limit the pavement improvements to a very few favored wide avenues paved with an unnecessarily high priced material while all the rest of the city endures the dust and mud of unimproved streets. Such a town is dressed in a silk hat and worn out overalls! Who has not remarked the excessively wide pavements usually found on these same streets, streets commonly deserted by vehicular traffic with the exception perhaps of Saturday. The speaker is familiar with many Wisconsin cities nearly all of whose pavements boast a width greatly in excess of present or future needs. This fact is usually evidenced in a wide macadam by a narrow strip in the center alone used by traffic, well defined by grass or weeds on the adjacent sides. The interest on the money foolishly invested in such excessive widths would maintain the actually needed pavements for all time, but if such repairs are now made under existing conditions it is at the expense of an already overtaxed community. Such an economic loss is all the more regrettable because it is entirely unnecessary.

In thus criticising the policy of installing too wide pavements the writer does not wish it inferred that he favors an excessively narrow pavement, for the reason that not only does such a pavement fail to furnish the required service for which it is designed, but its deficiency in width is quite certain to prove the controlling cause of its early destruction. Either too wide or too narrow pavements are only examples of failure to adopt a proper paving program in this important particular. Such American cities as have adopted a paving program extending over a period of five or more years are already occupying an enviable position as compared with those cities which still cling to the discredited, antiquated and expensive method inherent in the early development of any new country.

No other large corporation could successfully conduct its business by planning only for today. And yet if planning for the future is important for piling up dollars in private business, how much more important is it for the conservation of the health, comfort and happiness of our citizens?

Inadequate Inspection

A careful field examination in several states has disclosed to the writer the fact that too often failures in American pavements are easily attributable to poor inspection. Indeed, pavement failures are more often due to poor inspection than to poor design and specifications. It is rare that the design of a pavement is left to any except a carefully trained and experienced engineer, but it seems to be the common belief that almost anyone is qualified to serve as inspector on the construction of this work. No greater mistake could be made. Careful observance of this point, together with far greater efficiency in pavement construction would be secured if greater attention were paid to the qualifications of our inspectors.

During the past month the speaker has made a careful review of the instructions to inspectors given in many of our leading American cities. This study has disclosed very marked differences in the importance attached to the duties of inspector, although there seems to be a tendency to give the subject greater consideration, especially in the larger cities.

Anyone who has observed pavement construction widely must have been impressed with the fact that by no means are all the errors in construction due to a desire of the contractor to unduly cheapen the construction. On the contrary in many cases these errors are due to plain ignorance, it being often found that the correct method would have been cheaper.

Under such conditions it matters not whether the pavement is being constructed by contract or by day labor, for in either case success can only be gotten by the most careful and competent inspection and supervision. This is especially true in America, where the common laborers seem to lack the intense loyalty to the work often displayed by their European brothers. Again, the writer's observations lead him to the conclusion that European contractors display, as a rule, greater loyalty to the work in their charge than is usually seen in America. This seems to be due in part to the inertia which makes the eldest son content to follow in the same line as his father. He has been taught but one way to do the work, and that the best, and commonly displays remarkable loyalty in the detailed execution of his trust. In

America, where conditions are changing rapidly and where only the exceptional man is content with his status, the need of greater care in the inspection to insure thoroughness must be apparent.

It is encouraging to note that in our cities, and also in the state highway organizations, it is becoming increasingly common for the Public Works and Highway Commissions to organize and hold schools for the instruction of inspectors. The possibilities of this system for improvements in construction are not likely to be over-estimated.

Furthermore, much good could be accomplished by giving greater importance, permanence and prominence to the position of the inspector. The money spent in well earned promotions would be well justified in the results secured.

So far attention has been directed only to inspection of construction. It is equally important that the raw materials used in such construction should receive the most careful scrutiny, and, wherever possible, at the point of manufacture. To give just one example by way of illustration: Annually many millions of paving brick are shipped from the factory to a distant city, to be carted perhaps to a distant road, there rejected after being placed in the pavement, and again to be returned to the railroad depot for final disposition, involving in these operations a cost that practically has eaten up the intrinsic value of the brick. Most of this could have been prevented by proper inspection at the plant, an inspection which would include in some cases the shale material of which the brick was composed, as well as the finished product. That such an inspection would greatly increase the satisfaction of property owners paying for the brick pavements and thereby greatly increase the sale of brick, must be obvious to all.

The Importance of Highway Maintenance

The last and most important cause for bad roads and pavements, which I have to discuss, has been the general lack of a system of maintenance in this country. Centuries of experience have taught the European engineers and taxpayers that the time to begin the repair of a road is the day after its construction is finished. In America too generally we put off the repair of our roads until the day after they are worn out. As a result, the

European road services are well maintained and long lived, while American roads are rough and short lived. This criticism is true both of country highways and city pavements. Failure to give attention to this important need has caused a very serious financial condition with reference to future street improvements in both country and city. Money which should be spent for the construction of new streets in growing communities is required now for the repavement or repair of older streets under circumstances that, had proper attention been paid to their maintenance, replacement would not now be necessary. In no other construction does the old adage of ''A stitch in time saves nine'' apply more aptly than in road repair. Unhappily the lack of appreciation for the need of road maintenance is not confined to our humble country path masters, but is too frequently displayed by officials higher in authority. Nearly everybody is now in favor of good roads, but it may well be that a better service will be afforded by a cheaply constructed road, well maintained, than by an expensively constructed road without such maintenance. The present enthusiasm for expensive hard surfaced highway is sure to wane unless more attention is paid to the proper maintenance of already constructed roads. This is especially necessary in communities where roads and pavements have been constructed from the proceeds of bonds. Witness the sad experience of some of the eastern states, notably New York. It requires more courage to tax ourselves for the proper maintenance of our roads than it does to construct much greater mileage out of the sale of long time bonds, thereby transferring the burdens of today upon generations yet unborn. New York state has learned this lesson of the need of maintenance, but as a result of many years of indifference is now paying an excessive price for the cost of such maintenance now about a thousand dollars per mile per year, and amounting to several millions of dollars each year.

One reason for our general indifference toward this question of maintenance is found in the failure to visualize the future traffic. Here again experience leads one to be optimistic for the future. We have learned that the building of a hard surface road at once disturbs the old traffic equilibrium by attracting to the new road new traffic which generally sought other routes.

This change of amount of traffic upon the completion of a new road may amount to 300 or more per cent., and may involve an entire change of character of the vehicles using the road.

Heavy trucks, fast moving automobiles and heavily laden narrow steel tired wagons are responsible for a large part of this excessive cost of road maintenance. In all justice to the taxpayers these classes of vehicles should be made to contribute to the maintenance fund in proportion to the damage done to the roads. This principle, in fact, has long been recognized and acted upon in Europe and a few of our states. Instead of a flat sum, generally insignificant, the license fee for all vehicles should be made proportional to the weight or horse power of the vehicle; thus in England a forty-five H. P. touring car would pay a license fee of about $100 per year. Certainly smaller sums would create an adequate maintenance fund in this country. Such a wheel tax can be justified not only on the grounds of damage done to the road, but also as coming from the class to whom such a tax would be far from a burden.

Another method of securing funds for maintenance would be the taxing of all gasoline used in motor cars. During the last year it has been estimated that a tax of six cents per gallon (the tax in England) would produce a fund of nearly $2,000,000 in New York state alone. Such a tax would have the advantage also of being proportional to the use of the roads. The writer believes this system or some modification of it deserves a wide adoption.

But better still than paying for excessive wear of our roads, would be the enforcement of properly designed legislation for preventing such wear. Several eastern states and a few western have already enacted such legislation. The writer believes that the damage done by the narrow steel tires is generally underestimated.

The writer disclaims any partiality toward foreign practice of road making, in fact, except for their superior systems of road maintenance, his investigations fail to show any superior knowledge of road construction over that possessed by the best American engineers. Indeed so far as the theory and practice of asphaltic materials are concerned, European engineers frankly confess that they look to America for future solution of bituminous problems. In America the good road movement is scarcely fifteen years old. In this brief experience we have learned how to make our standard roads as well suited to our comparatively thinly settled country and the attendant traffic conditions as the French roads are suited for French conditions. Indeed one might go still further and say that no county in England or France has a system of roads so permanently constructed as the Cuyahoga county system in Ohio. So far as city pavement construction is concerned we can learn from Europe chiefly the necessity of paying the closest attention to the apparently unimportant constructional details. This general principle is well illustrated in our present knowledge of how to construct a first class brick pavement.

For nearly a century our American states have been engaged in the construction of country and city roads, placing the construction of the work in the hands of short lived and incompetent officials. Enough money has thus been wasted to pave with the most expensive materials a very large proportion of all our roads. The futility of this policy has, at last, been realized. I congratulate the state upon the organization of our present efficient highway department. The highest efficiency and continuity of management of our roads will be promoted by placing the maintenance of all state and main trunk roads in the hands of the state highway department where they should be outside of the influence of petty township politicians. What can be more logical than the belief that the same authority which designed and constructed the highways are also the most competent authority to be charged with their maintenance.

Most significant to highway engineers and especially encouraging to taxpayers is the present well founded and growing confidence in and reliance on scientific methods, both in the selection of raw materials and their incorporation in the completed road. Not until our people are equally well converted to scientific maintenance can we realize our ambition for good roads.

THE ENGINEER IN AGRICULTURE

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It will be best perhaps to start with a statement explaining the title given this article. The agricultural engineer as such, has a somewhat limited field at the present time, not because he is not needed or wanted, however, but because he is not well enough known. At the present time, when a farmer wishes assistance, he goes to engineers who are specialists in a particular line as, the mechanical engineer, the civil engineer, the sanitary engineer, or the architect. These men, while expert enough, often fail for lack of the view point of, or sympathy with, the farmer.

There is no class of people in America to day that has a better appreciation of the value of a dollar than the farmer for he digs it out of the soil. Before he invests that dollar in improvements, he must be shown conclusively that it will pay and pay well. Investing in engineering advice is a new venture with him and he is not always willing to risk his money where value to be received is not immediately apparent. Here is where a broad sympathy and an intimate knowledge of farm conditions is of value to the professional engineer who would have the farmer for his client.

With the advance made in the production of farm machinery in recent years, and the application of motor power to its propulsion, both of which are the work of the mechanical engineer, the farmer is calling upon the agricultural engineer for instruction in operation and also for aid in making an intelligent choice of implements to suit the conditions met in his locality.

Following an increasing demand for farm products and higher prices for the same, the value of land has advanced until the farmer has been compelled either to adopt a more intensive cultivation of his high and well drained acres or to extend his operations to the low and swampy lands. For this he has called in the drainage expert. The drainage expert must be at once civil engineer, agriculturalist, and arbitrator. As civil engineer, he deals with the problem of rainfall and runoff, slopes and outlets, layouts and installation. As agriculturalist he presents and drives home the arguments for what he expects to accomplish as an engineer. As arbitrator, he settles differences and adjusts claims of adjoining property holders.

Along with other improvements, buildings suitable for the specialized forms of agriculture became a necessity for economic and sanitary reasons. Architects, with little knowledge of the practical side of agriculture and with experience gained in designing country places or "estates" only, could not reach the average farmer. The buildings suited to his needs are largely the outgrowth of long study and experimentation in our agricultural colleges. The agricultural engineer with his training, is called upon to determine the stresses in the frames and trusses and to select economical timbers. In the building field, he will have in the future to give much time to the demonstration and use of concrete in its many applications.

The professional agricultural engineer, then, must be near the concept that, "an engineer is one who utilizes the forces and resources of nature for the benefit of mankind." He must be a farmer, for without the perspective of the farmer, he will be an exceptional man to attain success. He must be a teacher, for this will be his greatest task if he hopes for the future of the profession. His advance will be in the education of the farmer to an appreciation of the value of professional engineering service.

Is he in demand now? Yes. Departments of Agricultural Engineering have been organized in many agricultural colleges and more are being developed with the result that men with the necessary qualifications are being sought as teachers. Manufacturers of farm implements are glad to get men who are familiar with both engineering and agriculture. Millions of acres are awaiting the coming of the engineer to change them from waste places to our most productive lands. The farmer with building and housing problems is only waiting for him to make himself known.

OFFSET PRINTING

J. R. Blaine, m '05, M E '11

Offset printing is one of the newer processes of printing and one which is fast coming into use commercially. Before going into the principles of the method, let us look at the subject of printing in general.

Perhaps no industry has had more bearing on the progress of civilization than that of printing. The original method as discovered by Gutenburg is what is now known as the typographical process and is the one with which we are all familiar. There are two other kinds, however, which are not so well known. These are Planographic and Intaglio.

The distinctive features of each of the three processes are:

Typographical—Printing from a raised surface.

Planographic—Printing from a plain surface.

Intaglio—Printing from a depressed surface.

In the third or Intaglio process the design is etched or engraved into the surface of a metal plate. Ink is then flowed over the plate and all excess is scraped and wiped off leaving the ink in the depressions. The paper on coming in contact with the plate blots or soaks up the ink from these minute depressions. This method has produced some of our finest specimens in art printing.

In the second or Planographic process comes offset printing and lithographic printing. Planographic printing makes use of the fact that water and grease have an aversion for each other. The original method used a certain grade of stone called lithographers' stone upon which the artist drew his design with a greasy ink. A thin film of water was then applied evenly over the entire surface regardless of the design. The exposed stone readily absorbed the water while the greasy design refused it. Ink was then applied over the entire surface. The exposed stone, being moist, refused the ink and remained clean while the design, being greasy, readily took up a fresh supply. The paper was then pressed against the stone and an impression taken.

Progress in the manufacture of metal sheets soon made itself felt in this branch of industry. The cumbersome lithographers' stone was soon supplanted by thin sheets of aluminum and zinc. These metals, grained on one side similar to ground glass, were found to possess almost identical properties with the stone besides being many times cheaper and more practical for handling. For instance a sheet of aluminum weighs a few pounds whereas a stone of the same surface weighs from four to five hundred pounds.

The advent of thin plates opened the way to the development of the rotary type of press for planographic printing. It was only a step from printing direct from the plate to offset printing since it required merely the addition of an intermediate surface between the plate and sheet to be printed.

The theory of the offset principle is that any unevenness in the surface of the plate or paper is counteracted by the yielding properties of a rubber blanket or transfer surface. Again the rubber eliminates all harsh lines by squeezing out the ink, giving a soft tone not obtained in typographical printing.

Briefly outlined, the offset press consists of a plate cylinder, an intermediate blanket cylinder and an impression cylinder. The plate cylinder is provided with suitable clamps for holding the plate firmly in position and has a set of inking rollers and water rollers. The water must be applied before the ink, otherwise the design would be eliminated. The intermediate or transfer cylinder is covered with a rubber blanket held firmly in place by means of clamps. The impression cylinder has the ordinary mechanism for carrying the sheet between the cylinders as it is being printed. It is a question of the correct adjustment between the three cylinders to obtain a true rolling contact and only when this condition is obtained can perfect results be expected.

The chief reason for the offset method not being more generally used is because of its newness. The experimental stage is not yet past but improvements are rapidly developing and before long the industry will be on a good solid foundation. The distinct advantages are in the greater capacity over the type press, a lower grade of paper that can be used, and a certain softness of tone not possible to obtain by the typographical method. On a type press when a job is started a considerable amount of time is taken by getting the type matter set up properly to give the best results. This is known as "make-ready" and means repeated trials until every part of the design shows up uniformly. In some cases this time may even amount to a day or two. On offset presses there is practically no "make-ready" since the design is on a single plate being a unit in itself. Also the yielding intermediate blanket makes up for any slight unevenness there may be. Type presses on account of the reciprocating movement of the bed can only run from fifteen hundred to twenty-two hundred impressions per hour. Offset presses being of the rotary type allow a much faster speed, going as high as forty-five hundred impressions per hour. This increase is an item not to be ignored in commercial printing.

The cost of paper is one of the biggest items in printing. In type presses, especially for color work, a high grade of coated paper is absolutely necessary for good results. In offset printing the quality of paper is not so important. In fact, a much lower grade can be used without in any way impairing the quality of the printing. This means a great saving in the cost of material and for many kinds of work, gives even a more pleasing effect on account of rough surfaced stock. Heavy cardboard can be printed just as easily as ordinary weight paper.

The aim of all manufacturers now is to perfect the machines so that there will be no stoppages due to minor troubles. The increased rate of speed means a greater loss when the press is held up for any reason. These stops must be entirely eliminated in order to make full use of the gain in speed and in the absence of "make-ready."

At present many catalogues and magazines are being printed by the offset process. Some well known magazines make a special point of the covers and show very good examples of offset work. Some of our finest letter heads printed by this method approach so nearly to actual engravings that it is hard to distinguish between them. A great deal of the work now done by the typographical process will eventually be done by the offset methods and a good sound business will result for manufacturers of this type of machine.

SOCIETY OF AUTOMOBILE ENGINEERS SCREW STANDARD.

HARRY C. ANDERTON.

With the evolution of the motor vehicle from an experimental stage into a practical standardized commercial product two things became necessary: the first was to make the parts few and to combine minimum weight with maximum strength, at the same time making all of them as nearly fool-proof as possible; the second was to secure all parts that must of necessity be detached at intervals so as to resist all vibrations, and not to shake, rattle loose or create any unnecessary noises.

To meet these requirements the Association of Licensed Automobile Manufacturers, better known as the A. L. A. M., in 1906 adopted standard specifications for hexagonal head screws, castle and plain nuts and termed them the A. L. A. M. standards. These same standards, with some few minor changes, were later taken over by the Society of Automobile Engineers in 1911 and termed the S. A. E. Standard, which is the one now used universally in the automobile industry.

The material specified for these products was steel with a tensile strength of not less than 100,000 lb. per sq. in. and an elastic limit of not less than 60,000 lb. per sq. in. In this standard the regular United States Standard thread, sometimes known as the Sellers or Franklin Institute Standard and first proposed by Mr. Wm. Sellers of Philadelphia in 1864, was used. The only radical change in the standard was the increase of the number of threads per inch. The shape and proportions of the thread remained absolutely the same as that in the United States Standard.

The rules for proportioning the United States Standard thread are as follows: Divide the pitch, or, what is the same thing, the side of the thread, into eight equal parts; take off one part from the top and fill in one part in the bottom of the thread; then the flat top and bottom will equal one-eighth of the pitch, the wearing surface will be three-quarters of the pitch, and the diameter of screw at the bottom of the thread will be expressed by the relation diameter of bolt=(1.299/number of threads per inch). For a sharp V thread with an angle of sixty degrees the formula is, diameter of bolt=(1.733/number of threads per inch.) The angle of the thread in the Sellers system is sixty degrees.

The ordinary screw stock is a free machining and a very cheap steel, lacking toughness and strength. It is an unsafe steel and must be kept out of the important ports of an automobile. If screws of this material should be used, they should be heat treated and must not be used in the rolled or annealed condition.

The S. A. E. Standards committee adopted the following specifications for screw stock:

	Per Cent.
Carbon	0.8 to 0.20
Manganese	3 to 8
Phosphorus (not to exceed)	1.2
Sulphur	0.6 to 1.2

This steel may be made by any process and is primarily intended for high screw machine production in which strength and toughness are again secondary considerations. Its composition and texture are of such nature as to permit rapid removal of stock in the machines. This stock, however, when subjected to the heat treatments prescribed by the S. A. E. gives an elastic limit of 120,000 pounds per square inch and forty per cent. reduction in area, which is enough to leave the material in a very tough and enduring condition. The endurance of steel so treated under alternate stress or vibration is at least ten fold that of a steel in an annealed condition. The prescribed heat treatment is as follows:

(1) Forge, (2) anneal, (heat 1,500° to 1,600° F. and cool slowly), (3) machine, (4) carbonize to a depth of .02″ to .04″ at temperature not to exceed 1,750° F., (5) cool slowly, (6) reheat to 1,500° F., (7) quench in oil, (8) reheat in hot oil at 300° to 350° F. (cool slowly).

Automobile manufacturers agree generally that the right hardness for screws and bolts should be forty to fifty on the Shore scleroscope but these ordinarily run from twenty to thirty-five. When subjected to shearing the resistance offered increases ninety-five per cent. for each increase of one hundred per cent. in hardness.

It should be borne in mind that a fine thread screw should be of excellent material and of accurate workmanship, otherwise there is not the gain there ought to be in the use of the screw. It should also be noted that this fine screw is not suitable for such materials as cast iron, aluminum, bronze, or, in fact any cast material. This applies, of course, where there is any appreciable strain on the screw. The theory is that a fine thread can be stripped more readily from metal than can a coarse one, on account of the thickness of the pitch of the thread rather than the depth of the thread. For this reason a fine threaded screw should never be used wherever such an accident is possible.

There are five "M's" in business: Money, Materials, Machinery, Merchandise and MEN.

* * *

There are plenty of fellows who can "DO IT NOW" if some one will just tell them what to do and how to do it.

* * *

Bossing rubs a high-strung man the wrong way; intelligent supervision puts him on his mettle and brings out the best that is in him.

A REVIEW OF THE UNIVERSAL SAFETY STANDARDS

The first volume of the Universal Safety Standards, MACHINE SHOP AND FOUNDRY, by Carl M. Hansen, M. E., chief engineer of the Workmen's Compensation Service Bureau, New York City, member of American Society of Mechanical Engineers, is a handbook of concrete examples of safeguarding and rules for practice in machine shops and foundries.

This is the first one of a series of books which will be issued under the direction of the Workmen's Compensation Service Bureau, in the course of the next two or three years. The titles of the others will be Woodworking, Leather and Shoe, Mercantile and Theaters, Textile and Clothing, Brick, Pottery and Glass, Paper, Printing and Allied Trades, Electrical, Grain and Flour Milling, Dyeing and Laundry, Mining, Miscellaneous. These books will all be compiled under the direction and with the approval of the Workmen's Compensation Service Bureau. They will all bear the endorsement of the leading compensation and liability insurance companies and these standards will be exclusively used in fixing the rates for workmen's compensation insurance under the Universal Analytic Schedule.

Compensation laws have made indemnity for accidents compulsory. This indemnity is one of the large items in the cost of production. To reduce the cost of production and effect a saving in operation, accident prevention is one of the most prolific fields. Employers and others interested in safety need authoritative information on the methods of assuring safety which will meet the requirements of the rulings of their insurance companies.

In order to supply this demand, safety must be standardized. The Workmen's Compensation Bureau has seen fit to adopt Universal Safety Standards as its minimum requirements for industrial safety. It makes this approval because the book, MACHINE SHOP AND FOUNDRY (Universal Safety Standards) represents, in its opinion, the ideal condition for which they are constantly striving. These standards were prepared with the aid of some eighty engineers working under Mr. Carl M. Hansen's direction and with the advice of and contributions from the leading industrial organizations in the country.

These standards have been quoted so freely by the different state labor commissions that they now represent the basis of the safety laws in practically every compensation state in the Union. This book is the only means of familiarizing one's self with the basic standards of accident prevention. It is the only "How" book on the industrial safety. It is the only standard handbook on safety engineering in the world. It is a collection of conditions ordinarily found in machine shops and foundries with proper safeguards applied. It treats these conditions with plain, clearly worded, brief specification and illustrates these specifications with drawings. It shows at a glance what is needed and this need is supplied with what is advised by the insurance companies and incidentally the state labor departments. It takes up conditions in the construction of the plant, follows the products from the receiving department to the shipping room and shows how in each instance, safety measures may be applied.

The book is purely a "How" book on safety as opposed to the usual type of "Why" book. It starts where others stop; viz., where others convince you that safety is necessary, this book shows what is necessary for safety. It describes and specifies conditions and machines and safe means and measures for guarding these conditions and machines.

But it does not stop there. With each specification it shows a detailed drawing of what the specification means, all of which is the application of the principle of safeguarding. This arrangement makes everything absolutely clear, even to the machine operator. Very interesting examples are the treatment of stairways, steam engine guarding and grinding wheel protection.

The volume is attractively bound, in limp seal leather, 312 pages, indexed. Price—$3.00 net. Universal Safety Standards Publishing Company.

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EDITORIALS

"PUTTING IT OVER"

Not infrequently the above expression is heard, used in the sense of getting the best of some one or of giving a false impression. In student parlance, it usually means deceiving the instructor. All too often the attempt is successful and the student gets off with less than the required amount of work. Later he finds that he has stored up trouble—the practice must be continued or an extra effort made to master the neglected work. Bluffing may work for a time—with good luck it may even last until the close of the course. The next course, however, is more difficult because the previous one was neglected. There is a gradual slowing down process and the bluffer soon finds himself at the foot of the class or hopelessly lost. Isn't a frank "I don't know" usually a better answer than bluffing? Presuming to know what you do not know is not a very efficient way of gaining knowledge. "Putting it over" the instructor in the long run usually means putting yourself under.

A. V. MILLAR.

* * *

The Exposition is History. The six months' product of the energy of five hundred men has had its brief but wonderful fruitage. Most of us here at the University, and some of the citizens of the state from outside the city were privleged to enjoy it. We found that it fulfilled every prophecy; that it even surpassed our fondest expectations; that it was indeed worthy of every tribute that has been paid to it.

To the engineer the engineering exhibit naturally appealed as the finest in the entire exposition. But just as well did the agric think his the finest of them all. The medic had an equal right to be proud. Each to his own liking. Although the crowd had to wait their turn in line for a sourvenir watch fob at the Shops' Booth, there was just as large a crowd at the Biology exhibit, and it took a good display of football tactics to elbow one's way through the Psychology Booth. The point was very evident in the beautiful desk and office of the graduate of the law school. Even the engineer could understand that. The English Booth was hardly lacking in suggestion, nor could one deny the evident appeal of the Home Economics Bungalow.

While we would not for a moment detract from the praise and the thanks that is so justly due to J. B. Edwards and his corps of lieutenants and privates in the line, we try to remember for what the exposition was conceived and finished. Surely it was not to afford the rivalry of the various departments the opportunity to seize another outlet for their strife. It was not to raise the engineering school above the other colleges of the campus. The purpose of this Exposition was *co-ordination.* If therefore we do not get the intended lesson the Exposition has meant nothing to us except another place to spent an evening pleasantly.

* * *

HIGHBROW AND LOWBROW

The direful question is settled. There need be no further doubt. If you have deemed yourself of the highest intellectual species or hopelessly resigned yourself to the lower classification an awakening may be in store. For the benefit of those of us who have been in the twilight zone as to the rating of our exact likes and dislikes, a Boston newspaper has properly catalogued and classified humankind.

Here are the definitions for high, low, jack and the game:

Highbrow: Browning, anthropology, economics, Bacon, the uplift, inherent sin, Gibbon, fourth dimension, Euripides, "eyether," pate de foie gras, Henry Cabot Lodge, Woodrow Wilson.

Low-highbrow: Municipal government, Kipling, socialism, Shakespeare, politics, Thackeray, taxation, golf, grand opera, bridge, chicken a la Maryland, "eether," stocks and bonds, Theodore Roosevelt, chewing gum in private.

High-lowbrow: Musical comedy, Richard Harding Davis, euchre, baseball, Anthony Hope, moving pictures, small steak medium, Ella Wheeler Wilcox, Robert W. Chambers, purple socks, chewing gum with friends.

Lowbrow: Laura Jean Libbey, ham sandwich, haven't came, pitch, I and her, melodrama, hair oil, the Duchess, George M. Cohan, red flannel, toothpicks, Big Tim, Bath House John, chewing gum in public.

How high do you bid?

CAMPUS NOTES

On Saturday, March 13, Prof. L. W. Wallace of Purdue spoke in the auditorium on the subject, The Possibility of Fire From Locomotive Sparks. The lecture was in the form of a report on a series of experiments, made to determine the probable responsibility for a large fire at LaFayette, Ind. The speaker showed that, under all ordinary conditions, the possibility of setting fire to even the most inflammable materials at a distance greater than fifty feet from the center of the track was practically nil. He further demonstrated that the possibility of fire within that radius was very small.

A misunderstanding as to the time of the lecture was responsible for the small crowd that greeted Professor Wallace. The junior civils and mechanicals, together with all of the seniors, were excused from eleven o'clock on Thursday, but the speaker did not arrive until Saturday. It is hoped that we may have him with us again; not because he gave us a little vacation by his late arrival, but both because of his ability as a speaker and because we would like to have him get a true idea of the manner in which a Wisconsin audience responds to a visiting speaker.

* * *

It has been said that all great men have hobbies. Prof. J. G. D. Mack has shown us that he is no exception. His hobby is not only a good one but it is extremely well "had." He disclosed said hobby when he spoke before the Engineers' Club on The History and Development of Small Fire-Arms. He showed us that a professor actually thinks of other things in addition to the daily grind of problems and reports. It is needless to say that the subject was most capably and completely covered, and that the audience was highly appreciative of the treat. The development was illustrated by over fifty actual specimens, representative pets from a large collection. Serg. Atkins, Lieut. Garner, and Mr. W. D. Mack assisted in explaining the various guns after the lecture.

Things that never happen:

A senior Eng'r fusses up the hill and fails to get a sky-rocket.

A mechanics course starts without an assignment for the first day.

A soph finishes a Mechanism plate in the scheduled number of hours.

Steam and Gas lab. is excused for a convocation.

Says ye Business Manager, "We have collected every bill that is due up to date."

Says ye Boss Editor, "All my flunkies got their copy in on time this month."

Add any others that may suit your fancy.

* * *

We hear that a sophomore furnished a substitute to occupy his seat at a descrip. lecture early in the semester. It is needless to record his success. We wish to assure the unsophisticated under-classmen that Prof. Millar knows everyone who even thinks of taking his course.

* * *

We trust that the hydraulics department will have its new reservoir completed and open for business before our class spirit rises to its spring flood. It will be much handier than dragging the freshies all the way down the Hill to the lake. Moreover the saving in time will make possible a much-needed increase in the volume of the trade. Not so much that the Frosh need it as that we all need the recreation.

* * *

Does it often occur to you that the University embraces departments other than engineering? An occasional lecture on romance languages or a tuberculosis exhibit out at the Ag. school tends toward that broader culture. Ne quid nimis! But the danger lies not so much in excess of technical knowledge as in narrowness of view-point.

* * *

We understand that a certain member of the class in T. E. 108 always takes great pains to run the telescope on the transit out to its full length when the gun is not set up. Such precautions are said to be the result of an upperclassman's advice that this was the best way to prevent a short circuit of the crosswires.

CHANGES OF ADDRESS

F. W. Lorig, m '13, remains as Draftman for the West Penn Traction Co., First National Bank Bldg., Pittsburg, Penn.

H. H. Lynn, e '08, is Engineer for the St. Andrews Bay Dev. Co., Lynn Haven, Florida.

H. C. Lynch, c '13, is now Supt. of Construction for C. E. Bryan, Inc., 1134 Otis Bldg., Chicago, Ill.

C. B. Little, e '14, has located as Electrical Inspector for the B. & O. Ry., 714 B. & O. Bldg., Baltimore, Md.

F. B. Lucas, ch '13, we are glad to hear, is recovering nicely from incipient pulmonary tuberculosis, with which he was laid low for a time. Write him a cherry letter at Brownsville, Texas.

F. H. Mann, c '05, who was Supt. of Bates & Rogers Engineering Co., of Turners Falls, Mass., is now at Shullsburg, Wis.

F. C. McIntosh, c '13, remains in the Track Elevation Office of the Penn. R. R. Co., South Chicago. His home is at 453 W. 61st St., Chicago, Ill.

Victor Morris, e e '14, is working on street lighting for Vaughn, Meyer & Sweet, Milwaukee, Wis., offices at 1007 Majestic Bldg. His home is at 333 Summit Ave., Milwaukee.

A. H. Miller, m '05, formerly with the Globe Foundry Co., Sheboygan, Wis., is now Mfg. Supt. for the Vollrath Co., Sheboygan, and lives at 1218 N. 5th St., Sheboygan.

Lucius A. Morris, e '14, starts work in the Consulting Engineering Dept. of the General Electric Co., Schenectady, N. Y.

W. A. North, fellow '11, likes banking and at present is with the Mercantile Trust & Savings Bank, Evansville, Ind.

O. P. Peterson, m '14, has located as Geologist for the Adbar Development Co., Deerwood, Minn.

S. H. Phinney, c '14, enters the employ of Sloan, Huddle, Fenstel and Freeman, Railroad Valuation, at 14 Kelly St., Boston, Mass.

S. S. Rumsey, c '97, formerly Chief Eng. for the Oliver Mining Co., of Duluth is engaged in private practice now. His office is 717 Wolvin Bldg., Duluth, Minn.

R. F. Robinson, e '05, has been promoted to Central Office

Foreman of the Pacific Tel. & Tel. Co., 333 Henry Bldg., Seattle, Washington.

E. F. Sturgeon, c '12, has risen to Supt. of the T. W. Snow Construction Co., Pocatello, Idaho.

J. C. Taylor, e '01, still holds the position of District Mgr. of the Denver Rock Drill Mfg. Co., Houghton, Mich.

Wm. J. Titus, c '13, who was with the C., M. & St. P. R. R. Co., is now with Daniel B. Luken, Consulting Eng., 802 Traction Terminal Bldg., Indianapolis, Ind.

L. L. Tessier, m '93, remains as Supt. of the DePere Electric Light & Power Co., DePere, Wis.

S. Terhorst, e '06, believes farming is his vocation and may be addressed at Donnybrook, S. Dak.

C. L. Van Auken, c '10, is still with the Condron Co., Structural Engrs., 1215 Monadnock Bldg., Chicago, Ill.

T. E. Van Meter, t e '07, is still Asst. Supt. of Deere & Co., Harvester Dept., East Moline. His home is at 463 14th St., East Moline, Ill.

Louis Witt, ch '09, is Examiner of Efficiency with the Chicago Civil Service Commission, Room 610 City Hall, Chicago, Ill.

A. B. Whitney, c '08, remains with the C., M. & St. P. R. R. Co., Room 1217 Railway Exchange Bldg., Chicago, Ill.

H. R. Whomes, m '00, formerly Engineer for the Packard Motor Car Co., is now a Mech. Engineer in Chicago, and can be reached at his home, 4215 Park Ave., Chicago, Ill.

C. A. Betts, c e '13, has taken up the duties of assistant engineer for the city of Norwalk, Conn., and may be addressed at 55 Newtonn Ave., Norwalk.

A. F. Blossey, m '05, is still with the Alton Gas and Electric Co., Alton, Ill., but is now holding the position of gas engineer. His address is 1913 State St., Alton.

H. L. Budd, e '10, formerly with the Edison Illuminating Co., of Detroit, is now with the Diehl Mfg. Co., 1019 W. Jackson Blvd., Chicago, as sales engineer.

R. V. Bacon, e '14, enters the employ of The Union Co., 314 First National Bank Bldg., Omaha, Nebraska.

J. M. Bichel, e '12, is farming in Taylor county, Wis., his home being at Curtis, Wis.

Leo Cowin, m '14, is at present apprentice for the Westinghouse Elec. & Mfg. Co., East Pittsburg, Pa., and may be addressed in care of the Educational Dept.

W. H. Curwen, c '11, may be addressed at Stillwater, Colo.

S. Dougall, ch '13, is president of the Anchor Concrete Construction Co., 706 Furniture Bldg., Evansville, Ind.

A. E. Delgado, e '06, has taken the position of assistant manager of the Motor Car & Supplies Ltd., 67–71 Harbour St., Kingston, Jamaica, B. W. I. He was formerly with the Kingston Industrial Works.

A. W. Ely, c '12, who was a concrete inspector in Ortonville, Minn., now holds the position of junior engineer for the Interstate Commerce Commission, Divison of Evaluation, with offices at 914 Karpen Bldg., Chicago, Ill.

G. J. Gaskelt, m '12, has been transferred from assistant manager of the Insulation Dept., to assistant manager of the Construction Dept., of the H. W. Johns-Manville Co., 501 N. Third St., St. Louis, Mo.

C. F. Gray, m '11, is now salesman for the Merryweather Machinery Co., Detroit, Mich., giving up his position as foreman for the Wagner Elec. & Mfg. Co., of St. Louis.

W. F. Gettelman, c '14, surveyman for the U. S. Reclamation Service, Camp No. 2, Babb, Mont., was on a furlough January and February, and will now receive proposals.

C. Hambruechen, e '99, has been promoted from superintendent to secretary of the American Carbon and Battery Co., of East St. Louis.

A. H. Heyroth, e '07, is development engineer for Frank Strough & Co., Denton, Montana.

J. A. Hinckley, m '14, is an instructor in the Steam and Gas Laboratory of the University of Tennessee, and may be addressed at Estabrook Hall, U. of Tenn., Knoxville, Tenn.

L. R. Howson, c '08, is assistant engineer for the Alvord & Burdick Co., Hydraulic and Sanitary Engineers, Hartford Bldg., Chicago, Ill.

M. S. Houston, e '14, has located as cadet engineer with the Denver Gas & Elec. Light Co., Denver, Colo.

E. H. Horstkotte, c '12, has been promoted to foreman of the Dept. of the G. E. Co., Schenectady, N. Y.

B. W. James, m '97, is an irrigation engineer and may be reached at his home, 1623 El Cerrito Place, Los Angeles.

W. E. Jessup, c e '12, formerly with the Stone and Webster Corporation, is now in the Construction Dept. of the U. S. Reclamation Service, Salt River Project, Box 765, Mesa, Ariz.

C. H. Kypke, ch '09, is now Missouri head salesman for the Roach-Fowler Pub. Co., Kansas City, Mo.

R. H. Kroenig, c '12, is general manager of the Kroenig Construction Co., Majestic Bldg., Milwaukee, Wis.

Edwin Kottnauer, ch '14, may be reached at his home, 826 Locust St., Milwaukee, Wis.

A. H. Liver, c '08, has located as civil engineer in White, Montana.

H. N. Legreid, ch '08, is county highway engineer of Humboldt county, Iowa.

Mr. C. M. Scudder, c '12 has been appointed instructor in Mechanics to take the place of Mr. H. E. Pulver, who recently joined the faculty of the Chinese Polytechnic Institute at Shanghai. Since graduation Mr. Scudder has been engaged chiefly in Hydroelectric work with the Knoxville Power Co., Alcoa, Tenn., and the St. Lawrence River Power Co., located at Mossena, N. Y.