...THE...

MACHINERY EDITION

OF THE

CANADIAN MANUFACTURER

DEVOTED TO THE PROBLEMS AND NEEDS OF THE MACHINE SHOP, THE FOUNDRY AND THE WOOD-WORKING SHOP.

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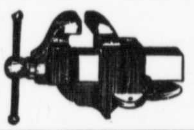

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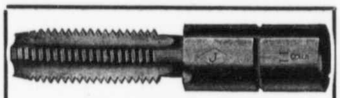

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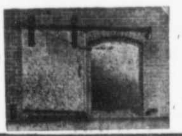

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OUR OPPORTUNITY FOR GREATER SERVICE.

With the appearance of this issue our four specialized editions are complete for our readers' inspection. Many have already expressed their appreciation of the preceding editions. Now we are anxious to have criticisms and suggestions from all readers as to the whole plan.

Every manufacturer is deeply interested in these four departments: his power plant, his office, his machine shop and foundry or his manufacturing plant, and lastly the construction and equipment of his manufacturing plant. Thus with our four editions, the Power Edition, the Office Edition, the Machinery Edition, and the Construction and Equipment Edition, we have the opportunity of being of great service to all manufacturers in the practical conduct of these several departments of their business. Besides which the advantages of a weekly paper to manufacturers are many. Chief of these is the weekly news service. The problem with the specialized paper in Canada has been the supplying of news frequently enough to make it valuable. A manufacturer cannot wait a month to follow up business opportunities. Thus THE CANADIAN MANUFACTURER with its specialized weekly editions now has the advantages of specialization, with none of its disadvantages.

We know we now have the opportunity of being of eminent value to the manufacturer. Each of the specialized editions already issued have been well received. This leads us to believe that our readers have appreciated our efforts. However, we are sure we can make succeeding issues much more deserving of appreciation. To that end we wish the assistance of all our readers.

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We desire the interest and cooperation of each practical man in his special edition. We look to our practical readers, the engineers, the superintendents, the foremen, and the machinists for practical articles, suggested by their own experiences in their own work. Such articles we will pay well for. To the office man we look for articles based on his practical experience in office work which will be of interest and value to other office men. We will gladly give suitable remuneration for available material.

The original object of making these far reaching changes was to give greater value to our readers. The new plan of publication provides this opportunity. We will do our best to take advantage of it. We look to our readers for their hearty support.

CHANGE IN FORM OF GEAR TEETH.

In this issue is an article descriptive of a new form of gear tooth which is being advocated by a certain gear cutter manufacturer. The new tooth is called the "stub tooth." It differs from the standard involute tooth only in shortened addendum and increased pressure angle. By increasing the pressure angle the teeth may be shortened so that only such portions of the curve are used as will give nearly a complete rolling action, the most desired end in designing toothed gearing. With only this increase in the pressure angle or angle of obliquity the advantages are limited; but the addendum being shortened as well, will increase the strength and durability.

This article deserves the careful consideration of all interested directly or indirectly in this subject. The advantages of the new tooth are well advocated, and very plainly shown. We will be glad to have our readers express their opinion through the columns of this paper.

Stub Tooth Gear: Features and Advantages

New Form of Gear Tooth, Differing Only from the Involute in having Greater Obliquity and Shortened Addendum, Giving a Better Rolling Action and Increased Strength and Durability, Advocated by Fellows Gear Shaper Co.

A new form of the involute gear tooth is being advocated by the Fellows Gear Shaper Co., Springfield, Vt., known as the "stub tooth gear." It is a shortened and strengthened involute tooth cut with a stub tooth cutter. The difference is that the stub tooth is shorter and the angle of obliquity greater than in the standard involute tooth. This company have published a booklet outlining the reasons for advocating this change. Extracts are made from this booklet, and explanations added in order to make the comparison between the two more comprehensive to readers not familiar with the involute tooth.

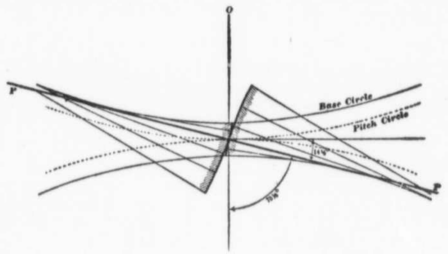


Fig. 1.—Method of Developing the Involute Tooth.

Before touching on the "stub tooth," a brief description of the standard involute tooth will be in place.

In the involute system of gearing, the outlines of the working parts of a tooth are single curves, which may be traced by a point in a flexible, inextensible cord being unwound from a circular disc, the circumference of which is called the base circle, the disc being concentric with the pitch circle of the gear.

In Fig. 1, the two base circles are represented as larger to the line P.P. This line is variously called "the line of pressure," "the line of contact," or "the line of action." In our practice this is drawn so as to make with the normal to the center line (00′) 14½ degrees. This angle is known as the angle of obliquity. In the stub tooth system this angle is larger, 20 degrees instead of 14½ degrees, and the tooth is shorter.

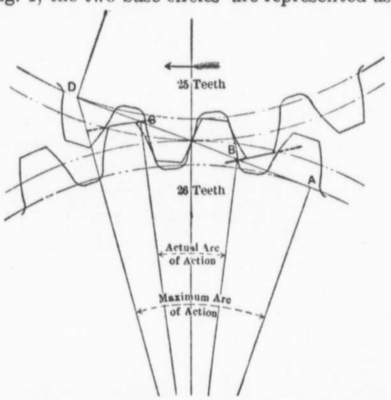


Fig 2.—Comparison of Actual with Maximum Arc of Action in the 14½ Degree System.

With the constantly increasing use of gears for transmitting power in widely varying quantities, the question of the correct shape and size of gear teeth becomes of far greater importance than ever before. It is not sufficient that a gear be well cut and the teeth properly spaced, but the shape and proportions of the tooth itself must be carefully considered.

The two most important features are the securing of the nearest approach to a rolling action that it is possible to obtain and the strongest tooth that will meet this condition. The first includes easy running, reduces the friction to the lowest point, and consequently has the least wear in action.

In the matter of length, it is a fallacy to argue that teeth should be made as long as possible in order to have two or more teeth in contact at once. An equal division of the load is never possible between two contact points, and it can be shown that the lengthening of the tooth to produce more points of contact gives an excessive sliding action at certain portions of the tooth action, especially with gears 14½ degrees of standard angle. By increasing this angle, the teeth may be shortened so that only such portions of the curve are used as will give nearly a complete rolling action. This increase in obliquity has been advocated before, but its advantages are very limited, if a tooth of the standard length is retained.

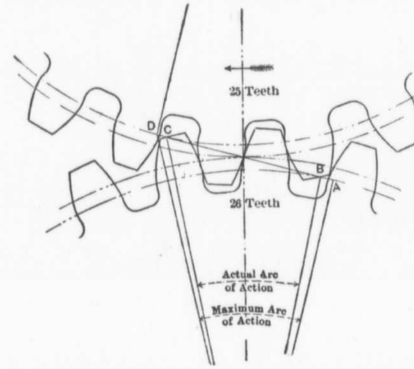


Fig. 3.—Comparison of Actual with Maximum Arc of Action in the Stub-tooth System.

In Figs. 2 and 3 are shown comparisons of the tooth form of a gear of the standard and of the stub-tooth, the driver having 25 and the driven 26 teeth. If, in the diagrams, the gears are supposed to rotate in the direction of the arrow, the theoretical action begins at A and ends at D, the line AD being termed the "line of action." It is obvious, however, that the actual action can only begin at B, where the outside diameter of the upper gear intersects the line AD, and ends at the corresponding point C. Drawing the radial lines from these points to the center O (not shown) the triangle AOD defines the maximum or the greatest possible arc of action, and BOC the actual arc of action.

In Fig. 4 is shown an involute curve of 14½ degrees obliquity of each of the gears, the curves being of sufficient length to cover the maximum arc of action, and drawn

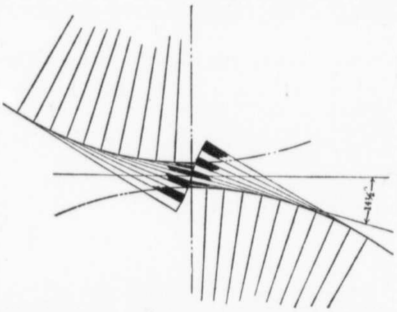


Fig. 4.—The Involutes are those of Fig. 2. The Alternate Shaded Divisions show the Portions of Each which are in Contact with the Corresponding Portions of its Mate during Equal Angular Movements.

to the same scale as Figs. 2 and 3. The alternately shaded divisions of the curves show the portion of each that is in contact with its mate during an equal angular movement of the gears. In Fig. 5 is seen a similar diagram for a tooth having an angle of obliquity of 20 degrees.

In Figs. 6 and 7 the involute curves of Figs. 4 and 5 are developed into straight lines, marked off into divisions corresponding with the divisions on the involutes. These

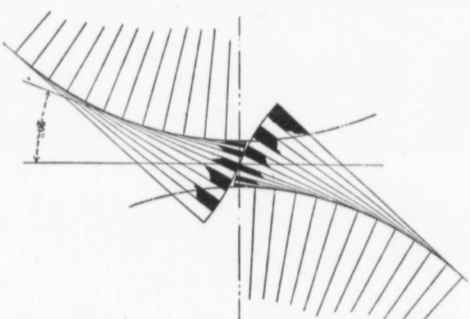


Fig. 5.—The Involute of the Stub-tooth Gear in Fig. 3, treated as in the Preceding Figure.

division points are connected by cross lines. It will at once be seen that the angularity of these cross lines may be taken as a measure of sliding that takes place at any given point, since a large division on one involute making contact with a small division on the other involves an amount of rubbing measured by the difference between the two distances. To any one who has labored under the impression that if the involute curves of a pair of gears are correct, the action is nearly a rolling one, a comparison of these diagrams will be both interesting and instructive. two points will be noted.

First, on account of the greater angle of the line of action of the sub-tooth, the maximum arc of action is much increased.

Second, the ratio of the actual to the maximum arc of action of the stub-tooth is much less than in the standard.

This latter point is a very important one, as we thus eliminate contact at both ends of the line of action. When we realize that this is the portion of the action in which the greater part of the sliding takes place, with its inevitable wear, we see that it is a good thing to cut it out if possible. The point of the tooth which wears out the flank of its mate is removed with the adoption of the stub-tooth, and this reduces the friction while increasing the efficiency. A comparison of Figs. 6 and 7 shows that the action of the stub-tooth is as nearly a rolling one as it is possible to obtain. The action of the standard tooth at the base line is that of a stone-boat being dragged over the ground, while the action of the stub-tooth can be compared with the same stone-boat mounted on wheels

It is, of course, impossible to entirely eliminate the wear

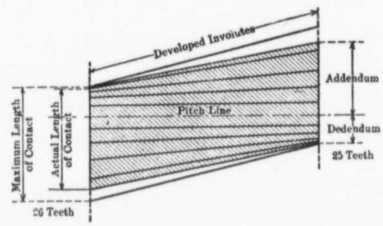


Fig. 6.—The Involutes of Fig. 4. Separated and Developed into Straight Lines with the Division Points Connected as shown. The Angularity of the Connecting Lines is a Measure of the Rubbing.

between the teeth of gears working under a load. But if the wear can be evenly distributed over the entire working face of the tooth, the correct form of tooth is retained indefinitely, and a worn-out gear should, aside from the excessive backlash, run as well as a new gear. And, if this wear can be evenly distributed, the durability of any gear will be increased many times.

We have so far discussed only the points of efficiency and durability, but there is another advantage of the stub-tooth over the standard form, and one which some might think entitled to first consideration, especially

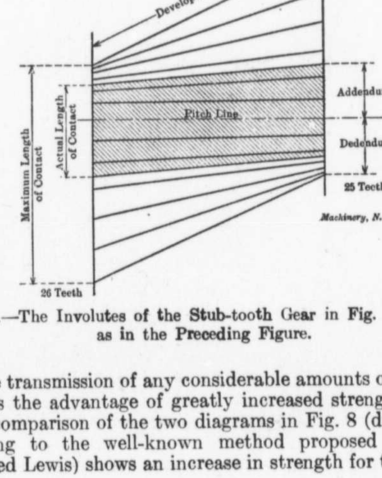


Fig. 7.—The Involutes of the Stub-tooth Gear in Fig. 5 treated as in the Preceding Figure.

in the transmission of any considerable amounts of power; this is the advantage of greatly increased strength.

A comparison of the two diagrams in Fig. 8 (drawn according to the well-known method proposed by Mr. Wilfred Lewis) shows an increase in strength for the stub-tooth form of 80 per cent. It will be noted by comparing different combinations of gears that the increase in strength is greatest for pinions, which are almost invariably weaker than the gears they run with.

To understand the importance of this consideration of strength, it may be mentioned that if comparisons are made between a 15-tooth 6-pitch 14½-degree gear and one with 20 teeth 8-10 pitch of the stub-tooth standard,

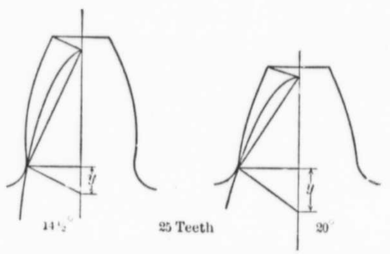


Fig. 8.—The Strength of a 14½ Degree Tooth and a Stub Tooth Compared by the Wilfred Lewis Method; the Strength is measured by Dimension *y*.

both having the same diameter, it can be shown that the stub-tooth, though shorter and of finer pitch, has 20 per cent. greater strength, and while the bearing surface per tooth is shorter, the total area of bearing surface is 6 per cent. greater.

Some of those who are not entirely familiar with this system of gear teeth have made the mistake of thinking that it consists simply of the shorter tooth than the standard form, while retaining the same pressure angle, and have, therefore opposed it on the ground that the arc of action, in the case of a small pinion, is not equal to the pitch arc, and that the action is therefore, not continuous, because one tooth is out of action before the next tooth takes up the load.

It should be thoroughly understood, and we wish to emphasize the fact as much as possible, that the increased angle of obliquity is an essential and vital part of the stub-tooth system, and that with this increased angle, the arc of action is as long as that of the 14½-degree tooth.

That this form of tooth is growing in favor is shown by the fact that fully one third of the cutters made by the advocates of this system are now of the stub tooth form.

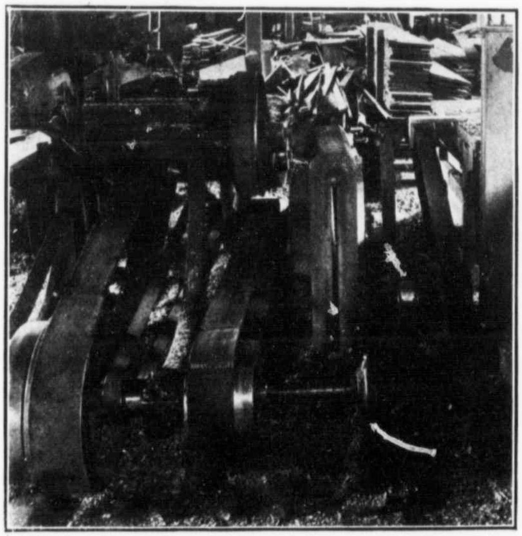
Electric Drive in Woodworking Plants

In many respects the conditions encountered in lumber mills present problems in power transmission that are not found in other industries. The inflammable nature of the material used, the size of the work handled and the severe power demands for starting and operating wood-working machinery of necessity require a motive power that is not only immune from fire risk, but one that will withstand heavy fluctuations in load and operate the various machines with as little obstruction to the handling of material as possible.

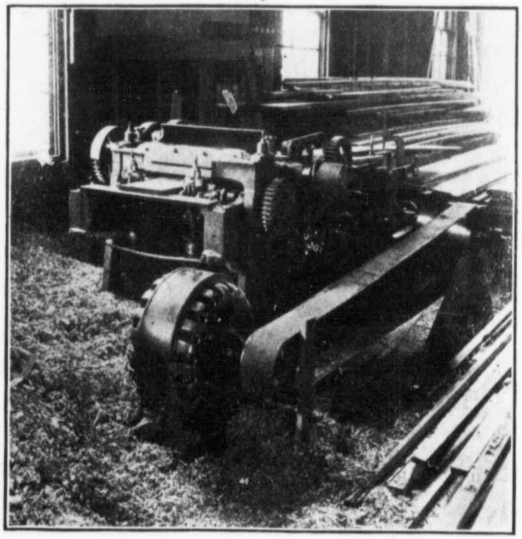
These conditions have only been partially fulfilled in the past by the use of overhead belting and shafting driven from a central source of power, which is transmitted through numerous countershafts to the final point of application. In such installations there is an excessive loss of power by overcoming friction, which is increased by the slipping of belts and the severe fluctuations of load. Belts and shafting also obstruct the free handling of material and add to the fire risk on account of the accumulation of dust and grease on pulleys and around bearings.

The foregoing conditions led to a demand for some method of operation that would in the main eliminate many of the objectionable features, and electric drive was the natural outcome. By its adoption the various floors and sections can be subdivided so that any machine or group of machines may be operated independently, producing a flexibility which is especially valuable in overtime work, when power requirements are small. Further, the use of electric motors to a large extent eliminates the use of overhead belting and shafting, which removes the objectionable features attending its use.

The accompanying illustrations show how one firm



Rip Saw Driven by 3 h.p. Induction Motor



Wood Planer Driven by 15 h.p. Induction Motor.

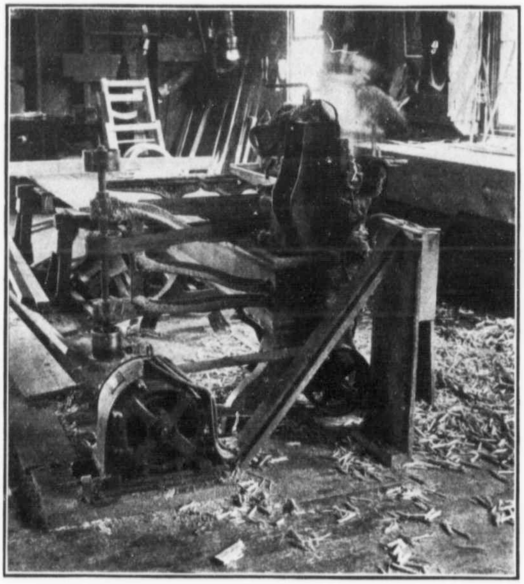
solved the drive problem in their wood-working plant. The motors are Westinghouse 2-phase induction motors operating on 60 cycle, 220 volt circuits. At the time the photographs were taken the mill was running night and day, necessitating a large accumulation of shavings and sawdust, in some instances nearly covering the motors. This furnishes a forcible illustration of the immunity from fire risk secured with induction motors.

The illustrations show well the methods of applying the motors to the machines, and the methods of conducting the wires to the motors, so that they are not in the way, yet safe.

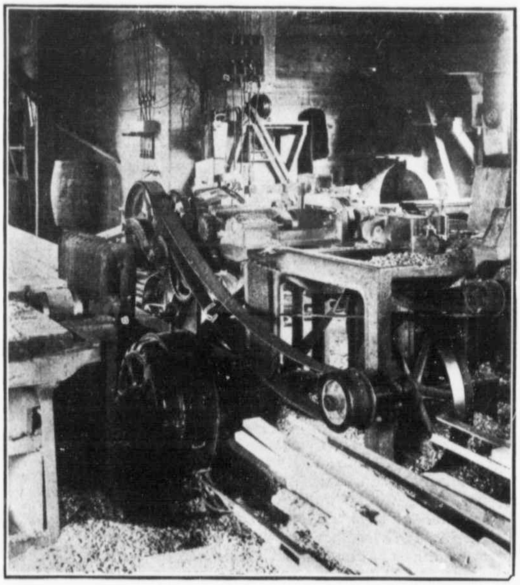
Saving Effected by Piecework System

Output of a Large Railway Shop Increased 52 Percent. and Earnings of Machinists 33 Percent. by Introduction of Piecework System. Report Prepared by the Master Mechanic and Published in Railway Age Gazette.

Remarkable evidence of what can be accomplished with a piece work system in a railroad repair shop is shown in a report prepared by the master mechanic of a large shop in the United States. The results to the road and to its machinists are summarized in this sentence: "If the 772 engines repaired in 1906 had received general repairs to tires, boxes, flues and machinery under the non-piece-work conditions existing in 1904 and 1905, the additional cost to the company would have been $163,470, or $211.75 per engine, whereas the average rate per hour for all machinists working piecework on the system in January, 1907, was 34.2 cents, as against 25.9 cents, average rate for day work during the same month—a gain to the individual workman of one-third."



Tennoning Machine Driven by 2 h.p. Induction Motor.



Moulding Machine Driven by 15 h.p. Induction Motor.

Interesting details of the operation of the system are furnished and some extracts from these are given below, taking up first the

Piecework Organization,

as it was introduced September 1, 1904:

(a) The mechanical superintendent, whose final approval of each price is necessary before it is put into effect.

(b) The assistant mechanical superintendent in charge of shop work, who approved all prices before they were submitted to the mechanical superintendent. This office has since been abolished.

(c) The shop specialist or piecework expert, who has general charge of making all schedules and putting into effect the piecework prices in all the different shops along the line and who reports directly to the mechanical superintendent.

(d) The master mechanic of the shop, who passes on all prices before they are submitted to the shop specialist.

(e) The general foreman of the shop, who personally signs all prices before they are submitted to the master mechanic.

(f) The assistant to the general foreman, who times all operations on which it is desired to make piecework prices, giving in detail the time necessary to perform the operation, which if performed on a machine would include:

Time to get machine ready.	Time to set up work.
Time to take rough cut.	Time to take finish cut.
Time to remove work from machine.	Time to set and grind tools.
Kind of casting.	Kind of tool steel used.
Kind and number of machine	Speed and feed.
Name of man performing work.	His day rate.
Number of pieces machined	Total cost per piece.
	The piecework price finally fixed for the work.

The workman must know in every instance that he is being timed for a piecework price, and he may also know, if he desires, the actual time that it took him to perform the operation and the piecework price that is going to be recommended for same. He has a perfect right to raise a question at any time when he is performing an operation on which it is intended to fix a piecework price.

(g) The piecework checkers who are employed in the different departments check up the amount of piecework performed by each man from day to day and make an accurate record of same on a blank card prepared for this purpose.

Comparative Efficiency.

The following statement shows shop output and cost under piecework as compared with day work. The figures include all costs in connection with the piecework organization, except the salary of the shop specialist and his office force, consisting at present of one man:

Statement showing Cost of Engines Receiving General Repairs for the Year—January to December, Inclusive—as Compared with Fiscal Year Ending June 30, 1905.

	July to June, 1904-1905				January to December, inclusive, 1906.			
	TBMF	Cost.	TBM	Cost.	TBMF	Cost.	TBM	Cost.
Shop A	36	$39,661	27	$19,749	79	$63,243	8	$4,305
Shop B	130	160,417	51	35,485	207	193,280	7	3,729
Shop C	75	68,776	19	9,386	161	116,286	1	457
Shop D	113	113,293	4	1,394	198	173,612	4	1,659
Shop E	37	30,438	2	733	72	50,544	0	......
Shop F	23	25,630	12	4,165	55	56,72[illegible]	12	7,008
Totals	414	$438,215	115	$71,912	772	$653,687	32	$17,248
Aver. cost*		$1,058.49		$625.32		$846.74		$539.00

* Per engine.

TBMF—engines receiving general repairs to tires, boxes, flues and machinery.

TBM—engines receiving all necessary repairs except flues.

Increase in shop output	52 per cent.
Saving per engines, TBMF repairs 1906 over 1904-5	$211.75
Saving per engine, TBM. repairs 1906 over 1904-5	86.32
On this basis had the 772 engines in 1906 received TBMF. repairs under same conditions as existed in 1904-5, they would each have cost $211.75 more, or a total of	$163,470 00
If the 32 TBM. engines had been overhauled under conditions as cited above, they would each have cost $86.32 more, or a total of	2,762 24
Therefore, total net saving on engines receiving general repairs in 1906 is	$166,232 24

The year 1906 shows an increase in output over 1904-5 of 275 engines receiving general repairs, and it is worthy of notice that but 32 engines received TBM repairs in 1906 as against 115 engines in 1904-5. In other words, in 1906 we gave practically all the engines that went through the back shop a thorough overhauling, thereby making them good for the maximum amount of service. The normal output of our locomotive shops is about 1,000 general repair engines per year, and on this basis the above figures would show a saving of over $200,000.

Explanation of Output Statement.

It is not claimed, of course, that piecework is responsible for all the saving shown above. The new machinery, consisting principally of lathes, planers, boring mills, shapers, slotting machines and such other machines as are used on the machine side of the back shop had a great deal to do with reducing the cost of output.

But in this connection it is fair to assume that the large increase of output in the new machinery was much of it due to the fact that we were making a systematic study of this work and that when piecework prices were once fixed the workmen were then required to perform the work in at least the fixed time in order to make their day rate, and when the earnings of the men were increased the increase in output was of course in exactly the same proportion.

As one among hundreds of cases illustrating this fact we might cite the operation of boring tires on a new 90-in. Niles boring mill in Shop D. The machine had been run for some months on a day work basis with an output averaging about five tires per day of 10 hr., day rate of workman 25 cents per hour, but the next day after a piecework price of 17 cents per tire was fixed the same workman bored 20 tires in 10 hr., thereby increasing his earnings 36 per cent., while the capacity of the machine was increased 300 per cent.

It should be remembered also that in places like F. E and A very few improvements have been made in the boiler shop, blacksmith shop, tank shop, paint shop, carpenter shop, fitting department, tin and pipe shop and erecting shop. The improvements at these points consist chiefly of the new machinery placed on the machine side of the shop. It is a fact, however, that the addition of pneumatic hammers, air hoists, special devices for handling certain classes of work in the departments enumerated above, some new furnaces in the blacksmith shops, with a new steam hammer here and there and an occasional small power hammer, has added very much to increasing the output, but it must not be forgotten that new tools alone will add little to the output of any shop unless they are worked up to their capacity.

The Gain to Employees.

Piecework benefits the employee by affording him an opportunity to increase his earnings, as illustrated in the following statement:

Gain Per Cent. Per Hour, by Piece Work Over Day Work for All Machinists Working Piece Work on the System, Month of January, 1907.

	Piece Work Total hours worked	Piece Work Total earnings.	Aver. rate per hour.	Average rate per hour, day work	Gain per hr. piece work, per ct.
Shop A	7,028	$2,167.57	$0.308	$0.249	23.7
Shop B	2,436	723.72	0.297	0.244	21.7
Shop C	1,430	569.48	0.390	0.277	40.7
Shop D	2,059	782.49	0.380	0.278	36.7
Shop E	1,916	692.82	0.361	0.273	31.9
Shop F	3,881	1,414.77	0.360	0.254	41.7
Shop G	15,888	4,977.11	0.313	0.244	28.2
Shop H	9,969	3,931.07	0.394	0.261	50.9
Totals	44,607	$15,259.03	0.342	0.259	33.0

We use the above rates, which apply to machinists only because we had the figures at hand. The per cent. of gain to workmen in other departments is substantially the same. The increase in shop output, as shown by a preceding table, is 52 per cent., while the increased earnings of the men amount to 33 per cent.

The month of January was selected because this usually is the coldest month in the year, and if any difficulties could arise which would retard the speed of the workmen and decrease their earning power they would show up at this time.

Attitude of the Men.

We do not believe that our workmen as individuals are opposed to piecework. It is only when we come in contact with the organizations to which some of our employees belong that we find an antagonistic feeling towards this method of shop organization. This statement is proved to be true from the fact that since September 1, 1904, when we first commenced to introduce piecework in all shops along the line we have had no trouble whatever with our blacksmiths, boilermakers, tin and pipe fitters, tank men, painters and carpenters.

None of the above classes of labor have been organized within the time specified except the blacksmiths. This department had the remains of an organization when we commenced the introduction of the present piecework system, but as the piecework went into effect the organization gradually went out of business.

Organization's Objections to Piecework.

The Machinists' Union objects to piecework because, as it claims, it puts one man against another, father against son and son against father in the scramble to increase their daily earnings. As a matter of fact, it simply places every man, regardless of relation, on his own merits. When the piecework price is once fairly established, it presents to all alike an equal opportunity to increase their daily earnings in direct proportion to the effort. Labor organizations always have maintained that a uniform day rate should prevail for each individual class of mechanics. Piecework, of course, is diametrically opposed to this proposition, because it fixes a fair price on the individual operation and then leaves it open for each workman to earn wages in proportion to his ability.

The foregoing tables clearly demonstrate this fact, because while the piecework prices are practically the same and in many respects the conditions are the same, a study of the figures will show that some shops earn much more than others on the same class of work. This is directly due to the intelligence, mechanical ability and efforts of the workmen. The principal effect, however, of a piecework organization is that it reduces to a minimum the number of mechanics required in the different departments of the shop, because the number of men must be reduced in direct proportion to the increase in efficiency of each individual mechanic.

It is a self-evident fact, however, that the more mechanics a shop employs in a certain line of work, the more money there is in it for the labor organizations, and it is therefore to their interest to maintain a stubborn fight against the further introduction of a fixed price for a given amount of work.

The Gear Hobbing Machine and Its Work*

Description of the Machine and Hob—Trouble in Making Hobs—Method of Avoiding Undercutting of Pinion by Hob—Advantages and Disadvantages of Hobbing Principle—Grinding Gear Teeth Advocated

By Thomas Humpage

In all gear cutting machines with the exception of the hobbing machine one tooth must be finished before another is begun. With the gear hobbing machine, however, the teeth are generated in circles, and they are all begun and finished practically simultaneously. The cutter or hob consists of a cylinder having wound around it a single right-hand thread. The thread has straight sides inclined to each other at an angle of 30 degrees. This thread is divided into teeth by spiral slots cut through it at right angles to the thread, and the tops, sides and bottoms of the teeth are backed off. The cutter is fed down through the blank, and the blank and cutter are geared together by change-wheels, so that they revolve at the correct ratio between the number of teeth to be cut and the thread of the hob. That is to say, for one revolution of the blank the hob must make as many revolutions as there are teeth to be cut. The action is the same as that of an endless rack which is moved along in gear with the wheel that is being cut. It is clear that the pitch line of the rack must move at exactly the same rate as the pitch line of the wheel. All the metal which interferes with the rack teeth is removed. Thus the teeth of the wheel are generated to the true involute form, and only one hob is required for all wheels of the same pitch.

In order to cut a correct spur-tooth, the axis of the hob must be tilted to the angle of spiral of the thread. Otherwise, as the cutter is fed downward, the spaces would be cut too wide. It is also necessary that one tooth should be set exactly on the centre line of the machine. This is the tooth which finishes the bottoms of all the teeth in the wheel. If no tooth in the hob is set exactly on the centre line, the wheel teeth will be cut slightly out of upright.

In the first gear hobbing machines, which were built, which was about 1893, the gear blank was carried on a horizontal mandrel, and the hobbing cutter was fed horizontally. By far the greater number are now, however, of the vertical type, and the cutter is fed vertically downwards.

Trouble in the Manufacture of Hobs.

The chief trouble of this system of generating gears lies in the manufacture of the hobs. The hob is made out of one solid piece of steel, which is bored and turned and the keyway cut. Then the thread is roughly milled out and also the spiral slots between the teeth. Next the teeth are relieved or backed off in a special lathe, and the lathe tool is carried in a rest which has a multiple motion. For every tooth, the tool is moved in and out by means of a cam, and at the same time it is fed forwards to follow the thread of the hob. During this process an allowance can be made for expansion or contraction anticipated in the hardening of the hob. After the teeth have been relieved, the hob goes into the tempering department. This is the most dreaded part of the process, for the work which has been done so carefully may be spoilt in the fire or in cooling even with the most experienced men. To complete the hob it is necessary to grind out the bore and over the tops of the teeth to true them up. Finally the cutting faces of the teeth are ground back sufficiently to remove the grinding marks on the tops of the teeth.

* Abstract of Paper read before The Institution of Mechanical Engineers, Bristol, Eng., July 1908.

Grinding Hobs After Hardening.

Even after this lengthy process it is sometimes found that a hob has gone slightly out of pitch in the hardening. Attempts have been made to correct this by grinding the sides of the hob teeth after hardening. For this purpose a small emery wheel was used in the backing-off machine, but, owing to the small diameter of the emery wheel which had to be employed to pass between the threads and the great speed required, this has not proved very successful.

The author has brought out a hobbing cutter with inserted blades or racks which are fitted into grooves cut in the body of the hob. These grooves are not cut radially, for in a cross section of the hob the centre lines of the grooves are tangential to a small circle concentric with the periphery of the body. The thread is roughly cut and then the blades are taken out and tempered, and the parts that fit in the body are ground. They are then replaced in the body and the thread is ground up all over, so that any error due to tempering is corrected. The blades are again taken out of the body and turned end for end in the grooves, being replaced so as to keep the continuity of the thread. Owing to the grooves being tangential, this will tilt the blades and so give the necessary clearance or backing off to the teeth. The blades are rigidly held in the grooves of the body by long keys. Several sets of blades of different pitches either diametral or circular can be used in the same body, and if a tooth gets broken, it only means that one blade is spoilt and this can easily be replaced. It is thought that this method of construction will lend itself particlarly to hobs of large pitch, as at present the large solid hobs are very expensive. At the time of writing only two of these hobs have been made, and it is still too early to say how far they have an advantage over solid hobs. The results obtained are, however, sufficiently good to encourage further trials.

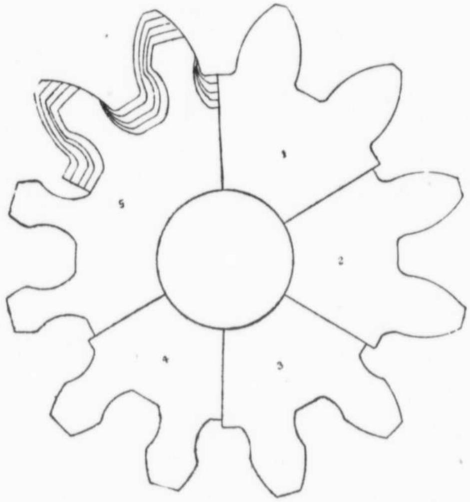


Fig. 1.—Portions of five 12-tooth Pinions on blanks sized for 11 teeth up to 13 teeth.

Undercutting of Pinions.

One point sometimes urged against the hobbing principle is that, as all the wheels are generated by rolling into a rack, the flanks of pinions must necessarily be undercut. The teeth of pinions could be made stronger by increasing the angle of the sides of the rack teeth, but this has the disadvantage of increasing the angle of obliquity and so throwing a greater outward thrust on the bearings. Nevertheless the evil effects of this increased angle of obliquity are thought by many to be exaggerated, and Wilfred Lewis recommends the use of involute teeth having an angle of obliquity of 22½ degrees.

The author is, however, in favor of retaining the present form of hob having sides inclined to each other at an angle of 30 degrees. In the case of wheels of less than 30 teeth he recommends that the blank should be turned to a rather larger diameter than the correct diameter for the number of teeth required. The cutter is set to the full depth of the tooth just as if the blank were the correct size. The base circle from which the involutes are unwound, is not altered by altering the size of the blank, but if the blank is over size we shall get teeth very strong in the roots with short flanks and long addenda. The centres of the wheel and pinions are, however, slightly fallen apart and the angle of obliquity is increased. Thus with the same hob, almost any desired strength can be given to the teeth of a pinion, and all the pinions will gear perfectly with the wheel cut on a correctly sized blank.

It must be understood that there are limits to the amount of error which can be given to the diameter of the blank, for if the error is too great the teeth will be cut off altogether. As an illustration, take a 24-tooth wheel gearing into a 12-tooth pinion of 2 diametral pitch. The correct centres for these are 9 inches apart and the angle of obliquity is 15 degrees. Now cut twelve teeth on a blank intended for thirteen teeth. The centres will now be 9¼ inches apart and the angle of obliquity is 21 degrees. This is rather an extreme case, but a very strong form of tooth can be obtained with a blank sized for 12½ teeth. The longer involute of the pinion teeth causes these wheels to run very smoothly together. Fig. 1 illustrates a series of 12 tooth pinions cut on blanks sized for 11 teeth up to 13 teeth. The third in the series is cut from a blank of the correct diameter.

Disadvantages of Disc Milling Cutters.

The introduction of automatic gear-cutting machines cheapened cut wheels to such an extent that they soon came into favor for all high-class work. As has been explained, unless the number of teeth to be cut in the blank correspond to the lowest number stamped on the cutter, the teeth will not be correctly shaped. Moreover, as the cutter gets blunt, the centres of the cutter and work mandrel are forced apart, and the bottoms of the teeth describe a slight scroll. Also as one tooth is finished at a time, the strains of the metal being released locally and the heat generated cause the wheel to be distorted from a true circle.

Disadvantages Overcome by Hobbing Machines.

The extraordinary demands of modern high speed machinery rendered it necessary to find something still better. In all gear generating machines the teeth, no matter what number there are in the wheel, are developed to the true involute form so long as the tool keeps sharp, and in the gear-hobbing machine which generates the teeth simultaneously nearly all the disadvantages of the disc milling cutter are overcome. Moreover, while the milling cutter has about twelve cutting teeth in the case of a hob the cutting is done by about thirty teeth. In practice it is found that with a good stiff hobbing machine, from two to three times as much metal can be removed per hour as with a machine using a disc milling cutter of the same pitch. With the improvements in hobs suggested by the author the troubles caused by the hob going out of pitch in hardening may be eliminated, and wheels cut with such a hob as this probably comes as near to perfection as can be obtained on any wheel cutting machines.

Disadvantages of Hobbing Principle.

Nevertheless, there are certain disadvantages of the hobbing principle. In the first place, owing to the spiral twist of the blades a section of the blade normal to the axis of the blank is not a perfectly true rack and in consequence the points of the teeth are very slightly too thick. Secondly, while the blank rotates continuously the cutting is intermittent, and after one tooth of the hob has taken a cut a small piece of metal escapes before the next tooth comes into action. If a hobbed wheel is examined it will be seen that the sides of the teeth show a series of small flats. By increasing the number of teeth in the hob, the flats are made smaller, and if there were an infinite number of teeth in the hob it would generate a smooth curve.

Grinding Teeth of Gears Advocated.

Of recent years there has been a great tendency towards grinding the teeth of the change gears for motor cars. At first the wheels were run in with emery and grease. This was found to take off as much metal from the parts that were correct as from those that were incorrect, and while some wheels ran much better after this treatment others were decidedly worse. However, something in the way of grinding has long been requisite, and about two years ago a machine was made by Messrs. Reinecker on the same principle as the machine used in the Fellows' gear-shaper system, for grinding the involute teeth of the cutters. The machine carries an emery wheel bevelled on each side to the shape of a rack-tooth with sides inclined at an angle of 29°. This wheel revolves at about 2,000 revolutions per minute. At the same time it moves bodily up and down through the space of tooth whilst the blank rolls under the restraint of two steel tapes, as in the Bilgram bevel gear planer. A few thousandths of an inch are left on the teeth for grinding, and the teeth are generated to the true involute form. One tooth is finished at a time and then the blank automatically moves forward to the next space. The amount of wear on the emery wheel is said to be small and the wheel can be trued up in its place. Gears ground by these machines show a great improvement over those which have not been ground. Nevertheless, owing to the gradual wear of the emery wheel there is a difference between the first and the last tooth finished in this way.

The author has devised a machine for grinding the involute teeth of gear wheels, which works on the principle of the hobbing machine. The teeth are generated simultaneously so that distortion due to the heating of the blank is eliminated, and, as the downward feed of the abrasive wheel is very rapid, the wear is practically negligible. For purposes of experiment an ordinary 22-inch gear hobbing machine made by the author's firm was chosen. In place of the hob was substituted a cylinder of corundum, Grit 50 and Grade M, 10 inches in diameter and 7 inches long, having a continuous thread of 7 pitch cut upon it. The sides of the thread are straight and inclined at an angle of 30°, which is the exact shape of the thread of the hobbing cutter. The thickness of the thread on the pitch line is however made rather less than the correct thickness for a 7 pitch tooth. This corundum worm practically amounts to a hobbing cutter having an infinite number of teeth. The thread was roughed out in a lathe with Huntingdon dressers in seven hours, and finished by grinding on a Greenfield universal tool grinder with a carborundum wheel in 21 hours. It is thought it may be possible to save much time in the manufacture by moulding the thread roughly into shape. In place of driving the corundum worm through the gear box and vertical shaft of the machine, a pulley is fixed directly on the spindle of the corundum worm itself. By this means the effects of the torsion of the shafts are got rid of. The corundum worm is revolved at a speed of 2,400 revolutions per minute, and it is geared up to the work table through change wheels as in a hobbing machine. A rapid downward feed is provided for, and the driving belt is led horizontally to the driving pulley to permit this.

The author has ground up several cast-iron wheels of 7 pitch on the experimental machine. The wheels are first hobbed, but the hob is not put into the full depth, so that a few thousandths of an inch are left on the sides of the teeth for grinding off. Before the wheels are ground the bottoms of the teeth are cut to the full depth with a special formed cutter. It would of course be far better to hob the teeth in one operation with a hob having teeth that are slightly too thin. The wheel is then put on the work mandler and the corundum worm moved down by hand until its centre is level with the top of the wheel to be ground. The corundum worm is then adjusted endwise by means of a screw turned by a worm and worm wheel by which a very fine cut can be put on, so that one side of the thread touches one side of the teeth in the wheel. Owing to the thread on the corundum worm being thin, as has been explained, the other side of the thread is not in contact with the teeth. The corundum worm is then allowed to feed down automatically, grinding up one side of all the teeth and generating them truly. The machine is then stopped, the corundum worm raised by hand, and a finishing cut taken. The other sides of the teeth are ground and finished in the same way. A stream of lubricant consisting of water, soda and oil is kept running on the wheel to prevent glazing.

In the best results obtained so far a cast-iron wheel of 70 teeth 7 pitch and 1¼ inches face was completely ground in eight minutes.

The wear on the corundum worm appears to be very slight, about 1-1000 inch in the worst part, but in the finished machine it is proposed to provide a carborundum wheel for touching up the corundum worm after each cut. The author has found that when he grinds 1-1000 inch off the corundum worm to true it up, the carborundum wheel which grinds it shows only 1-4000 inch of wear. The author has also found that the corundum worm is only worn on three threads for about one-third of their circumference. In the finished machine an arrangement will be provided for traversing the wheel that is being ground across the face of the corundum worm, like a wheel meshing with a rack, thereby wearing the corundum worm evenly. To compensate for this traversing motion, a differential gear will have to be provided like that of of the Reinecker machine when cutting worm wheels with a taper hob. The results obtained with the experimental machine have been so good that with these improvements there is every prospect of the success of a future machine

All Wheels Should Be Ground.

The author's idea is that not case-hardened wheels only should be ground on this machine, but every kind of metal should be ground in the soft state, no matter for what purpose the wheels are required. The wheels would be roughed out rapidly in the gear hobbing machine with no attempt at finish, and then sent to the grinding machine to be finished, just as all lathe work that is required to be both accurate and cheaply produced, is first roughed out in the lathe and then finished on the universal grinder.

System to Eliminate Waste in the Foundry*

A Practical Cost System Worked-Up in the Shops During a Period of Eight Years, to Determine Costs in Such a Way as to Eliminate all Waste from Foundry Operations. System Calls for a Minimum Amount of Bookkeeping and Clerical Work

By Harrington Emerson †

If all foundry operations were carried on that no waste would occur, so that costs could not be lowered, it would be of little importance to determine them. If, however, an elaborate system merely determines that costs are high, without also showing why and when they are high, and without indicating how, when and where they can be reduced, it is also of small value. The system described gives, before the work is begun, what its cost is going to be, gives the cost of each separate and single operation, shows exactly when and where failures occur and applies to every item, man, foreman or department, as well as to materials, supplies and methods. This is done with a minimum amount of bookkeeping and clerical labor. The system was not elaborated in the office by a skilled accountant, but was worked out in shops in close touch with actual conditions during a period of eight years, first in a plant employing 100 men, next in one employing 400 men, then in a series of plants under one management employing over 5,000 men, and finally it is now gradually being worked up in plants employing 25,000 men, one of which is in Pittsburg.

Failure of Industrial Enterprises

Ninety-five per cent. of American industrial enterprises are put out of business before the end of the second generation. A good system should not only tell to-day what next month's costs will be, but also enable business enterprises to escape the fate of the 95 per cent. who fall by the wayside. The cost system recommended is applicable to any kind of business, any class of men, in any part of the world. The system was originated and developed in foundry work, but is equally applicable to jobbing, manufacturing or special work, which does not, however, mean that various local difficulties and problems will not require much care for their solution.

Standard of Excellence.

The method consists of standards of excellence for every operation and every item of expense, and the registering continuously for every item the difference between what is actually attained and the ideal standard set up. The standard cost of each item, with the added per cent. of average inefficiency shown by the particular shop, is always the actual cost, and as standard costs are known in advance, as it is also the average inefficiency of the previous period, whether week or month, it is always possible, before work is begun, to determine its actual cost. The method of predetermining costs was suggested and adapted from the universal practice of life insurance companies, who know to a day the average life probability of selected risks, and they do not care if the person insured lives longer or less than the average. Scientific rates for life insurance were not possible until life standards had been determined, and similarly in shop practice, efficiency determinations are not possible until standards have been carefully worked out.

Determination of Standards.

This determination of standards is at once the most important and difficult part of the whole work, but it is not an impossibility nor as difficult as it seems, and it has, on a variety of work, been done on a very large scale.

Standards, to be of value, must be established with the greatest care by the aid of skilled observers, records, competent estimates, allowances, etc. However imperfect the determinations may be at first, the persistent use of records will soon bring up the standards to a high degree of accuracy. The man who by practice can become so expert as to tell by the touch whether the joker is in a pack of cards or a card is missing can, if it is his business from day to day, gage closely the standard time required for any new work. Men who imagine that this is impossible because they have never done it, can in a short time under guidance become very expert, and it is one of the essentials of the method that the standards shall be self-correcting, so that however wide of the mark they are at first, they will soon approximate closely to what they should be.

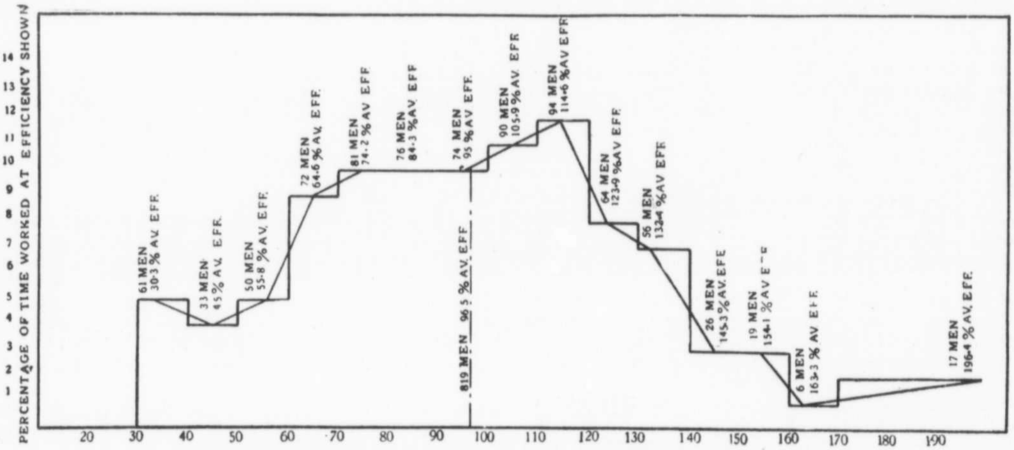


Fig. 1—Efficency Report, Nov., 1907, 819 Men; Average Efficiency, 96.5 Per Cent.

Results of the Efficiency System.

As an example of results attained by the use of the efficiency system, the following records are quoted from a large shop in which the method was installed, each record being for a separate month:

	No. of men	Standard hours.	Actual hours.	Efficiency percent.
	21	2,011.2	3,613.9	55.6
	50	4,350.2	7,418.8	58.6
	77	7,649.6	12,748.3	60.0
Mar. 1907..	251	27,051.8	41,463.0	89.3
Aug. 1907.	656	122,736.4	126,534.4	97.0
Sept. 1907	731	120,357.5	120,478.0	99.9
Oct. 1907 .	771	148,841.0	146,434.0	101.7
Nov. 1907.	819	155,276.5	160,701.0	96.5

* From an Address before the Pittsburg Foundrymens' Association.

† Consulting Engineer on Shop Practice to the Santa Fe Railroad and American Locomotive Co.

The gain to the shop is easily figured between the first record and the last, assuming the first to represent the average efficiency of the whole shop of 819 men.

	(1)	(2)
Average efficiency........	55.6*	96.5*
Number of men..........	819	819
Average pay per hour.....	$ 0.25	$ 0.30
Average surcharge per hour including interest and depreciation............	$ 0.25	$ 0.25
Cost per hour per man....	$ 0.50	$ 0.55
Cost of product, labor and shop expense, per day..	$409.50	$450.45
Increase in cost...........		$ 40.95
Increase in output........		73.5*
Assumed profit...........	$ 40.95	$231.08
Selling value of product..	$450.45	$781.53

*Per cent.

Increase in Wages.

As one of many means employed and by no means the most important to secure greater efficiency and elimination of waste, the men averaged 20 per cent. more wages. Each man and foreman is, however, paid on an efficiency basis. Each is guaranteed a regular day rate, but if his efficiency rises above 67 per cent the pay is increased on a sliding scale according to a standard table which covers all efficiencies from 67 per cent. upward at intervals of 1-10 of 1 per cent., as shown below:

Efficiency.	Increase in Wages.
67 per cent.	0.00 per cent.
70 " "	0.22 " "
75 " "	1.31 " "
80 " "	3.27 " "
90 " "	9.91 " "
100 " "	20.00 " "
110 " "	30.00 " "

Above 100 per cent. efficiency the worker is paid at his standard rate for all the time he saves.

The 819 men have by no means reached the highest efficiency, as is shown by the table of classification below:

Per cent.	Workmen	Average Efficiency, per cent.
30—40	61	30.3
40—50	33	45.0
50—60	50	55.8
60—70	72	64.6
70—80	81	74.2
	—.97	
80—90	76	84.3
90—100	74	95.0
100—110	90	105.9
110—120	94	114.6
120—130	64	123.9
130—140	56	132.4
140—150	26	145.3
150—160	19	154.1
160—170	6	163.3
170 and upward	17	196.4
	—522	
	819	

The high men are considered the most valuable asset in the shop, and the highest averages are attained as a rule by the blacksmiths, where the willingness to stand all day against very hot iron and pound with might and main, deserves high reward. More loss from efficiency occurs in blacksmith shops than in any other department. The superintendent of a shop reported a few months ago that in the blacksmith shop the net result of the method had been a reduction in the total pay roll of $500 per month, but the output increased fully 100 per cent. It is evident that if the 297 men whose efficiencies are below 80 per cent. were carefully toned up, dropping the few who could not be improved, the average of the whole shop would rise. The decline in efficiency in November compared to October was largely due to the accession of new and untried men not accustomed to the system, and, as the records of of some of them show their results were of low efficiency. Their record is given herewith:

Standard hours.	Actual hours.	Efficiency, per cent.
4.3	99	4.3
5.3	89	5.0
2.4	39	6.0
48.7	180	26.3

Were it not for the efficiency check, these men might continue at work indefinitely in spite of the fact that however good they might be at something else they are misfits where they are.

Increase in Profits.

It was shown that the profits to the employer from shop labor and expense were very much increased. The worker under the system fares as well as the employer. Assuming that a worker receiving $90 a month spends for living expenses $87. His net profit is $3 a month, a margin that leaves him discontented and hostile, but his employer, knowing that the efficiency of the worker is probably not more than 40 per cent., is equally hostile and longs for an opportunity to cut the worker's wages to $75 a month. Under the efficiency plan, if the worker takes as little as 20 per cent gain on his wages, he receives $108 a month, his net gain above living expenses becomes $18 a month, or six times as much as before the efficiency plan was adopted. The efficiency report of a large industrial plant is graphically shown in Fig. 1 and the increase in output in Fig. 2.

Inefficiency of Labor.

A railroad president recently complained of the inefficiency of labor, giving it as one of the causes of the heavy increase in operating expense of railroads. He said that it was impossible to secure efficiency because the only available discipline was to discharge the man, and the man cared nothing for this punishment because he could cross the street and secure another job equally good. The railroad president was fundamentally mistaken as to the impossibility of securing efficiency, or as to their being no means of

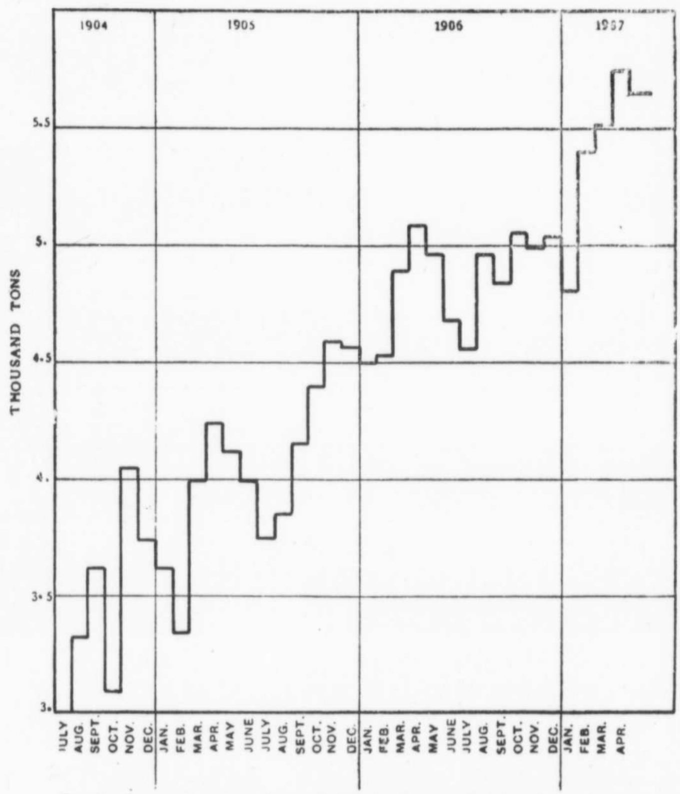


Fig. 2—Output Per Day From All Plants Showing Increase From June, 1904, to April, 1907.

discipline at his disposal. Under the efficiency plan, it is impossible for the worker to cross the street and secure another job just as good. The employer across the street unable to measure the efficiency of the applicant, can only afford to offer him $90 a month and as a consequence, the worker who in the efficiency shop is receiving $108

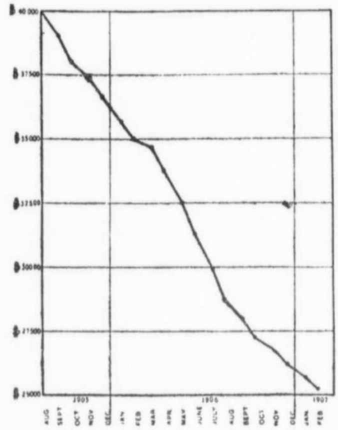


Fig. 3—Decline in the Total Disbursements for Shop Machinery and Tools

with a possibility of making $180, cannot be pried from his job with a pinch bar. Furthermore, the employer is unwilling to lose the valuable man of high efficiencies, so that the usual hostility and ill-will are replaced by cordial relations of mutual esteem and forbearance. Discipline is maintained because the penalty to the worker is very great if he has to pass from a shop where his high efficiency is rewarded to one where he is graded and paid on the same basis as men who are not doing more than one-fourth as much.

EFFICIENCY STANDARD APPLIED TO OTHER ITEMS.

Let it not be supposed that efficiency applies only to the worker. It is equally applicable to material, to supplies, to methods, to tools and to machinery. By the adoption of this standard the disbursements for machinery in one large plant were reduced as shown in Fig. 3. When, as has been recently shown by English tests, certain selected files will make six times as many strokes before wearing out as other files, and at each stroke remove three or four times as much metal, it is evident that there are other inefficiencies than those of labor. In a foundry, for example, the cost of iron in castings may be $1.50 per hundred pounds. Direct labor costs $0.50, surcharges on labor $0.55, total $2.55. It is evident that inefficiencies in the cost of iron (for instance 3 per cent. in short weight of pig received) and inefficiency in surcharges on direct labor, may prove more serious than labor inefficiency. Also even if labor contends for a fixed rate and limited output and is willing to give an efficiency of only 60 per cent or less, a great difference will occur in the quality of the output, and this would place one man in a 20 per cent. class, another in a 60 per cent. class, up to the permitted standard.

STANDARD APPLIED TO FOUNDRY WORK.

The efficiency method has been applied to foundry work with success. To determine foundry cost, expenses pertaining to the office are separated from those of the foundry proper. All foundry items of expense are sub-divided into

(1) Those that make up the cost of iron.
(2) Those that cover direct labor.
(3) Those that are a surcharge on labor.

In a grouping of accounts worked out for a very large foundry, the main items appear as follows:

(1) Cost of iron in cupola.
(2) Surcharges on iron in ladle.
(3) Sum of 1 and 2—total cost of iron in ladle.

TOTAL COST OF GOOD CASTINGS ....

NET WEIGHT OF GOOD CASTINGS ....

AVERAGE COST PER POUND .... 2.24 ....

STANDARD COSTS				INEFFICIENCY	ACTUAL
CLASS	COST PER LB CENTS	NO OF LBS	TOTAL STANDARD COST	PER CENT	COST
A	1 75	1000000	17500		
B	2 00	1800000	36000		
C	2 10	800000	16800		
D	2 20	400000	8800		
E	4 00	200000	8000		
		4200000	87100	92.5	94080

Fig. 4—Diagram Illustrating Table of Costs.

(4) Floor surcharges on iron in castings.
(5) Total cost of iron in net good castings.
(6) Applied labor.
(7) Surcharge on applied labor.
(8) Sum of 5, 6, and 7—total cost of net good castings per pound. This is, however, of very little value until classes are arranged and every separate casting assigned to its proper class; one in class $1.75, another in class $2.00, a third in class $2.25, and so on through 10 or 12 classes. A diagram showing a table of standard foundry costs is shown in Fig. 4.

By the adoption of this system the cost of power is standardized; cost of rent is standardized; depreciation is standardized; cost of iron in net good castings is standardized; surcharges on labor are standardized; applied labor per piece is standardized, and someone is made responsible, for every standard item and is expected to work on it to bring it down, so that while the foundry moves along smoothly on a system of standard costs, everybody from the manager down is desperately busy bettering the standards and reducing the inefficiencies.

Cost determinations become a matter of simple entries on the records which can be made by any clerk, but reductions in standard cost, and elimination of inefficiencies become the business of every one from the president down to the cleaner up, and inefficiencies are specifically and automatically revealed and brought home to some one who is responsible.

Manufacturers' Catalogues

D.C. MOTORS—TYPES S. AND S.A.—Circular No. 1,068 of the Canadian Westinghouse Co., Hamilton, Ont., descriptive of their D.C. motors, types S. and S.A., constant, varying and adjustable speed. This is a very complete circular on these types of motors. It contains 47 pages and is profusely illustrated. There is a section containing data on application of motors to machine tools, pumps, etc.

BLUE BOOK ON GEARING.—Catalogue and price list of the Horsburgh & Scott Co., Cleveland, O., on their rawhide gears, cut metal gears, planed bevel gears, spiral gears, racks, worms and worm gears. The catalogue contains a short article on the manufacture of rawhide gears.

ALUNDUM.—A neat little booklet gotten out by the Norton Co., Worcester, Mass., giving an illustrated account of the manufacture and use of alundum, the trade name of the material from which their grinding wheels are made.

TESTS OF "TRIMO" WRENCHES.—The Trimont Mfg. Co., Roxbury, Mass., have recently published a booklet containing a report of a series of tests made on several sizes of the "Trimo" monkey wrench, and also the corresponding sizes of several other makes. These tests showed the "Trimo" wrenches to be well worth investigating. Anyone interested in monkey wrenches should see the results of this test.

ENGINEERS AT NIAGARA FALLS.

The fall course of meetings of the Toronto section of the American Institute of Electrical Engineers was inaugurated last Saturday, when the members held an excursion to Niagara Falls. In the morning visits were paid to the generating stations of the Electrical Development Co., and to the transformer station of the same company, and also to that of the Canadian Niagara Power Co. In the afternoon the generating stations of the Canadian Niagara Co., and of the Ontario Power Co., were inspected. During the day the retiring secretary, Mr. W. G. Chase, was presented with a club bag. Mr. Chase will shortly leave for Winnipeg.

Modern Style of Miller

The following description of the Milwaukee Milling Machine gives an idea of up-to-date milling machine practice. There are three styles of these millers, the universal, the plain and the manufacturers' miller. The general features of these machines are the same, the difference being in the details.

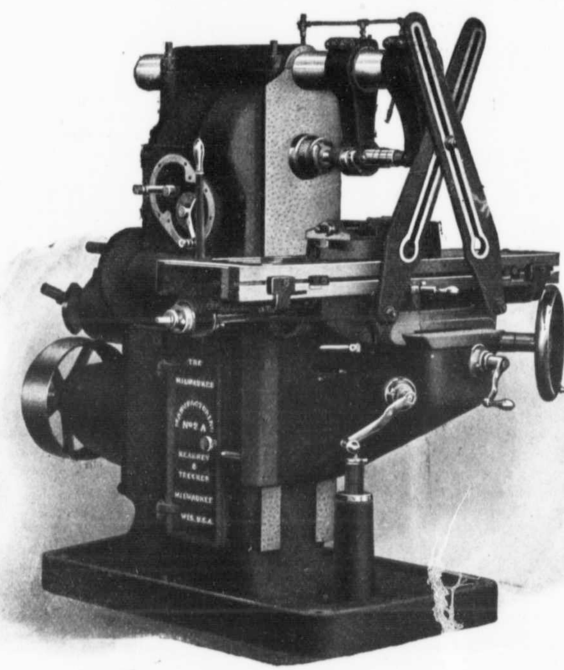


Fig. 1.—The Milwaukee Manufacturing Miller.

The first thing to consider in the design of a miller is the frame. The frame on these machines is cast in one piece and is entirely closed, providing great stiffness to withstand the strain of the cut. The knee is a box section, closed on both the top and bottom. The fact that the knee is cast without hole through the top is an important fact as this prevents all distortion due to clamping the saddle or from strains set up by a heavy cut. Large bearing surfaces are provided for the saddle and swivel carriage and the table.

The drive is through a single pulley which is belted direct to line shaft or the electric motor. The chief advantage of constant speed drive is that greater power can be delivered to the machine.

Maximum output demands that the cutters be given the correct surface speed, and in order that the operator will always use the correct speed it must be easily obtainable and the plate showing these speeds must be simple enough to be read at a glance. Eighteen spindle speeds are provided in geometrical progression. This all geared speed change makes the application of constant speed motor drive a simple matter.

Comparatively slow speed and coarse feed will, in most cases, give better results both in the life of the cutters and the amount of material removed. Coarse feeds are best obtainable when the feed is driven from a constant speed shaft, rather than from the spindle. In these machines the feed is driven from a constant feed shaft running about 100 R.P.M., the shaft lying midway between the highest and lowest spindle speeds. Feed changes are obtained through the gear box bolted to the back of the machine. The power is transmitted to the knee through a universal joint shaft. Feed levers are conveniently located and arranged so that no mistakes can be made.

Automatic flooded lubrication is arranged for all gears and bearings in the main frame of the machine including the pulley bracket and feed box. The oil pump is simple spur gear construction. This is an exclusive feature of these machines.

These machines are provided with cutter lubrication system. Fifty per cent. greater output can be obtained by flooding the cutters with oil, and also the amount of sharpening necessary is very much reduced, and the life of the cutter increased.

The universal machines are provided with universal spiral dividing centre. A feature of these centres is the largeness of the worm-wheel, being twice as large as in ordinary practice, thus tending to reduce the error by one half, other things being equal. The index plunger is directly connected with the worm shaft.

The horizontal machines are provided with vertical spindle attachments.

Other attachments for the different machines are the rack cutter spindle and vice for cross cutting on long work; the rotary table, for the universal or plain machine; plain centres for rapid manufacturing work on the plain or universal machines; universal centres for use on the plain and manufacturing millers; the universal chuck and the vice.

These machines are made by Kearney & Trecker Co., Milwaukee, and sold in Canada by the A. R. Williams Machinery Co., Toronto.

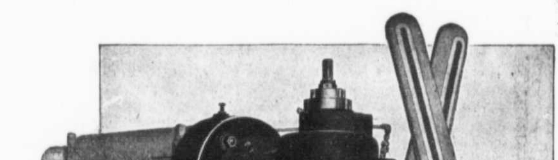


Fig. 2.—Vertical Spindle Attachment.

TRADE NOTES.

Fetherstonhaugh & Co., patent solicitors, have changed their Toronto offices from the Bank of Commerce Building to the new Royal Bank Building, 10 King St. East.

The Canada Furniture Manufacturers, Limited, are considering moving their head offices from Toronto to Woodstock.

Compensation for Accidents to Workmen

By Wm. Hard.

A curious thing happened in Germany in the year 1900. In that year the German Chemical Industry Association offered a prize, in free public competition, for the following interesting object:

The Safest Soap-Press.

It wasn't for the soap-press that would make the most soap. It was for the soap-press that would save the most limbs and the most lives. Real money was offered to inventors for designing a thing of that kind.

It was as if Joseph Leiter, of Chicago, instead of allowing all the safety regulations of the state of Illinois to be violated in his big coal-mine down at Ziegler in Franklin County, thereby producing an explosion of gases that killed some fifty of his workmen on the third day of April, 1905, should have obeyed all those regulations to the letter and should then have gone further and inserted in a Chicago newspaper the following advertisement:

Wanted—A Perfect System of Driving gases out of mines. The state regulations are not enough for me. I want something better. $2,500. J. Leiter.

Herr L. Hertel, of Bayreuth, royal inspector of factories, won the prize for the safest soap-press. Hundreds of Germans have won similar prizes in similar contests. The Elbe Navigation Association, for instance, has given a prize for the safest ship-winch. The union of all the German Trade Associations has given a prize for the best protective arrangement to go over the eyes of workmen who are exposed to flying chips and sparks. The German railways have given all kinds of prizes for all kinds of safety-devices.

Mr. Edgar T. Davies, factory-inspector of Illinois (and one of the most practical and shortest-haired reformers in the country) says that in the year 1906 in the factories of Illinois a hundred men were killed, or crippled for life, by one little shop institution called the set-screw. The set-screw stands up from the surface of rapidly revolving shafts, and as it turns, catches dangerously at hands and clothes. It is no unchangeable provision of nature. For thirty-five cents, says Mr. Davies, this danger device could be recast into a safety device. For thirty-five cents the projecting top of the set-screw could be sunk flush with the rest of the whirling surface of the shaft, and then no sleeve could be entangled by it, no human body could be swung and thrown by it, no woman could be widowed by it.

What remote consequence of tears and lonely years may lie in a quarter and a dime! And what satire! More than once it must have happened that a widow has had her rent paid by a charity society to which yellow-backed bills are contributed by a manufacturer who could have kept her from being a widow by the expenditure of a quarter and a dime!

But why is it that German business men will offer prize-money for safety-devices, while American business men so generally fail to adopt them even when they have already been invented, even when they are well known and cheap, even when they are required by law?

The difference is not in personal character. If it were, it would be the Americans that would be buying the safety-devices. The individual American is the kindliest man living. He can't even keep his children out of the jam-closet (though he knows it's bad in the long run for their teeth), because the immediate sight of unhappiness makes him uncomfortable. He is soft-hearted to a fault with his family and his friends. Personally, individually, the American is charitable and humane beyond the charity and humanity of the inhabitants of any other country in the world. The fact that the particular country he owns and operates is the world's industrial slaughter-house is a paradox in international character.

And the heart of this paradox is in the law on the subject of Compensation for Accidents to Workmen.

The Germans have a law that makes them better than they naturally would be. We have a law that conceals the real, hideous nature and the real, appalling cost of industrial accidents from our eyes, and makes us blindly and artificially selfish and cruel and brutal.

Germany has a system of compulsory insurance to which both employers and employees contribute. Every injured German workman, no matter how he was injured, whether by his own fault, by the fault of his employer, or by nobody's fault, draws regular weekly compensation either from the sickness-insurance fund or from the accident-insurance fund until he is able to go back to work again.

Whereupon the following profound reflection occurs to the Germans:

"The more accidents there are, the more injured workmen we shall have to support and the larger will be the premiums that we shall have to pay into our insurance funds. But the fewer accidents there are, the fewer injured workmen we shall have to support and the smaller our insurance premiums will be."

This thrifty consideration leads the Germans to address their workmen as follows:

"Here are safety-devices. We implore you to use them. We shall esteem it a favor if you will try not to get hurt. But if an accident does happen and you do get hurt, here are the best doctors and the best hospitals in the empire. Use them and get well as soon as you can. We shan't let you crawl away to your home and get good and sick, and good and poor, and then send a claim-agent to the side of your bed and offer you a month's rent just about the time the landlord is coming round, and get you to sign your name to a release. We aren't interested in seeing your signature on a piece of paper. We are interested in restoring you to health. The sooner you are well, the sooner you can go back to work. And the sooner you can go back to work, the sooner we can stop paying you your weekly indemnity."

In pursuance of this wise thought, the employers and the employees of Germany, united in their insurance associations for the common welfare of both wage-earners and dividend-drawers, have spent $120,000,000 in the past twenty years on workmen's dwellings, workmen's baths, workmen's hospitals, workmen's sanatoriums, and workmen's convalescent homes. It was good business. It helped to decrease the insurance premiums. It was good Christianity. It helped to make sick people well.

A good law is a law that gets men and women into the habit of doing the helpful thing, the noble thing, the right thing. Nine tenths of every one of us is habit. The German Compulsory Insurance Law is a good law, not only because it hands out coin and medical supplies at convenient times to injured workmen, but because it sets the face of the whole German nation habitually toward preventing the crippling and mangling of human beings, toward healing the wounds of those who, in spite of all precautions, have been overtaken by the bloody misfortunes of peace, toward lessening pain, toward spreading happiness.

The difference between the German situation and the American situation is the whole difference between the modern, scientific, peace-making device called "Compulsory Insurance," and that medieval unscientific strife-breeding contrivance called "Employer's Liability."

Under compulsory Insurance the remedy for an acident is to get the victim on his feet again as soon as possible, and to think up the best way of preventing all accidents of that particular kind in the future. Under Employer's Liability the remedy for an accident is to start a lawsuit.—Everybody's Magazine.

A THREE HUNDRED MILLION DOLLAR LOSS FROM LACK OF SYSTEM.

According to Mr. Harrington Emerson, an authority on several branches of engineering, the railroads of this country waste more than $300,000,000 every year by petty leakages. He believes that this waste, or a large part of it, could be saved by the proper organization of railroad operations. The waste consists of thousands of small items such as the stealing of coal, unskilled supervision in the shops, petty jealousies between officials, red tape, duplication of tools, and similar items. He cites a single large shop in which the annual tool bill was more than cut in half by one year's careful supervision.

Practical operating officials of the railroads are not disposed to dispute Mr. Emerson's figures. They admit that there is an immense amount of waste. Here and there, notably on the Harriman lines, one may find men who claim that everything possible is done to cut out this waste. Two years ago Mr. Harriman undertook to standardize his entire equipment, simply in order to eliminate an immense waste in the repair shops and in the interchange of cars and engines. Several millions of dollars have been spent in this effort, but as yet the annual saving cannot be accurately measured.

That some of this waste can be saved is undoubtedly true. The railroad men, however, declare that a large part of it turns upon the efficiency of the individual workman. That, they say, is the real railroad problem. There was a time when railroads could get efficient American workmen to labor on the tracks, in the shops, in the handling of freight. To-day the class of labor on the roads has deteriorated beyond conception. The lowest class of foreign laborers demands, and must get, the highest wages, wages that ten years ago were not paid to the best of American laborers in the same line of work. Until this condition remedies itself, the railroad men say, the larger part of the annual waste is beyond any effective remedy.

This whole controversy emphasizes the need of proper training for the semi-technical workman. The spread of technical schools will produce, as time goes on, a host of men fit for the shops, for the supervision of freight traffic, for the handling of track work. Only a few years ago the big Canadian railroads coöperated in establishing a sort of railroad school in connection with a Canadian university. To-day they draw from it dozens of young men fit for the railroad service. As the years go on this process will result in increased efficiency all around. Our own technical schools, the large locomotive companies, and the big car-building companies are graduating every year hundreds of young men for the service of the railroads. This is the ultimate solution of this problem of waste.

But there is need of more system on the railroads. The railroad world needs more presidents like Mr. Harriman (his financial activities apart)—men who personally go out and watch their railroads, keen for every improvement in operating methods, eager for traffic efficiency. The railroad field has not been cursed so much with dummy directors as it has with dummy officers. The railroad kings of to-morrow must know their railroads better than the kings of yesterday knew theirs.

Drop-Hammer Foundations

The E. W. Bliss Co., Brooklyn, N.Y., builder of drop forge hammers, contributed

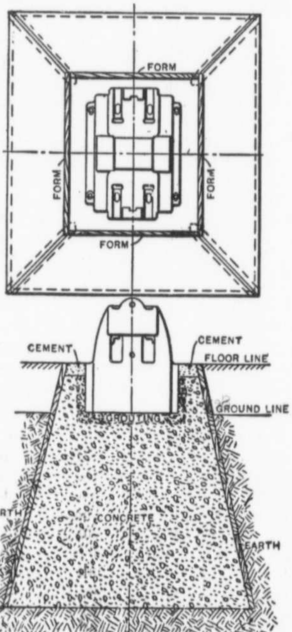


FIG. 1.

the following information regarding the construction of drop-hammer foundations.

The endurance and effectiveness of drop-hammers depend in no small degree upon the proper ratio between the weight of the base and the weight of the hammer. It has been demonstrated that 12 to 1 is decidedly better than a smaller ratio, and that the best results

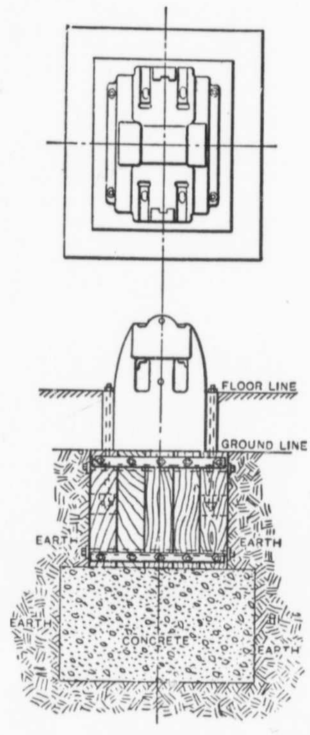


FIG. 2.

are obtained with a ratio of 15 to 1 or 16 to 1 with all parts made in proportion; the extra cost of the heavier machine being more than compensated for by the larger quantity and better quality of the finished product and by the comparative freedom from breakdowns.

For the successful operation of drop-hammers, it is very essential to have a good foundation. Both of the types here illustrated have been found to give good results. The wood cushion foundation, as shown in Fig. 2, is used where the bottom is not good and where the jarring of the surrounding buildings is objectionable. The solid concrete foundation shown in Fig. 1 is recommended as best when it can be used, as it is like a continuation of the base on the hammer, and therefore makes the drop more efficient. In deciding the depth of foundation of either of the above types, care should be taken to determine the best point to stop the excavation. Bed rock is the best bottom, cement gravel next best, and a strata of sand or clay, say 4 feet thick, and in its original and undisturbed condition, also makes a good bottom. The trouble with the sand or clay is that on account of the heat of a drop forge shop drying the soil and a continual jar, they are apt to shift provided they get an outlet in the shape of other near excavations. By spreading the bottom of the foundation the desired result is sometimes obtained without going very deep, but for any size of drop hammer the concrete should not be less than 4 feet thick, whether the wood cushion is used or not.

Meeting of A.S.M.E.

The season of professional meetings of The American Society of Mechanical Engineers will be opened on Tuesday evening, October 13, by a meeting of the Gas Power Section in the Engineering Societies Building at 29 West 39th Street, New York.

Mr. H. L. Doherty, chairman of the Meetings Committee of the section, will present a report for discussion outlining plans for future work and there will also be a discussion of standards to be used in gas power work.

Two papers will be read, one by E. A. Harvey on gas producer plants, with data upon costs, performance, etc.; and one by N. T. Harrington, giving the results of tests to determine the loss of fuel weight in a freshly charged producer, due to increase of ash contents in the fuel bed. The first paper will be illustrated by lantern slides, showing actual plants and plans for the arrangement of apparatus.

Politics at Steel Mills

A special despatch to the New York Times from Granite City, Ill., says that the 1,200 employees of the American Steel Foundries Co., at Granite City, found in their last pay envelopes a circular letter, which by implication lays the blame for the recent financial troubles upon the Republican National Administration. The circular in part reads:

"You have been out of work for a long time. Why have you been out of work?

"Because the company that has been giving you employment had no orders for its goods.

"Why has it had no orders?

"Because the railroads and other persons and corporations with which it deals could not buy supplies.

"Why could not the railroads order supplies?

"Because they could not borrow money, for the reason that nobody would loan it to them. The business of the railroads was crippled by the hostile attitude of the present Administration and by the adverse legislation of some of the States.

"Why could not the railroads get money?

"What should you do to get steady work?

"Talk it over with your neighbors and see what they think. Do then what you think is best for yourself. Remember when the railroads are prosperous we will have work for you and that you will then have money to buy what you need."

The plants of the company, after a shut down for months, resumed recently with about half of their regular force.

Discussing the relative position of various countries as musical centers, Germany seemed to have the most votaries, much to the evident displeasure of one excitable Italian. "Italy is turning out the most musicans, and has always turned out the most," he cried. "Ach, Gott!" exclaimed a German present, "can you plame her.

CAPTAINS OF INDUSTRY

Opportunities for Business. News of Building or Enlargement of Factories, Mills, Power Plants, Etc.—News of Railway and Bridge Construction—News of Municipal Undertakings—Mining News.

ONTARIO

The American Multigraph Sales Co., Limited, Toronto, have been incorporated with a capital of $40,000, to deal in office appliances of all kinds. The provisional directors of the company are J. S. Innes, J. E. Day, J. M. Ferguson, Toronto.

The Canada Metal Company, Toronto, have taken out a permit to erect a factory building on Fraser Avenue, to cost $12,000.

The Ross-Taylor Co., Exeter, Ont., have added another branch to their business, the manufacture of boxes.

Two new Canadian cement manufacturing plants are being planned: the Bell's Lake Portland Cement Co., Markdale, Ont., will erect a cement mill at Walter's Creek, Ont., to have a capacity of one thousand barrels per day; the other plant is to be built at St. Mary's, Ont., by the Brant Portland Cement Co. It will have a daily capacity of eight hundred barrels.

T. W. Oke, Ashburnham, Ont., owner of the Peterborough Furniture Co., has purchased new premises on which he will erect an additional large factory.

The Nimpkish Lake Logging Co., Limited, Vancouver, B.C., have been authorized to take over the sawmill and wood manufacturing business of Stracey & Garland, Limited.

The Windsor Launch & Power Co., will erect a dock and automobile repairing plant at Windsor, Ont.

A new Government dock will be constructed at the Ontario Iron & Steel Co.'s plant in Crowland township, Ont.

The Ottawa Hunt Club will build a concrete and rough-cast club house at Bowesville, Ont.

The Harris Co., Limited, Toronto, intend enlarging their abattoir. Estimated cost, $38,000.

Messrs. Mitchell Bros'. sawmill at Berkeley, Ont., has been destroyed by fire.

A new school building will be erected at Amherstburg, Ont.

A new post office and custom's house building is likely to be erected at Dundas, Ont.

An abattoir will be erected at Guelph, Ont., W. A. Mahony, architect.

The Monarch Brass Works, Port Colborne, Ont., have been destroyed by fire.

An addition will be built to the Eglinton public school, Eglinton, Ont.

The Hamilton Steel & Iron Co., will build additions to their spike mill at Hamilton, Ont.

A new flour and feed mill will be erected at Magnetawan, Ont., by J. Schadie, of the same place.

A new armoury will be erected at Orillia, Ont.

The Concrete Engineering & Construction Co., Toronto, have been awarded the contract for the laying of sewers in Preston, Ont.

The Marmora Cooperage mill, Marmora, Ont., was destroyed by fire recently.

The Eglinton, Ont., and Davisville, Ont., school buildings, will be enlarged.

The Hawthorne Hill Rural Telephone Co., Limited, Palmerston, Ont., have been incorporated with a capital of $10,000. The provisional directors include W. H. Mallett, J. Goodwin and A. Darroch, Palmerston.

H. Bilskey & Son, Limited, Ottawa, Ont., have been incorporated with a capital of $40,000 to carry on a jewelry business. The provisional directors include M. Bilskey, O. E. Culbert and S. Bilskey, Ottawa.

The office building of the Experimental Farm, Ottawa, will be enlarged and altered.

The Ingersoll Nut Co., Limited, Ingersoll, Ont., have been incorporated with a capital of $100,000, to manufacture iron, steel, lead, etc. The provisional directors include J. L. Ross, H. A. Holmstead and F. H. Potts, Toronto.

The Phoenix Oil & Gas Co., Limited, Milverton, Ont., have been incorporated with a capital of $100,000. The provisional directors include J. Torrance, R. Miller and R. Loderman, Milverton.

The Hayes Track Appliance Co., New York, have been licensed to carry on business in Canada. G. R. Harvey, Hamilton, Ont., has been appointed to be their attorney.

The Standard Milling Co., Limited, Listowel, Ont., have been incorporated with a capital of $40,000. The provisional directors include R. H. Stewart, J. M. Schinbein, and Geo. Bray, Listowel.

The South Bay Canning Co'.s factory at Picton, Ont., has been destroyed by fire.

The Bell Telephone Co., Toronto, will erect a five-story building for central exchange on Adelaide Street.

The factory of the Belleville Iron & Horseshoe Co., Belleville, Ont., has been destroyed by fire. Loss $15,000.

A party of Montreal financiers after examining the mines of Cobalt, Ont., give a good report. A new vein has been discovered five inches wide practically all silver. The Kerry Mining Co., with a lease on Cart Lake, struck a rich calcite two inch vein at a depth of fifty feet. The company have ordered a compressor plant for immediate installation.

The Hoop-Spring Cushion Tire Co., Limited, Toronto, have been incorporated with a capital of $150,000, to carry on the manufacturing of wheels and tires for automobiles, etc. The provisional directors include Clair Hodgson, A. H. Britton, M. Hodgson, Toronto

The North Lanark Marble & Granite Quarries, Limited, St. Catharines, Ont., have been incorporated with a capital of $150,000, to carry on mercantile business. The provisional directors include W. H. Wylie, M. M. Wylie, St. Catharines, Ont., and M. Lays, Ottawa, Ont.

The St. Lawrence Engine Co., Brockville, Ont., will build an extensive factory for the manufacture of motor engines.

A. D. Burrows has erected a new planing mill at Eden Mills, Ont.

The Northern Ontario Lumber & Milling Co. are insolvent and the London & Western Trusts Co. have been appointed liquidators.

Hercules Boxes, Limited, Toronto, have been granted a charter to manufacture wooden and paper boxes, etc., with a capital of $40,000.

The United Oil Fields, Limited, Toronto, have been incorporated with a capital of $100,000. The provisional directors include L. Cameron, G. P. Sylvester and J. F. Lennox, Toronto.

The American Hardpaperware Co., Limited, Toronto, have been incorporated with a capital of $300,000. The provisional directors include E. B. Ryckman, C. S. MacInnes and C. C. Robinson, Toronto.

The Holt Timber Co., Limited, Toronto, have been incorporated with a capital of $1,000,000. The provisional directors include E. Ryckman, C. S. MacInnes and C. C. Robinson, Toronto.

Alterations will be made to the Presbyterian Church, Queen St. East, Toronto.

The Canadian Barrel Handle & Veneer Co., Limited, Toronto, have been incorporated with a capital of $50,000. The provisional directors include M. Armstrong, H. J. Armstrong and J. B. McKinnon, Toronto.

The Veterinary Remedy Co., Limited, Toronto, have been incorporated with a capital of $20,000. The provisional directors include J. Waring, H. Oliver and A. Bartlett, Toronto.

The National Business Methods & Publishing Co., New Jersey, have been licensed to do business in Canada. Fred Nelson, publisher, Toronto, will act as their attorney.

The Graphite Mines' equipment and powder house belonging to Matthews & Cummings, Wilberforce, Ont., have been destroyed by fire.

The Canadian Flax Mills, Limited, Toronto, have been incorporated with a capital of $1,000,000. The provisional directors include D. Keith, A. R. Campbell and W. E. Hunter, Toronto.

The Monarch Brass Works, Port Colborne, Ont., have been destroyed by fire.

The South Bay Canning Co.'s plant at Windsor, Ont., has been destroyed by fire.

A new dam has been constructed at the power plant, Windsor, Ont.

Among the firms who have recently placed orders for pumps with the Smart-Turner Machine Co., Hamilton, are the Northumberland Paper & Electric Co., Campbellford; the Fred. Armstrong Co., Toronto; Electric Metals, Limited, Welland; the Reid Foundry Co., Ingersoll; the Temiskaming & Northern Ontario Railway Co., North Bay; Thos. A. Ivey & Sons, Port Dover, Ont.; the Canadian Pacific Railway at Kootenay Lake.

The plant of Wm. Malloch & Co., manufacturers' elevators and foundry, at London, Ont., has been sold to the Vulcan Co., Limited.

The Atikokan Iron Co., Limited, Toronto, is to be wound up and John D. Fraser has been appointed provisional liquidator.

The Levy, Weston McLean Machinery Co., Limited, Toronto, have assigned to E. R. C. Clarkson, Toronto.

Mayor Oliver, Toronto, has instructed City Engineer Rust to endeavor to have $200,000 of the trunk sewer contract let by November 1, so as to have the work started as soon as possible.

QUEBEC

The Tombyll Upholstering Co., Lemoine Street, Montreal, have taken out a permit for a factory costing $10,000, at the corner of St. James and Walker Streets, where their premises were destroyed by fire last winter.

Lawford Grant, Esq., has registered as manager of the British Insulated & Halsby Cables, Limited, Montreal.

An office building and turning shop will be erected at the Canadian Spool Cotton Co.'s Works, Montreal. Messrs. Brown & Vallance, Montreal, are the architects, and E. G. M. Cape is the contractor.

The Bank of Nova Scotia will build a branch at Harbor Grace, Newfoundland. L. P. Snyder, Toronto, is the architect, and Byers & Anglin, Montreal, are the contractors.

John Watson & Sons, Montreal, have been awarded sub-contract for ornamental iron work in the Eastern Townships Bank Building, Montreal. Peter Lyall & Sons are the general contractors

After Oct. 1, 1908, the name of the company Amiot, Lecours & Lariviere, Incorporee of Montreal, will be changed to that of Lariviere, Incorporee.

The Dominion Soda Water Co., Limited, Montreal, Que., have been incorporated with a capital of $49,000. The provisional directors include A. Rudner, A. Storm and J. Rosenberg, Montreal.

Larose & Larose, sash and door manufacturers, Montreal, have registered.

R. & T. Ritchie, Limited, Aylmer, Que., have been incorporated with a capital of $100,000, to manufacture and deal in lumber.

The new factory of the Sherbrooke Machinery Co., Sherbrooke, Que., is completed. The company are busy installing machinery and expect to commence work soon.

The Boston Asbestos Co., East Broughton, Que., are pushing the installing of their machinery in their large mill, and expect to be running soon.

A new post office will be erected at Mecantis, Que.

A new English bank will be established on Notre Dame St., Montreal, Que.

Millen & Brother, lumber dealers, Ahunstic, Que., have registered.

NEW BRUNSWICK

Mr. Joseph Feinbrook, of Nathan, N.B., has made application to the New Brunswick Provincial Government for the lease of 137 miles of crown lands on Cain's River and Little River for the establishment of extract works for the manufacture of turpentine, rosin and other products and the lease will be made with only a nominal rental being charged. Mr. Feinbrook has agreed to spend $100,000 or more the first year in machinery and plant to carry the business on for 10 years at least, employing a large number of men.

The Standard Printing Co., Limited, St. John, N.B., have been incorporated with a capital of $60,000 to carry on the business of newspaper proprietors and general publishers lithographers, and engravers. The provisional directors are:—Josiah Wood, Sackville, N.B., W. H. Thorne and R. B. Emerson, St. John, N.B.

The K. & V. Co., Limited, have been incorporated with a capital of $20,000, to carry on a general lumbering business in all its branches. The provisional directors include L. W. Just, Montreal, Knut Nordin, and Joseph Ander, Newcastle, N.B.

The Sackville Woodworkers' Co., Sackville, N.B., have started work on their new factory at that place.

James Beveridge, St. John, N.B., who is building a pulp mill on one of the branches of the Miramichi, expects to have the plant in working order in November.

A new woodworking factory will be built at Campbellton, N.B., by J. & D. A. Harquail.

NOVA SCOTIA

The Universal Spring Co., Sussex, N.S., intend enlarging their plant by the erection of a three-story factory building.

Messrs. Reid & Archibald, Halifax, N.S., have the contract for the building of the new wharf at MacPherson's Cove, C.B.

Messrs. J. W. Lowe & Sons' woodworking factory, sawmill and lumber sheds at Annapolis, N.S., have been destroyed by fire.

MANITOBA

A new hotel will be erected at Altona, Man., on the site of the old "Commercial," which was destroyed by fire.

A. S. Arnold, Shoal Lake, Man., is erecting a 30,000 bushel elevator.

The Western Canada Flour Mills Co.'s elevator at Oakburn, Man., has been destroyed by fire.

The Canadian Pacific Railway will remodel the depot and freight sheds at Portage La Prairie, Man.

A part of the business section of Altona, Man., has been destroyed by fire.

A new King Edward school will be erected at Winnipeg, Man. Estimated cost, $64,000.

SASKATCHEWAN

Improvements and additions will be made to the Canadian Pacific Railway Hotel at Moose Jaw, Sask.

A new collegiate institute has been erected at Moose Jaw, Sask.

An elevator will be erected at Estevan Sask., by Stromwold & Co., Mohall, N.D.

The Public Building at Prince Albert, Sask., will be enlarged and improved.

The Canadian Pacific Railway will build a new station at Sutherland, Sask.

A flax mill will be established in Saskatoon, Sask., by Douglas, Piper & Johnston, Saskatoon.

John Matthison, Estevan, Sask., is erecting a 30,000 bushel elevator.

ALBERTA

The Bank of British North America have purchased a site for a branch building at Calgary, Alta.

H. N. Calder, Edmonton, Alta., has the contract for cutting ties for 100 miles of the Grand Trunk Pacific.

BRITISH COLUMBIA

A store and office block will be erected on Hastings St., Vancouver, B.C., by J. Dodson, Vancouver.

Mahon, McFarlane & Mahon are erecting an up-to-date sawmill in Capilano Valley, B.C.

The Capilano Timber Co., Limited, have been incorporated in the province of British Columbia with a capital of $100,000, to manufacture and deal in lumber.

The Cooke Lumber Co., Nelson, B.C., have decided to proceed with the erection of a saw mill.

Wright & MacDonald, Vancouver, B.C., have completed plans for a bakery to cost about $30,000 and stables to cost $5,000 for Hanbury, Evans & Co.

The Kelowna Sawmill Co., Limited, capital $100,000, have been chartered to take over the business carried on under that name in Kelowna, B.C., and to manufacture wooden products.

A Salmon Arm, B.C., advice says that the lumbering firm of Brayden & Johnston, have decided upon the erection of a mill at Canoe Creek Siding, which will be proceeded with almost immediately.

The Graham Island Lumber Co., in which two of the prominent members are C. H. Shannon, Los Angeles, and J. C. Slean, Pittsburg, will build a large sawmill at Massett, on Graham Island, B.C.

The Malcolm Lumber Co., Fairview, B.C., have taken over the business of the Telford Lumber Co., and are fitting up a modern sawmill of 50,000 feet capacity per day.

The Elk Lumber Co., Fernie, B.C., have given orders for the cutting of 18,000,000 feet of logs this winter. This is taken as an indication that the mill will be rebuilt at an early date.

Glencoe Lodge building, Vancouver, B.C., will be enlarged at a cost of $50,000.

Exhibit of Steel Fractures

One of the features of the Machinery Hall this year was a show case exhibited by The Eagle & Globe Steel Co., Limited, of Sheffield, England, in conjunction with their Canadian agents, Messrs. Drummond, McCall & Co., Montreal and Toronto. This show case deals with the process of manufacture of high speed—special—and ordinary carbon tool steels, and we are confident will have been found of great interest by such of our readers, who had the opportunity of inspecting same. An examination of the show case immediately reveals to one the great care necessary to produce such perfect fractures, also to make the process easily understood by users, and we have pleasure in endeavoring to give a rough description of same. The first fractures are of the iron in the rough state, exactly as received at the works, in Sheffield, from Sweden. The next set shows the Bliske steel, or converted bar iron, which is broken into small pieces and along with the various alloys and rare metals, melted in a small crucible. The next fracture in direct order is the ingot fracture, from which the finished bar is forged. This, of course, is the one of most interest to the user. Fractures of a few of the standard grades of tempers, manufactured by this company, are displayed in the finished state, including the present day high speed steel ("Capital"), special Dannemora extra hard cast steel for use on chilled rolls and similar hard materials. "D.S.W." (Dannemora Steel Works) Brand—an oil or water hardening steel, suitable for roughing tools, etc., where the machinery is too heavy for the ordinary carbon tool steel, but not heavy enough for high speed, and is also an excellent finishing steel. As regards ordinary carbon steels, we think you will agree with us the following list covers a very large field, and we are confident that The Eagle & Globe Steel Co., Limited, will be able to satisfy even the most "hardened tool steel critic,"—from the following list:—

No. 1 temper ($1\frac{1}{2}$ % carbon), for razors, etc.

No. 2 temper, ($1\frac{1}{4}$ % carbon), for turning tools, small drills, and cutters.

No. 3 temper ($1\frac{1}{8}$ carbon), for punches, taps, rimers, and large drills.

No. 4 temper, (1% carbon), for chisels, small shear blades, etc.

No. 5 temper, ($1\frac{7}{8}$% carbon), for sets and large shear blades.

No. 6 temper, ($\frac{3}{4}$% carbon), for dies, hammers, snaps, etc.

Messrs. Drummond, McCall & Co. are also showing a few samples of "Capital" brand high grade files, of full standard Sheffield weight, and guaranteed to outlast the low grade, light weight, high discount article by 3 to 1. Also, as they are made from special material, actually costing to produce three times as much as the ordinary carbon file steel, one cannot do otherwise than see that they are eminently suitable for recutting, and we understand the manufacturer guarantees them to go through the process at least twice.

Physical Characteristics of Cast Iron

Paper Read Before the Engineers' Club of Philadelphia—Cast Iron in Structural Use—Experimental Results do not Harmonize with Theory of Flexure.

By James Christie.

Cast iron is probably the most complex, variable and uncertain form in which iron is used. Not only is the content of extraneous metals and metalloids variable, but the condition in which the associated carbon exists and the character of this association are determined largely by the influence of silicon and possibly other metalloids. Again, the physical properties of the metal are influenced by casting temperature, rate of cooling, etc., so that altogether we can only predicate the probable strength and stiffness of a casting in the most general way, and forecast results which will suit an average from which individual castings may vary widely in extremes. Gray iron of the foundry grades is alone considered here. The grading of the pig metal at the furnace has been determined in the past by the appearance of the fracture, but recently, as much of the product is run in metal molds and the appearance of the fracture is deceptive, the tendency is to grade by chemical composition, the softer and weaker metals having the highest silicon and the lowest percentage of combined carbon. Taking three grades of foundry pig and assuming that these are used for different classes of castings, we would have:

No. 1—2.5 to 3 per cent. silicon for light castings.

No. 2—2 to 2.5 per cent. of silicon for medium weight castings.

No. 3—1.5 to 2 per cent. silicon for heavy weight castings.

As a general average, all the grades will carry about 3.5 per cent. carbon in total.

Physical Properties.

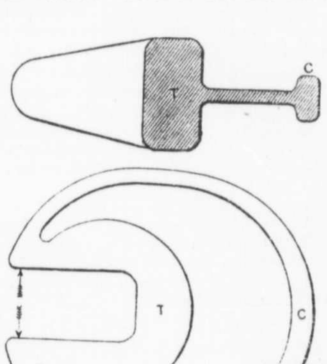
The recent specifications of the American Society for Testing Material require a transverse test on specimens $1\frac{1}{4}$ in. in diameter and 12 in. between supports, load in the middle:

2,500 lb. or over for light castings.

2,900 lb. or over for medium castings.

3,300 lb. or over for heavy castings.

with deflection before rupture not less than 1-10 in. The tensile strength of the aforesaid grades respectively is required to be not less than 18,000, 21,000 and 24,000 lb. per square inch of section. While these standards are valuable in maintaining a high quality of product, yet they may imperfectly represent the resistance of the metals in actual service. We know that cast iron is



Frame of an Open Gap Machine, Illustrating Tension and Compression Stresses in Cast Iron.

in extensive use that falls far short of these requirements. High tensile strength is frequently associated with brittleness and is not always indicative of superiority.

For heavy machinery, etc., cast iron is used in heavy masses, through which working stresses are imperfectly distributed, and probably is much softer and weaker in the middle of the mass, where it has cooled slowly, than at outer surfaces, where the metal has more rapidly cooled. Furthermore, castings are usually under considerable internal strain, due to unequal contraction, and although this internal strain gradually disappears, it may have some disturbing influence after the casting has been put in service. It has been the practice of the writer to assume an ultimate tensile strength of 16,000 lb per square inch for ordinary iron castings, and to limit working stresses from 2,000 to 4,000 lb. per square inch, according to the conditions and character of the service.

Cast iron offers a high resistance to compressive stress, and although this resistance varies within wide limitations, it may be assumed as a working basis to be about six times that of the tensile strength, or, say, 95,000 lb. per square inch of section.

Cast iron is imperfectly elastic as compared with the superior forms of the metal. It presents no definable elastic limit and exhibits marked permanent set under low loads, either in tension or compression. Experiments continued for several years indicate that when loads exceeding one-half the ultimate are applied, failure eventually ensues. It may, therefore, be assumed to have a practical elastic limit in tension of about one-half the breaking load.

The coefficient of elasticity is likewise variable, in contradistinction to the constancy of the elasticity, under ordinary conditions, of wrought iron and steel.

Recorded experiments indicate that the modulus of elasticity varies considerably in extreme cases, and is nearly alike in tension and compression. A modulus of 13,000,000 lb. appears to be a fair valuation for direct tension and compression, or for bending loads applied transversely this modulus appears to average 16,000,000 lb. when used in computation with the commonly accepted formula for flexure.

Cast Iron in Structural Uses.

In the middle of the past century, as cast iron became extensively applied to structural purposes, its physical properties were studied with great care, and the experiments of Hodgkinson and Fairbairn in England and their contemporaries yielded a fund of information on the subject. Seeking a section of beam which should exhibit the highest ultimate strength in proportion to area of cross section or of the weight of metal employed, Hodgkinson advocated a section in which the tension flange exceeded the compression flange about six to one in sectional area, the web usually tapering in thickness from the tension flange, diminishing toward the other flange. This form of beam was largely adopted and took precedence as long as cast iron was used for beams in structures. We find that the same method of reasoning influenced the machine designer in disposing cast iron to seeming advantage in the construction of machines, massing the metal to resist tension and permitting high unit stress on metal in compression. Especially is this observed in machines of the open jaw or gap type, such as presses and punching and shearing machines. The writer believes that usually the unit stresses should be little if any higher in compression than in tension, for the following reasons: In machinery rigidity or stiffness is usually the chief consideration. Many machines do not fulfil the intended purpose properly, not by failure through fracture, but by a want of sufficient stiffness. Deflection has to be limited, and when that is done breaking from excessive tension is sufficiently guarded. Remembering that cast iron yields to compression as much as with the same unit stresses it yields to tension, it follows that the compressive stress should not exceed the tensile strength per unit of section if it is desired to dispose a given mass of metal with least deflection. It is believed that rupture sometimes occurs in a machine apparently through tension, where the origin of the weakness could be traced to a want of material sufficiently to resist compression, the improperly supported tension side severing by cross bending or transverse stress.

Taking for example an open gap machine with frame as shown in the accompanying illustration—tension at T and compression at C, if the section is so shaped that compressive unit stress is six times that of the tensile unit stress, then, elastic moduli being equal, the frame will yield at C six times as much by compression as it does by tension at T. This permits an oscillation of the mass at T around its center. If this oscillation becomes dangerous, by extent or frequency, the frame will break by cross bending at the mass T, giving the impression that more material is needed to resist tension; whereas the fact may be that more material should be placed at C to prevent excessive yield by compression.

Theoretical Calculations Not Borne Out

Owing to the peculiar physical characteristics of cast iron, it has not been found practicable to harmonize experiments with the theory of flexure. Many reasons are offered for this, and modifications of the usual accepted theory have been propounded which will not be discussed here. It has been found necessary to introduce into the equations moduli or coefficients which have no apparent relation to the direct strength of the metal, and which vary widely for different dimensions and shapes of cross sections. As the cross sections under consideration are frequently of unsymmetrical and irregular shape, the computation of flexural moments is tedious and frequently useless if the computer has not a correct modulus to apply to satisfy the conditions of the section under consideration. It is, therefore, desirable for the designer to keep a record of experiments and of failure of castings under known loadings, and from these results derive coefficients by means of which the strength and stiffness of various sections can be approximately known without recourse to the usual calculation for the resisting moments of the section.

In machinery the working stresses are usually impulsively or suddenly applied, sometimes with actual percussion or impact, and frequently alternate stresses of equal intensity in opposite directions occur in rapid reciprocation. As it is known that a load so rapidly applied as to permit the unimpeded effect of gravity will produce a deflection double that due to the static effect of the same load, it can be seen that the total amplitude of vibration due to rapidly alternating loads must be very considerable. To prevent excessive vibration the structure should be designed with the limitation of deflection in view, and the amount of this limitation is derived solely from experience and should be governed largely by the nature of the service to which the material will be applied. For machinery under ordinary circumstances we might assume, in order to obtain satisfactory stiffness, that the deflection should not exceed one-twenty-five-hundredth part of the span, and under certain conditions should be much less than this. Indeed, it is quite probable that a deflection in direct proportion to length is not advisable, but that the ratio of deflection to length should decrease as length is increased. For long members in compression the sectional area must be augmented as the ratio of length to cross section increases, but for members under variable tension alone the section should be increased also, or the stress per unit of cross section reduced, as the ratio of length to cross sections increases, for the purpose of reducing vibration due to successive extensions.

When rapidly alternating stresses occur, it is acknowledged that provision must be made for something more than the greatest stress in one direction alone. There are still differences of opinion and practice on this subject among bridge designers. Some maintain that when the alternations are of slow recurrence, so as to permit actual rest between reversals, no special increase of section is required. Others specify that the sum of the sections required for the stresses in opposite directions should be used to suit the conditions. There can be little doubt that the latter estimate is little enough for machinery when the oscillation of the forces occurs with great rapidity, and especially when the metal under consideration is cast iron, with a modulus of elasticity about one-half that of steel or wrought iron. It is a safe general rule for ordinary cast iron in machine structures to limit tensile stress to 4,000 lb. per square inch of section under the most favorable circumstances, to 3,000 lb. when loads are suddenly applied and to 2,000 lb. when the force alternates in direction. These unit loads should be further limited to suit the ratio of length to section, as required for columns or any members in alternate extension or compression. For beams or members subjected to alternating transverse stresses, the unit stresses on the material should be limited so that the sum of the deflections in opposite directions will not exceed one-two thousand five hundredth part of the span, or such other limitation as, according to the judgment of the designer, will provide sufficient stiffness for the intended purpose.

The Chemical Engineer in Iron Trade

Facts in Connection with Analytical Chemistry and Chemical Engineering in Iron Trade—Criticism of Training Received in Colleges.

By George Auchy.

The term chemical engineer is given by the writer a very wide significance, being used to designate one who is, or who aspires to be, a manager, superintendent or director, not only in the making of chemicals but in any line of industry whatever, and who has a groundwork of chemical knowledge to start with.

The object of this paper is to call the attention of the iron trade to certain facts connected with analytical chemistry, and with chemical engineering, and also to criticize our colleges for the methods and scope of the training they have so far been giving in these lines.

What the Works Ask for and What they Get.

Taking a particular instance, the writer respectfully makes the charge that our colleges have not been meeting, intelligently and fairly, the demands that the iron and steel trade has made on them. The works have asked for analytical chemists simply, and have been given chemical engineers instead, who, it is true, are analytical chemists also, but only in a perfunctory and superficial way, and whose highest ambition is to

get out of analytical chemistry as soon as they possibly can. This condition of things is undesirable and the remedy that is obviously to be proposed is simply that colleges make a sharp distinction between chemical engineers and analytical chemists, and a sharp distinction in their respective courses of study, giving the analytical chemist no "engineering," and giving the chemical engineer no analytical chemistry, and starting the latter with the steel works office instead of with the steel works laboratory, as now. For the analytical chemist, it is necessary that the college course be cheap, comparable in this respect with a course in stenography, or an ordinary business course. Such a cheap and brief course would be no innovation. Our colleges to-day all give special courses in chemistry to whomsoever desire them.

Neither Party Gets What He Wants.

Although the demand for analytical chemists from the steel trade has been a great and growing one, yet probably in no other business do demand and supply connect with each other in such ridiculously loose and disjointed fashion as here. Neither party to the transaction gets what he wants or what he is entitled to have. The employer gets a whale instead of a minnow he is fishing for, and the chemical engineer just the reverse. instead of the dignified and well paid position that his long and expensive course at college entitles him to expect. The chemical engineer gets routine laboratory work in impossible amount, and at mechanic's wages, and with the hoped for "chance of advancement" year by year receding further into the dim and misty depths of doubt and uncertainty. And moreover, there is at best an element of economic waste about the whole performance that is entirely out of harmony with the utilitarian spirit of the age.

Supposing that the college graduate in chemistry succeeds ultimately in developing into a full-fledged chemical engineer, and gets the coveted post of steel works or furnace manager. In that event, his knowledge of general chemistry will be of the greatest help to him, but the years in college and at the works spent on analytical chemistry will have been years entirely wasted as far as any help or advantage to him is his final occupation is concerned. He might just as well have spent those years in the study and practice of dentistry or any other business entirely unconnected with the iron and steel trade.

The Steel Business Not Learned in the Laboratory.

At the same time, from the standpoint of the employer's interests, there is to be considered the waste involved in the appointment of a man who has his business all to learn after the appointment, or who, if he has learned anything of it before the appointment, has done so at the expense of the other work then engaged in. The analytical chemist can not learn the steel business in the laboratory. The office man, on the contrary, if not of the humblest type, learns the steel business almost with every breath he draws. The same is true of the man outside the office in the works. In fact, of all places about the works, the laboratory is really the only place where nothing whatever about the steel business can be learned.

It is true that the steel works manager should be a chemical engineer, or at least should understand the chemistry of the metallurgical processes under his charge. It is true also that the steel works chemist understands the chemistry of these processes (but it must be borne in mind he understands this entirely because he has studied general chemistry, and not in the least because he has studied analytical chemistry), but the waste involved in transforming the chemist into the manager is not the less plain. It is a performance that irresistibly reminds us of the alleged ancient Chinese method producing roast pork.

According to Charles Lamb, roast pork was unknown in China until one time a pig-sty accidentally took fire and burnt down, and the unfortunate owner incautiously touching the still hot carcass of a pig burnt his finger, and, hastily thrusting the injured member into his mouth to alleviate the pain, got the taste of roast pork and found that it was good. The news quickly spread, and pig-sty fires became soon a regular and frequent occurrence, and it was a long time before they realized that this was a crude and expensive way of getting roast pork. But in their main facts the ancient Chinese were undoubtedly right. Just as to-day, in the steel trade, it is undoubtedly true that a chemical engineer as a steel works manager is the right man in the right place. What must be criticized only is his devious, wasteful and uncertain way of getting there. Perhaps also on the ground of candor the tortuousness of his path to the steel work's superintendency is not strictly to be commended.

When an Analytical Chemist is Wanted, That is All.

But here exceptions may be perhaps taken by some to the writer's dictum that the iron and steel trade's demand for chemists is a demand strictly and exclusively for analytical chemists and not at all for chemical engineers and analytical chemists mixed. Without professing infallibility on this point, and with the fullest realization that he may be mistaken, the writer must, nevertheless believe from his experience and observation that when the iron and steel trade asks for an analytical chemist, an analytical chemist is all that is wanted, and there is no ulterior aim whatever. Just as a blacksmith is employed to do blacksmithing simply, and an office man to do office work, so a chemist is employed to do analytical work simply, and in no case, or at least in very few cases, the writer believes, is there also present in the employer's mind a determination to by and by make a practical steel man of his chemist.

There was a time, perhaps, in the very start, when the employer expected something more of the chemist than analytical chemistry, but this was merely because the employer was not aware either of the tediousness and laboriousness of analytical work or of the extent of his own demand for it, and was afraid that he could not keep his chemist busy with analytical work alone. But this fear has been dissipated, and the problem of iron and steel works to-day is how to turn out the analytical work required. The demand, therefore, for analytical chemists is a constantly growing one.

No Demand for the Chemical Engineer.

For chemical engineers, on the contrary, there has never been any demand from the iron and steel trade. The chemical engineer approaching here for a position finds no broad-flower-skirted avenue leading to the works and terminating in a wide open gateway with the inscription in great golden letters, "Welcome Chemical Engineer!" On the contrary, not only does he find no special entrance for himself, but he finds, moreover, all other entrances barred to him, except he assumes a humble disguise. Naturally enough the disguise he assumes is that of analytical chemist. Really it is no disguise.

He is in fact, and truly, an analytical chemist. But this is exactly what is to be deplored. He ought not to be an analytical chemist if he is a chemical engineer. Or, if he is really an analytical chemist, he should not be a chemical engineer. For, if he is both he is probably not much of either. As a matter of fact, he is usually a good bit more of a chemical engineer than an analytical chemist.

We do not have to scratch the ordinary steel works or blast furnace chemist very deep to find the chemical engineer. This is all wrong. Analytical chemistry, though far below chemical engineering in dignity and importance, is nevertheless too exacting a mistress to be taken up and contemptuously discarded at will. So, too, on the other hand, chemical engineering is too important and too absorbing a profession to be diluted with 10, 15, or 20 years of study and work in some extraneous and entirely irrelevant pursuit. What, for instance, would be thought of an iron and steel chemical engineer who with deliberate intent spent 10 or 20 years at dentistry as a preliminary to steel work's superintendency? Yet to the full-fledged iron and steel chemical engineer—that is, the blast furnace manager or steel works manager—20 years of preliminary work at dentistry would be just as valuable a training to him as 20 years at analytical chemistry.

The Future Iron and Steel Chemical Engineer.

Here let us reiterate that the chemical knowledge so useful to the iron and steel manager is a knowledge derived from the study of general chemistry, and not at all from the study of analytical chemistry, and the steel works or blast furnace manager in remembering how to make an analysis remembers nothing that is directly or indirectly of any value to him, as a manager or chemical engineer. To hazard a prediction, the iron and steel chemical engineer of the future will be a good bit more of a chemical engineer than his brother of to-day, and will not be an analytical chemist at all.

Young men choosing this profession should clearly understand that a jump from the work's laboratory to the work's superintendency is only accomplished at the expense of a violent strain on the eternal fitness of things, and it is hardly harshness to characterize the cherishing of such an ambition as a piece of effrontery on their part. This will best be seen by an illustration. Suppose that a man should apply for the postion of steel works superintendent, basing his application upon the fact that he had studied chemistry, physics, mathematics, French and German, Biblical geography, analytical chemistry and other things useful to the steel man, and that after all this, to still further qualify himself for the postion of steel work's superintendent he had taken a polar trip with Peary, what

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would be said to him? It would be said that his study of chemistry, etc., was all right, and excellent as far as it went (but that it did not go far enough), but that his trip to the North Pole, though a highly creditable performance in itself, yet viewed as a preliminary to the steel business it could not be considered as anything else than a piece of foolishness, because he could not possibly learn anything about the steel business at the North Pole.

But it is just as true that he could not learn anything about the steel business in the steel works laboratory. That is, of course, if he is conscientious, and steals no time from his work. Or even if he works overtime at learning the steel business, he is nevertheless taking time that belongs to analytical chemistry, time that he needs for his chemical journals and analytical books, or time that he needs to investigate the perplexing practical analytical problems that are always springing up, or that he needs to look to for the detection of error in his methods. The steel works chemist, if he has the love of his work that every worker should have, will have no time to learn the steel business, either in or outside the laboratory hours, unless, indeed, he is exceptionally able. Especially is this true if he, for his employer's benefit, takes up the study of metallography and of theoretical metallurgy in addition to analytical chemistry, and this latter is something that it is well for him to do, because nobody else around the works will do it—at least not systematically and thoroughly.

THE NEED OF THEORISTS.

Theorists at the works are just as scarce as practical men are plentiful. So that in metallurgical theory the steel works chemist finds a genuine field of usefulness if he desires one outside of, and in addition to, analytical chemistry. But, instead of taking advantage of this opportunity for usefulness, he is hardly settled in his place before he bends all his energies to making a practical steel man of himself, a performance which for absurdity throws the familiar "carrying coal to Newcastle" completely in the shade. It is, indeed, like selling potatoes to get money to buy coal to carry to Newcastle at a time when Newcastle is suffering with a potato famine.

The chemist will find an abundance of practical men at the works who are amply able to hold up their end, and the chemist cannot hope to compete with them on their own ground, or to catch up to them, handicapped as he is with his laboratory duties, and in trying to do so he likely succeeds in merely falling between two stools and becoming a sort of a hybrid nondescript. His ambition to become a practical steel man prevents him from being much of an analytical chemist or metallurgical theorist, and on the other hand his analytical duties prevent him from becoming much of a practical steel man. So, as a result, he is perhaps apt to be not much of anything—neither fish, fowl nor good red herring.

But if the writer is wrong, as well he may be, in believing that this is not what the steel man wants when he employs a chemist; in other words, if it is a fact that the iron and steel trade all along has been expecting chemical engineers in response to its demand for analytical chemists, then of course the writer's charge that the colleges here do not understand their business must be apologetically withdrawn. His guns must then be trained at the iron and steel employers instead, and it is against them then that the accusation must be made that in this particular they do not understand their business, and are like Charles Lamb's ancient Chinese, taking a wasteful, round-about way of accomplishing a simple thing. If the steel man's demand for an analytical chemist is merely a pleasant conceit, and what he really wants is a chemical engineer, then he is taking a very expensive and round-about way of getting him. Let him put his embryo chemical engineer in the office, or let him put him anywhere around the works except in the laboratory. The laboratory is the last place for the young chemical engineer—as well might he go in a grocery store. There is no resemblance or connection between the chemical relations of metallurgical processes and those of chemical analysis.

The probability is, as before stated, that the iron trade has been calling for analytical chemists simply, and the many cases where the chemist has developed into the manager are cases merely of the buoyancy of genius. That is, these chemists have risen to superintendency because they have had exceptional ability, and not because they have been analytical chemists. As blacksmiths they would have risen just the same. A long list could be given of men who were distinguished as analytical chemists and afterward distinguished as iron and steel metallurgists, but this proves nothing except native ability.
—Iron Age.

INDEX TO ADVERTISEMENTS

ifc=inside front cover; ibc=inside back cover; obc=outside back cover.

	PAGE
A	
Algoma Steel Co., Sault Ste. Marie, Ont	8
B	
Bank of Hamilton, Hamilton, Ont	33
Banfield, W. H. & Sons, Toronto	4-10
Barber, Wm. & Bro., Georgetown, Ont	11
Bertram, John & Sons Co., Dundas, Ont	ofc
Best Steel Castings Co., Montreal	8
Boiler Inspection & Insurance Co., Toronto	obc
Bourne-Fuller Co., Cleveland, Ohio	8
Bowman & Connor, Toronto	11
Bradstreets,' Toronto	11
Brandeis, C., Montreal	11
Bristol Co., Waterbury, Conn	obc
Brunner, Mond & Co	37
Budden, Hanbury A., Montreal	11
Butterfield & Co., Rock Island, Que	4
C	
Canada Chemical Mfg. Co., London, Ont	37
Canada Iron Furnace Co., Montreal	8
Canada Paint Co., Montreal	10
Canada Wire Goods Mfg. Co., Hamilton, Ont.	36
Canadian Billings & Spencer, Limited, Welland, Ont	ifc
Canadian Drawn Steel Co., Hamilton, Ont	6
Canadian Fairbanks Co., Montreal	7
Canadian Hart Wheels, Limited, Hamilton, Ont	10
Canadian Iron & Foundry Co., Montreal	33
Canadian Office and School Furniture Co., Preston, Ont	11
Cassella Color Co., New York and Montreal	37
Chadwick Bros., Hamilton, Ont	10
Cousins, C. C., Montreal	11
D	
Dodge Mfg. Co., Toronto	5
Drummond, McCall & Co., Montreal	8
E	
Edwards, Morgan & Co., Toronto	11
F	
Fensom, C. J., Toronto	11
Fetherstonhaugh & Co., Toronto	obc
G	
Gartshore, J. J., Toronto	11
Gartshore-Thomson Pipe & Foundry Co., Hamilton, Ont	33
Goldschmidt Thermit Co., Montreal	ibc
Gurney Scale Co., Hamilton, Ont	10
H	
Hamilton Facing Mills Co., Hamilton, Ont	obc
Hamilton Pattern Works, Hamilton, Ont	10
Hamilton Steel & Iron Co., Hamilton, Ont	33
Hamilton Tool Co., Hamilton, Ont	9
Hay, Peter, Knife Co., Galt, Ont	38
Horsburgh & Scott, Cleveland, Ohio	10
Hunt, Robert W. & Co., Chicago, Ill	11
J	
Jardine, A. B. & Co., Hespeler, Ont	10
Johnson, C. H. & Sons, St. Henry, Que	10
K	
Kelly's Directories, Toronto and London, England	ibc
Kent, P., Montreal	10
Koppel, Arthur Co., New York	ibc
L	
Leslie, A. C. & Co., Montreal	obc
Lockerby & McComb, Montreal	10
London Machine Tool Co., Hamilton, Ont	4
Lowell Crayon Co., Lowell, Mass	10
M	
Manufacturers' List Co., Toronto	11
Marion & Marion, Montreal	11
Metallic Roofing Co., Toronto	11
Millen, John & Son, Montreal	33
Mitchell, Charles H., C.E., Toronto	11
Monongahela River Consolidated Coal & Coke Co., Buffalo, N.Y	35
Montreal Fire Brick & Terra Cotta Works, Montreal	10
Mc	
McArthur, Corneille & Co., Montreal	obc
McCullough-Dalzell Crucible Co., Pittsburg, Pa	35
McKenzie, D., Guelph, Ont	10
McKinnon Dash & Metal Works Co, St. Catharines, Ont	obc
N	
Neff, A. C. & Co., Toronto	11
Nichols Chemical Co., Limited, Montreal	37
Northern Aluminum Co., Shawinigan Falls, Que., and Pittsburg, Pa	6
Nova Scotia Steel & Coal Co., New Glasgow, N.S	33
O	
Ontario Lime Association, Toronto	10
Ontario Wind Engine & Pump Co., Toronto	10
Orford Copper Co., New York, N.Y	8
Otis-Fensom Elevator Co., Toronto	38
P	
Parke, Roderick J., Toronto	11
Parmenter & Bulloch, Gananoque, Ont	10
Pennsylvania Fire Brick Co., Beech Creek, Pa.	35
Perrin, Wm. R., & Co., Toronto and Chicago, Ill	ibc
R	
Richards Mfg. Co., Montreal, Que	10
Rolland Paper Co., Montreal	11
S	
Sadler & Haworth, Montreal	6
Siemon Bros., Wiarton, Ont	10
Smart-Turner Machine Co., Hamilton, Ont	obc
Smith's Falls Malleable Castings Co., Smith's Falls, Ont	obc
Somerville, T. A., Hamilton, Ont	11
Stevens Co., Galt, Ont	4-10
Stevens, Frederic B., Detroit, Mich	31
Stowe-Fuller Co., Cleveland, Ohio	35
T	
Toronto Paper Mfg. Co., Cornwall, Ont	11
Toronto Stamp & Stencil Works, Toronto	10
Toronto Testing Laboratory, Toronto	11
Trimont Mfg. Co., Roxbury, Mass	ifc
Trussed Concrete Steel Co., Toronto	11
U	
Union Drawn Steel Co., Hamilton, Ont	6
United Fire Brick Co., Pittsburg, Pa	35
W	
Williams, A. R., Machinery Co., Toronto	3
Winn & Holland, Montreal	37