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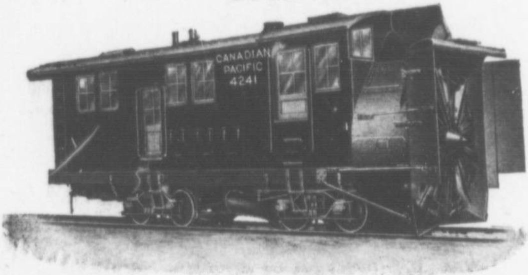

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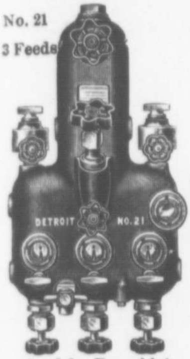

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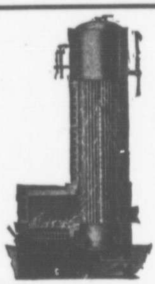

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PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA MEETING.

PRINCE GEORGE HOTEL, TORONTO, Nov. 22, 1910.

The 1st vice-president, Mr. Baldwin, occupied the chair.

Chairman,

As our president is a little under the weather, he does not feel equal to the occasion of filling two positions—as president and lecturer, and he has asked me to take the chair.

The first order of business is the reading of the minutes of the previous meeting, and as you have all had a copy it will be in order for someone to move their adoption.

Moved by Mr. Herriott, seconded by Mr. Neild, that the minutes of the previous meeting be adopted as read. Carried.

Chairman,—

I will now call on the secretary to announce the new members.

NEW MEMBERS.

Mr. W. E. Adams, Shipper, Structural Department, Canada Foundry Co., Toronto.

Mr. W. H. Church, Foreman, Pipe Shops, Canada Foundry Co., Toronto.

Mr. G. McLachlan, Erector, Canada Foundry Co., Toronto.

Mr. T. C. Tinline, Manufacturer, Toronto.

Mr. F. Bastow, Gentleman, Toronto.

Mr. W. C. Skelding, Sales Manager, British American Oil Co., Toronto.

Mr. H. B. Vivian, Apprentice, G. T. Ry., Stratford.

Mr. R. Muirhead, Engineer, G. T. Ry., Stratford.

Mr. A. A. Allen, Manager, Holden Co., Montreal.

Mr. W. A. Grocock, Engineers' Representative, Toronto.

Mr. J. J. Harris, Chief Engineer, O'Keefe Brewery Co., Toronto.

Mr. T. Graham, Assistant Engineer, City Hall, Toronto.

Mr. M. Foy, Chief Engineer, Toronto Cold Storage, Toronto.

Mr. G. G. G. Ffolkes, Manufacturer, Wilkinson Plough Co., Toronto.

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H. G. Fletcher.	J. F. Campbell.	A. Stewart.
L. S. Hyde.	C. L. Worth.	

Secretary,—

I may say, that at the last three or four meetings we have had a pretty fair number join the Club.

It is not often that I get up and say anything, but I want to say that there are a whole lot of members who have never introduced a new member. We have got a good Club and there is not a member who could not bring in one or two new members, if he would interest himself.

Chairman,—

Regardless of what Mr. Worth has said, last meeting night we brought in 21 new members, and as we have 14 new members to-night, that makes a total of 35 new members in two meetings, which is a pretty fair showing, but still I would like to see a few more names on the list each night.

The next order of business is the reading of papers and the discussion thereof.

Our esteemed president, Mr. Duguid, is going to give us a paper to-night on High Speed Steel, and I have now great pleasure in calling upon him.

HIGH SPEED STEEL.

BY J. DUGUID, GENERAL FOREMAN, G.T.R., TORONTO.

I have given this paper the above name so that I would have a big field to talk about and therefore I could not be accused of wandering away from the title of this paper. I am not going into the subject of high speed steel technically, but will give you my observations through using this steel and also what I have read about it. High speed steel got its name no doubt from the fact that when it was first introduced the only way to get the increased efficiency of it was to run the machines at a high speed as the old style machines were not built to carry heavy cuts, the driving belts and cones being too narrow to transmit the necessary power, and it was found

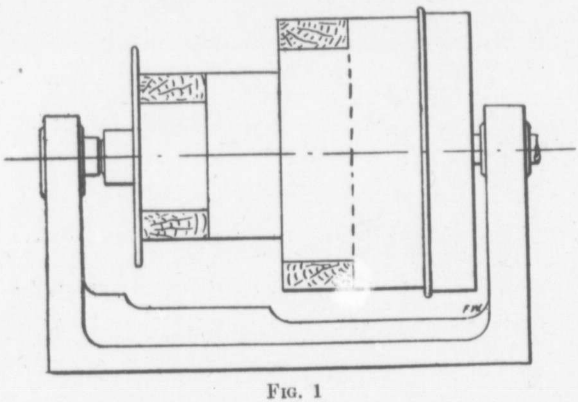


FIG. 1

if you increased these, as was done in some cases, as shown on Fig. 1, the other parts of the machine gave out under the strain. These parts then being strengthened up it was then found that the whole machine frame was not rigid enough and caused the tools to break on account of the vibration, and in the face of these facts all that could be done was to carry about the same size cuts with the high speed steel as with the old carbon steel, but speed up the machines. It was at this point that the manufacturers of machine tools saw the necessity of building more powerful and rigid machines, and to them should be given as much credit for increased output of machines as the high speed steel manufacturers. Although the great majority of machine shops are using high speed steel at the present time I venture to say that very few of them are getting over 75 per cent. of the total efficiency of the steel, principally for the following reasons:—

1st. The great number of old and out of date machines and heavy work being done in them, they are therefore not carrying a heavy enough cut, neither can they be run to proper speed, and about 50 per cent. of the steel efficiency is all you are getting under these conditions. There are conditions, however, where old machines can be used to good advantage with the high speed steel and that is on repair work such as skimming up old piston rods, valve rods, etc.

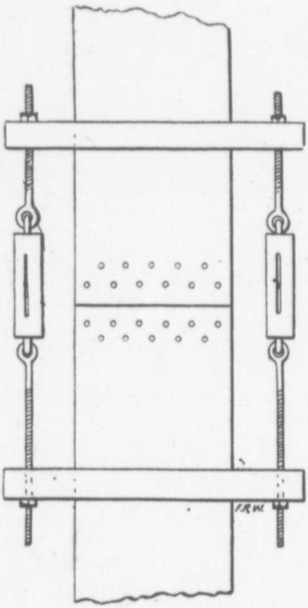


FIG. 2

2nd. The different shape of tools on uniform work. Workmen will grind machine tools about the same as ladies choose their hats, which is every shape and some of these the most ridiculous. I believe if there was a uniform system in every shop for the grinding of tools (such as some shops have adopted) that it would greatly increase the life of the steel: also the efficiency.

3rd. The different speeds and size of cuts on uniform work and material. This is one of the most serious defects in the use of high speed steel or in fact any steel.

4th. The use of belting not of proper tightness and belts that are worn out. I think you will agree with me that a great many manufacturers will use a belt until it all falls to pieces, although it may be decreasing the output of their high steel by 50 per cent. All belting that is driving machine tools should be adjusted with spring clamps as shown with sketch (Fig. 2) so as to ensure proper tension and driving power.

The proper tension for belts per inch of width: 2 ply about 38 lbs.; 3 ply, about 47 lbs.; 4 ply, about 56 lbs.

5th. The over hang of tools in tool rest causing excessive chattering and consequently breaking of tools.

6th. The use of dull tools also the want of reforging. The use of dull tools causes excessive heating destroying them and also a great loss on account of the extra power required to drive the machine.

7th. The want of proper supply of cooling water used, thereby allowing the tool to become overheated and fail.

8th. The want of variable speed enough on the machines to suit the different diameters of work.

9th. The use of too light tools on heavy work.

Now these are some of the reasons why we are not getting nearly the full efficiency from high speed steel, which must be quite apparent to those of us connected with machine shops and are all defects that can be remedied with proper supervision.

I will now try to describe to you the action of a tool and its wear in cutting metal. A great many of us imagine that it is the sharp edge of the tool the same as a razor that is doing the work, such however is not the case.

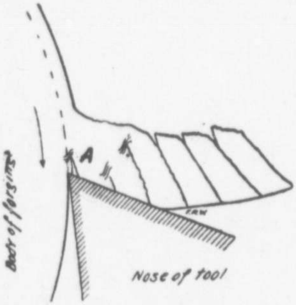


FIG. 3

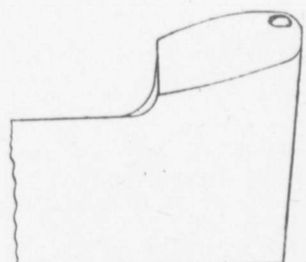


FIG. 5

Fig. 3 is an enlarged view of the action of a tool in cutting a chip from a forging at its proper speed, and it is therefore plain that in all roughing cuts the chip is torn away from the forging, rather than removed by the action which we term cutting. The familiar action of cutting, as exemplified by an axe or knife removing a chip from a piece of wood, for instance, consists in forcing a sharp wedge (i.e. one whose flanks form an acute angle) into the substance to be cut. Both flanks of the wedge press constantly upon the wood, one flank bearing against the main body of the piece, while the other forces or wedges the chip or shaving away. While a metal cutting tool looks like a wedge, its cutting edge being formed by the intersection of the "lip surface" and "clearance surface" of flank of the tool its action is far different from that of the wedge. Only one surface of a metal cutting tool, the lip surface, ever presses against the metal. The clearance surface as its name implies, is never allowed to touch the forging. Thus "cutting" with a metal cutting tool consists in pressing, tearing, or shearing the metal away with the lip surface of the "wedge" only under pressure, while in the case of the axe and other kinds of cutting both wedge surfaces are constantly under pressure. The enlarged view of the chip, tool and forging, shown in Fig. 5 represents with fair accuracy the relative proportions which the shaving cut from a forging of mild steel finally assumes with relation to the original thickness of the layer of metal which the tool is about to remove. Now some of you may think this theory is all wrong, because you have noted that the cutting you have taken off a forging was of the same size as the depth of cut and the feed you used, but that only shows that you were not using a heavy enough feed and not running at a proper speed.

In experiments made to show the pressure of the chip on the tool cutting a chip of uniform size it was found that the pressure varied with wave like regularity and that the smallest pressure was about two-thirds the maximum pressure and this is the reason that old light machines will not handle the heavy cuts of high speed steel. The cause of these variations in pressure is the breaking of the chip in sections. It would appear that the chip is torn off from the forging at a point above the cutting edge of the tool and this tearing off action leaves the forging in all cases more or less jagged or irregular at the exact spot where the chip is pulled away from the forging, as shown to the left of A. An instant later the line of the cutting edge, or more correctly speaking, the portion of the lip surface immediately adjoining the cutting edge, comes in contact with these slight irreguliarities left on the forging owing to the tearing action, and shears those lumps off, so as to leave the receding flank of the forging comparatively smooth.

The cutting edge of the tool is continually in action, scraping or shearing off or rubbing away these small irregularities left on the forging, yet that portion of the lip service close to the cutting edge constantly receives much less pressure from the chip than the same surface receives at a slight distance away from the cutting edge. This allows the tool to run at higher cutting speeds than would be possible if the cutting edge received the same pressure as does the lip surface close to it.

There are many things which indicate this tearing action of the tool. For example, it is an everyday occurrence to see cutting tools which have been running close to their maximum speeds which have been under cut for a considerable length of time, guttered out at a little distance back of the cutting edge, as shown in Fig. 5. The wear in this spot indicates that the pressure of the chip has been most severe at a little distance back from the edge. Still another manner in which in many cases the tearing action of the tool is indicated is illustrated in Fig. 6 in which a small mass of metal is shown to be

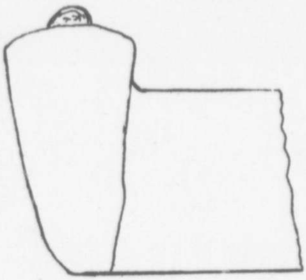


FIG. 6

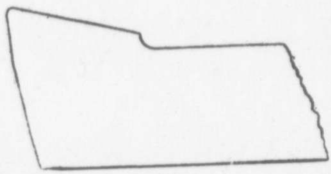


FIG. 7

stuck fast to the lip surface of the tool after it has completed its work and been removed from the lathe. When broken off, however, and carefully examined, this mass will be found to consist of a great number of small particles which have been cut or scraped off the forging, as above described, by the cutting edge of the tool. They are then pressed down into a dense little pile of compacted particles of steel or dust stuck together and to the lip surface of the tool almost as if they had been welded. In the case of the modern high speed tools, when this little mass of dust or particles is removed from the upper surface of the tool, the cutting edge will in most cases be found to be about as sharp as ever, and the lip surface adjacent to it when closely examined will show in many cases the scratches left by the Emery wheel from the original grinding of the tool.

With roughing tools made out of old-fashioned tempered steel, and which have been speeded close to their "standard speeds," in most cases after removing this "dust pile" from the lip surface the cutting edge of the tool will be found to be distinctly rounded over. And in cases where the tool has been cutting a very thick shaving, the edge will be found to be very greatly rounded over, as shown in the enlarged view of the nose of tool in Fig. 7.

With carbon steel tempered tools at standard speeds the cutting edge begins to be injured almost as soon as the tool starts to work, and is entirely rounded over and worn away before the tool finally gives out, but the tool works well in spite of its cutting edge being damaged. While with high-speed tools at standard speeds, the cutting edge remains in almost perfect condition until just before the tool gives out, when even a very slight damage at one spot on the cutting edge will usually cause the tool to be ruined in a very few revolutions.

Carbon tempered tools and also, to a considerable extent, the old-fashioned self-hardening tools (such as Mushet), when run at their "standard" speeds, pass through the following characteristic phases as they progress toward the point at which they are finally ruined; "rounding of the cutting edge," "mounting of steel upon the lip and the rubbing away beneath the cutting edge"; long before the tool is ruined the fine particles of steel or dust scraped off by the cutting edge begin to weld or stick to the lip of the tool and mount upon it sometimes from 1-16 inch to ¼ inch in height, as shown in Fig. 6. As stated above, in the case of modern high speed tools the damage caused to the tool through the action of cutting is confined almost entirely to the lip surface of the tool. Doubtless also the metal right at the cutting edge of the tool remains harder than it is directly under the centre of pressure of the chip, because the cutting edge is next to and constantly rubs against the cold body of the forging, and is materially cooled by this contact.

Whether the lip surface be ground away at high speeds or at slower speeds, the nose of the tool is generally "ruined" in a very short time after the cutting edge has been so damaged that it fails to scrape off smoothly even at one small spot the rough projections which have been left on the body of the forging by tearing away the chip. The moment the body of the forging begins to rub against the clearance flank of one of these high-speed tools at or just below the cutting edge, even at one small place, the friction at this point generates so high a heat as to soften the tool very rapidly. After a comparatively few revolutions the cutting edge and the flank of the tool beneath it will be completely rubbed and melted away, as shown in Fig. 8. A tool which was still in "fair" condition when removed from the lathe, although showing some slight signs of ruining is shown in Fig. 9. The above characteristic of holding their cutting edges in practically perfect condition while running at economical speeds up to the ruining point is a valuable property of the high-speed tools, since it insures a good finish, and the maintenance throughout the cut of the proper size of the work, without the constant watchfulness required on the part of the operator in the case of old slow-speed tools with their rounded and otherwise injured cutting edges, which when run at economical speeds were likely at any minute to damage the finish of the work.

But when one of these high-speed tools is nearing its ruining point, a very trifling nick or break in the line of the cutting

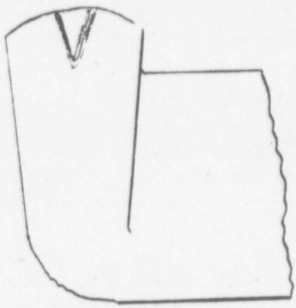


FIG. 8

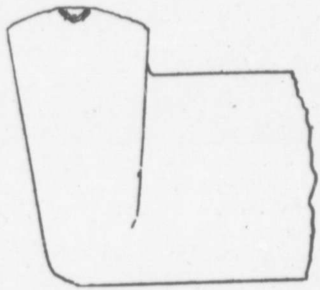


FIG. 9

edge will be at once noticed by its making a very small but continuous scratch, projecting ridge, or bright streak, on the forging, that is, upon that part of the forging from which the spiral line of the chip has just been removed, thus warning the operator of the impending breakdown of the tool.

Regarding the proper speed to run high speed steel. There can be no uniform standard for the speed for the reason that even on the same class of material there is a wide variation in the speed that it can be economically worked and then again a forging of large dimensions can be cut at a greater number of feet per minute than a small one on account of its capacity for carrying of the heat generated and the tool is not cutting on the same point on the circumference so often on account of the larger diameter. A cutting speed which will cause a given tool to be ruined at the end of eighty minutes is about twenty per cent. slower than the cutting speed of the same tool it it were to last twenty minutes. On the whole it is not economical to run roughing tools at a cutting speed so slow as to cause them to last for more than one and one-half hours without being re-ground, this of course refers to working on ordinary machinery steel.

High speed can be used on forgings up to 110 feet per minute, but only on short cuts and light feeds on such work as bolts, pins, etc., but when working on heavy rigid forgings that require heavy reduction to bring them to desired size, it is more economical to increase the feed to the limit of the machine capacity and reduce the speed to suit, as you will find that by reducing the speed 25 per cent. the feed can be increased 50 per cent.

Heavy cuts and heavy feeds have become specially necessary because Superintendents of shops have found it more economical to reduce forging to size by the heavy modern tools and high speed steel than under the hammers in the forge shop, and are therefore having much more material to remove than they formerly did.

The following are some tests I have seen from time to time with high speed steel:

1st. Locomotive driving axle, speed 75 feet per minute, reduction in diameter 1 5-16 inches; feed, 3-16.

2nd. Old locomotive steel tyres, two tools, depth of cut ½ inch, feed 5-16 inch, speed 28 feet per minute, metal removed, 155 pounds in twelve minutes.

3rd. Six pair of old and two pair new 63 inch locomotive driving tires turned in 5 hours 50 minutes, average time 43.75 minutes each; average cutting time, 35.87 minutes each pair; speed from 14 to 21 feet per minute; 5-16 feed; depth of cut, ⅜ inch.

4th. Forged steel shaft 16 inches diameter; 13 feet long; feed ⅜; depth of cut, 1 1-16 inches; speed, 50 feet per minute; the tool took this cut entire length with one slight grinding.

Now I do not claim that the above is the average efficiency by which metal can be machined, but only to show what high speed will stand.

Regarding the shape of turning tools you will note in this paper that I have only referred to standard roughing tools. The shape of tools is of just as much importance as the material they are made of, and must have the following requirements:

1st. To have the work true and sufficiently smooth.

2nd. To remove the metal in the shortest possible time.

3rd. To do the largest amount of work with the lowest cost of grinding and forging.

4th. To be adapted to the largest variety of work.

5th. To remove the metal with the lowest horse power.

6th. It must be shaped to have the point as strong as possible and cutting edge supported.

One difficulty in practice is to have always a supply of sharp tools for the machinist, and it is better to have a few shapes and plenty of tools, than to have many shapes and not enough of any one kind. These should be ground to templets, if they must be done by hand; but an automatic tool grinder will pay even in a moderate-sized shop.

Fig. 10 represents a good standard roughing tool, and note that the lip surface is raised above the body of the tool, this is to increase the life of the tool before being reforged and also to reduce the grinding to a minimum.

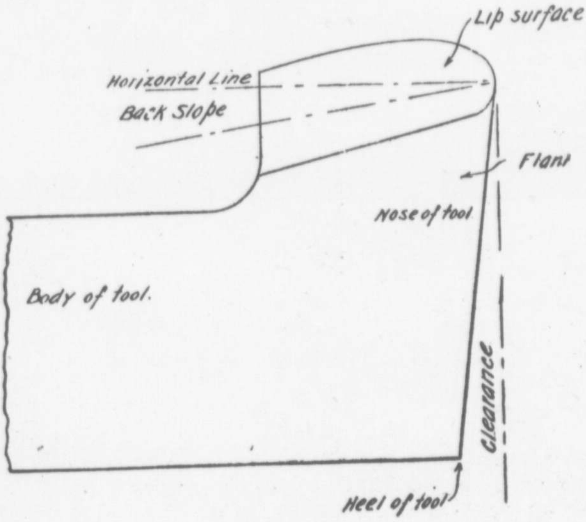


FIG. 10

CURVED CUTTING EDGE BEST.

The curved-edge cutting tool is best for roughing in all cases for the reason that it removes a shaving which varies in its thickness at all points, and that the part of the cutting edge which finishes the cut is removing so little metal that it remains sharp even though most of the cutting edge has been worn or broken away. The effect of this is shown in Fig. 11. This indicates that the accuracy and finish of the work depend on that part of the edge from "A" to point "B," remaining sharp and uninjured.

The curved face as you will note on Fig. 11 also puts the heaviest part of the cutting back from the point and where the tool is heavy and can carry off the generated heat.

Standard tools should have a clearance angle of six degrees for all classes of material and a back slope of eight degrees for all material, and a side slope of fourteen degrees for cast iron and hard steel and twenty-two degrees for medium and soft steel.

The lip angle is determined by making it just blunt enough to stand the cut without crumbling or spalling. A sharp side slope is better than a sharp back slope, because the tool can be ground more often without weakening it, the chips run off better, the strain is more on the base of the tool and it is easier to feed.

It may seem strange that the lip angle for cutting cast iron is not as keen as for the softer steels, but the highest cutting

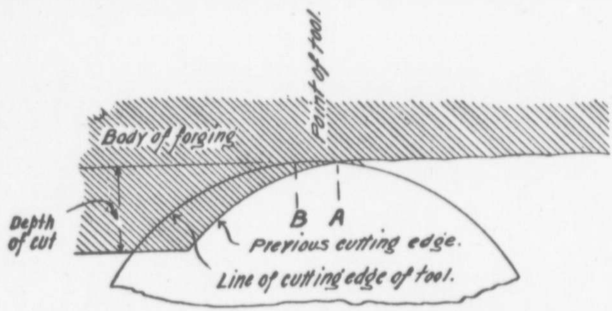


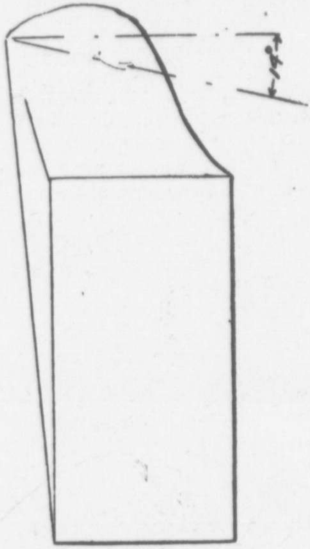
FIG. 11

speeds with equal depth of cut and feed can be obtained by using the angles given. The thickness of the shaving has the most important effect of the cutting speed, much more so than the depth of the feed. This is the reason for the advantage of the large curve on the cutting edge, as this decreases the thickness of the shaving as can be seen in Fig. 11.

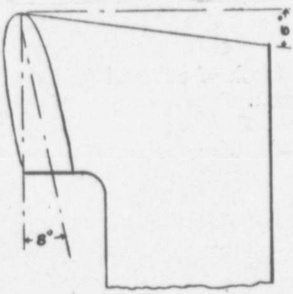
The clearance angle of any tool is the most important and if it is more than six degrees it will not properly support the cutting edge, which will break and cause a fracture of the tool.

GRINDING HIGH SPEED TOOLS.

I believe more tools are ruined by careless grinding than by any other means, and it is a peculiar fact that while high speed steel can be run at a high temperature in work without injury, they are easily destroyed on an emery wheel, and if the too is pressed firmly against the wheel and allowed to heat up you will find small cracks started in the steel. In a great many shops high speed tools are ground on a dry wheel, but I think this is a mistake, and again when a wet wheel is used there is not a sufficient amount of water used. Experience has



A

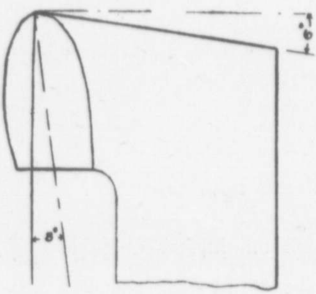


B

shown that not less than four gallons of water per minute should be used. Automatic grinders should be used for heavy grinding on all high speed tools, as the pressure on the wheel is uniform and the shape of the tools are kept uniform, and much better results will be obtained in turning out work.

USE OF WATER ON MATERIAL WHERE TURNING.

Water used on a high speed steel increases its capacity in every case and the gain is practically the same for all qualities of steel, and for removing thin or thick chips. With high speed tools a gain is made by using water on cast iron, contrary to most beliefs.



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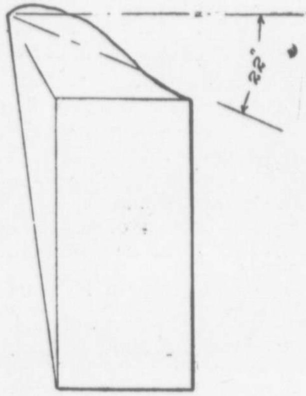

D

HOW TO USE IT AND WHAT IT GAINS.

A heavy stream of water should be thrown directly on the chip as shown in Fig. 12, and not up under the chip as in Fig. 13, even though this might seem the correct way. Experience

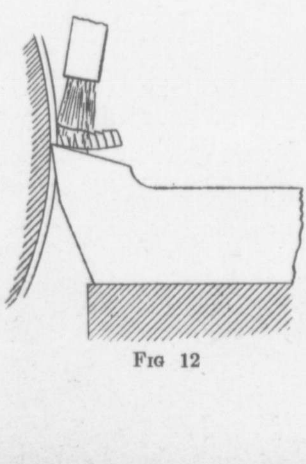

FIG 12

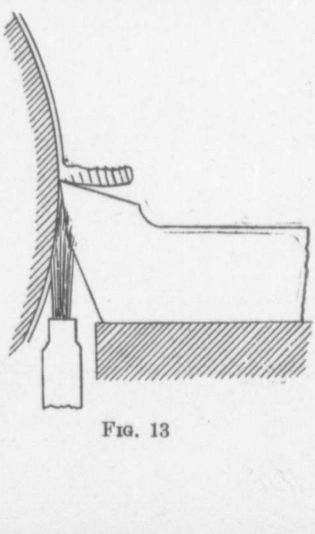

FIG. 13

has shown that throwing it on the chip takes away the heat fastest. A guide to the amount of water to be used is that three gallons a minute is right for tools $2 \times 2\frac{1}{2}$ inches, and less for smaller tools. The gain in efficiency by the use of water is given as:

40 per cent. with modern high speed tools.
30 per cent. with old style self-hardening tools.
20 per cent. with carbon tempered tools.
16 per cent. in cutting cast iron.

In some shops various cutting compounds or lubricants (as they are called) are used on lathes and planers, but there is no extra efficiency using this material on an engine lathe or planer any further than that it does not rust the machine. However these compounds give first class results on drills, screw-cutting machines and turret lathes, but with these you require both a cooling and lubricating mixture, whereas on ordinary turning all that is required is cooling.

HORSE POWER REQUIRED USING HIGH SPEED STEEL.

With the advent of high speed steel the power required to drive the machines to their maximum increased enormously, for example:

A 12 inch lathe increased from 1 to 4 horse power;
A 30 " " " " 5 to 20 " "
A 72 " " " " 15 to 50 " "

and in a test made with a 72 inch lathe with a cut $1\frac{1}{2}$ inch deep and $\frac{1}{4}$ inch feed and 30 feet per minute, required 75 horse power. Fig. 14 shows the horse power required to remove

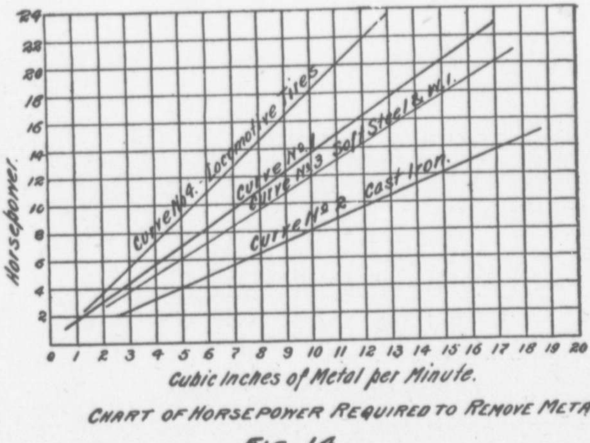

CHART OF HORSEPOWER REQUIRED TO REMOVE METAL

FIG. 14.

metal with roughing tools of the shape mentioned previously in this paper, and it must be remembered that the shape not only increases the life of the tools and is easier on the machine, but there is also a marked difference in the power required.

FORGING.

For forging high-speed steel an ordinary forge fire will serve; though, indeed, better results may be expected if better apparatus is used. The principal thing is to secure the required heat, and to keep air currents away from the tool in heating. For small tools of the simpler sort good results are sometimes obtained from an ordinary open fire. The result is, however, much more likely to be satisfactory if a sort of hood is built over the fire. This serves to prevent the radiation of heat and the circulation of air currents, and is a necessity in heating tools of any size. It also makes it easier to bring up the heat gradually, and to apply it uniformly on all sides of the tool, so that the heat penetrates uniformly. This is an important point. Unless the mass of steel to be wrought is uniformly hot throughout, it will work unevenly in forging, with the result that internal strains are set up which may ruin the tool when it is put at work, if not before. Though the heating is to proceed gradually, in the sense that it must be regular, it may go on quite rapidly. In fact it should be done as rapidly as may be without burning projecting edges or corners. Unless this is done the heat soaks up into the neck or shank, and when hardening takes place this important part of the tool loses some of its toughness.

THE RIGHT HEAT.

However, the fire must not be too hot, for in that case the outside is likely to be burned before the interior is thoroughly heated. In any event there is a likelihood that the tool smith may be deceived into thinking the whole mass properly heated when in fact only the outside is hot enough for forging. If the interior has not reached a bright red heat, or 1800 degrees F. it is not ready for hammering. Of course it is impossible to know the condition of the interior, except through its behaviour under the hammer after removal from the fire, and it is largely a matter of experience to determine the proper time during which a tool is to be heated.

HEATING FOR HARDENING.

The extent to which the heating is to be carried for hardening may vary within narrow limits, just short of melting point. The steel will then be at a dazzling white, and just beginning to flux. Some brands reach this point somewhat short of the extreme white color. Where this is the case, care must be taken that sharp edges and angles of the tool are not melted down. As in forging, it is necessary to see that the heating proceeds uniformly and reaches through the entire mass of metal.

THE AIR BLAST.

As most of the high speed steel hardens by mere exposure to air, little apparatus is absolutely required in addition to the heating furnace; and some very good results have been obtained with none at all. The hardness of the steel depends considerably, however, on the rapidity of the cooling, therefore mere exposure to the air and slow cooling is not always satisfactory—for many purposes, indeed, it is very unsatisfactory. Most makers recommend the air blast for hardening, and as this furnishes a continuous supply of cool air in rapid motion, the result is generally good.

Since part of the latent heat in the air is extracted in the process of compression, compressed air is better for the purpose than that from a blower. The convenience and simplicity of this agent, where available, recommends it.

THE DIFFERENT USES OF HIGH SPEED STEEL.

When high speed steel was first introduced users were of the opinion that it was only fit for roughing tools. This was a fact at that time as the edges of the tools would not keep sharp enough for the finer classes of tools. However, since that time the manufacturer of high speed tools have improved it so that at the present time it can be used and is used for milling cutters, reamers, cold saws, and in fact all machine shop tools with good success and a great increase of efficiency over carbon steel, and at the present time it is also used for the very finest of tools, even razors.

High speed steel is also now used extensively for twist drills, and good results can be attained with these providing you use them on heavy castings or forgings, but if used for light work it must be securely bolted to the drill table otherwise too many drills will be broken, as high speed twist drills will not stand quick torsion strains, for all classes of rough work I have found that flat drills made from high speed steel give better results than twist drills as the points can be forged thick and will not break even with severe usage.

In conclusion let me say that on account of the high price of high speed steel care should be taken that short ends of tools are not scrapped or mixed up with other pieces of carbon steel, as these short ends can be used up for special cutters or drawn out for smaller size tools than the original.

The best method of marking is by planing or milling a small concave groove the whole length of the tool, then the steel can be distinguished no matter how short a piece it is.

Chairman,—

We have all, especially the machinists who happen to be present to-night, listened with very great interest to the paper which our president has brought before us to-night, and I would like to know if anybody would like to ask any questions.

Mr. Wickens,—

I am sure Mr. Duguid has given us a splendid illustration to-night of the use of high speed steel.

The Chairman kept looking at me, and although I am not now a working machinist, I suppose he expects me to say something on the matter.

When I was in a machine shop there were no high speed steels and we used carbon steels. Our work was not on heavy forgings, the majority of it was on castings. It was only an ordinary machine shop where we made steam engines, and three-quarters of the work was on cast iron.

The first steel we got that was better than ordinary tool steel was called Mushet steel. This was about 34 or 35 years ago. This Mushet steel did not need tempering, but had to be handled carefully in the fire. We were able to get very good tools from this steel and we were able to work at about double the speed of the ordinary carbon steel.

One of the chief difficulties we had, was in turning up large fly wheels, as we had to drive the tool below the scale which formed the outer edge of these wheels, which were 12 or 18 feet in diameter; we would be forced to cut just below the scale, and then we might get a cut three-quarters of an inch deep, on one side or part of the wheel.

Very much of Mr. Duguid's talk is somewhat foreign to me, on account of not having had any practice whatever with modern high speed tools, I have often been in shops where they were using them, and have, of course, watched the operation with considerable interest.

I feel that in the early days we knew something about dressing tools. The average machinist in those days always dressed his own tools, and if ever a first-class lathe hand came to the shop he always wanted to go to the fire to dress his own tools. I am speaking about shops that were not large enough to have a regular tool dresser who did nothing else. I think the reason that the machinists of those days made a better job of dressing the tools than the blacksmith, was, because they had more patience than the blacksmith, and would take time to heat the tool to the right heat before hammering. As you know if this is done the tools will not have any cracks, and therefore the tools would probably stand three times as long as the tool which was not so carefully heated while being dressed.

There is no doubt that high speed steel can be over heated, although high speed steel will stand much more heat than carbon steel, but when it has once been over heated part of its usefulness is gone, and cannot be restored, while you can restore the usefulness of carbon steel after it has been over heated.

Mr. Duguid spoke about the difficulty of getting heavy enough cuts with high speed steel. Our old lathes were built on the old style, the spindles were light, the belts were narrow, and if we put on too heavy a cut the tool carriage would spring and we would have everything twisted out of shape. We were also bothered by trembling, or as we call it, chattering.

All this was not the fault of the steel, but simply because we were trying to make the tool do more work than it should. When we were turning engine shafts, we never got a round shaft, and you can imagine the difficulty we had in making these shafts fit into the holes that had been bored round and true.

Chairman,—

From time to time we have old members, who have left the city attend our meetings. I know you will all be pleased to hear that we have with us to-night Mr. Harkom, consulting engineer, of Richmond, P.Q., and we will be pleased to hear from him. He is one of the old school as well as one of the modern ones, and can link the past with the present.

Mr. Harkom,—

I must confess that when I came here to-night I did not intend to say anything; however, when I received a notice of this meeting I did hope that I would be able to be present, and I am very pleased that I was able to be here and express my personal gratification and appreciation of the instructive paper which our president has read to us to-night.

During the course of his address I began to wonder whether it was possible to have another illustration like the one showing the horse power required to remove metal with high speed steel, making a comparative table in which the use of carbon steel could be shown. I know, of course, that it would be very difficult to do so, and it would be necessary in making this test to set aside the ordinary work. This would, of course, be out of the question under the conditions under which we have to work in these days. Before the advent of high speed steel we did not find it necessary to formulate such a table as that.

There is no question about one point that Mr. Duguid made, and that was the great increase in power necessary to remove a given quantity of metal, with high speed steel tools, with quick removal as compared with ordinary carbon steel at the former rate of removal. This just illustrates the story of driving a steamboat at her ordinary speed. If you want to increase the speed you will use up more steam and burn a great deal more coal in proportion to the increase of speed. It is an illustration of an exception to that old adage, "most haste less speed," but in this particular case we get speed and we also get more haste, and so we get through quicker by using this speed.

In regard to diagram Fig. 1, I would like to say a word in defence of the "old man" who said "Don't make the tools too broad." I am not sure myself but what perhaps Mr. Duguid has overlooked the chief points in the old man's favor, as later on he spoke of the manner in which the cutting edge of the old carbon steel tools crumbled away, therefore the use with high speed steel of the larger edge no doubt helps to preserve the tool, but there is no doubt as to the superior results with high speed steel, and that class of tool is the right one.

Mr. Duguid spoke of certain conditions in the old days:—the tool dresser. I am looking back, and it is a long while ago, to the time when I was working on a lathe and planer. I was somewhat of a crank myself, I do not say that I was a cracker-jack, but I do say that I was a crank, and one of the things I was always most particular about was the forging of my tools.

Mr. Harkom then gave an illustration on the blackboard of what was considered the best method of shaping tools for heavy cuts when machines were not so rigid and steel had not the qualities of the modern high speed article.

The practice of throwing a heavy stream of water directly on the chip, as shown by Mr. Duguid, and not under it, is undoubtedly right. It stands to reason that it must be right as this is unquestionably the best way of applying the cooling medium to the point where the heat is greatest.

Mr. Wickens,—

I think the thanks of the Club are due to our president for the paper which he has read to us to-night. It has been more than well prepared, and he has shown us that he is master of his subject, and I have very much pleasure in moving a hearty vote of thanks to our president for his very able lecture.

Mr. Newman,—

Before seconding that motion, I would like to ask for a little information. This is not about something that happened forty years ago, but something that we were up against six weeks ago. We had a conical shaped casting about 58 inches in diameter, and on examining the casting we found that there was a very bad flaw in it. The casting was sent back to the mill, and a piece of metal was electrically welded into the flaw. When it came back to the works we attempted to turn it down but we could not find a high speed steel, Mushet steel or carbon steel tool that would touch it, and I would like to know why this was?

Mr. Duguid,—

I have not had any experience with trying to turn down a casting that had a piece electrically welded into it, but I have had considerable experience in trying to turn down driving tires, and these are about the hardest thing that I know of. I have found that we do not get much better results in cutting chilled cast iron or hard steel with high speed steel than we did with the old carbon steel. The great difference is that with light cuts and light feeds used with carbon steel the tool is always forced away from the work or destroyed, but with the high speed steel and heavy cuts and heavy feeds the hard spots are broken up and in this way the efficiency of high speed steel is much greater than the carbon steel, so that if any one imagines they can cut chilled or tempered material any better with high speed steel than they can with carbon steel, they are mistaken.

Mr. Harkom,—

The electrical welding of a flaw in a heavy steel casting is a very dangerous operation, always uncertain and frequently unsatisfactory. In the first place it is very seldom that you get anything more than a wash over the flaw.

The annealing of the casting has nothing whatever to do with the electrical process and the excessive hardness of the spot was most probably due to improper treatment or impure material being used, and this was the reason that you had so much trouble.

There is one thing in annealing that must not be overlooked, that it is absolutely necessary to bring the entire casting to a heat of somewhere about 1,200 degrees Fah. to ensure successful annealing.

Mr. Newman,—

The annealing was done at the mill.

Mr. Harkom,—

It is very probable that it was not annealed at all, but that the flaw was filled up with a very hard piece of steel, or some other substance, and the only way to deal with it was to find a tool that would get under the scale. It would be necessary to get a very deep cut and that is what you are able to do with high speed steel. Failing that the only practical method was to grind it off.

Mr. Newman,—

I take much pleasure in seconding the vote of thanks.

Mr. Duguid,—

I thank you very much for the hearty vote of thanks, but I am not going to promise to get up another paper as I found I had undertaken a bigger job than I anticipated; however, I am well paid for the trouble I have taken, by your close attention to-night.

Chairman,—

The next order of business is the appointing of a Nominating Committee for the nomination of officers for the year 1911. I will read you Section 10 of the By-laws, which is as follows:—"At the meeting preceeding the annual meeting a Nominating Committee of five shall be elected, who shall present at the annual meeting nominees for each office to be filled; it shall be the privilege of any member of the Club to nominate other candidates, the nominees receiving the highest number of votes for each office, to be declared elected."

The Nominating Committee is for the purpose of bringing in a list of the officers to serve for next year. This list will be presented for your consideration at the next meeting. Of course you are not bound to accept the names which they bring in, each office will be open to any one at the next meeting to nominate anybody else they prefer. I would like somebody to nominate the officers for the Nominating Committee.

The following were nominated as officers for the Nominating Committee:—

C. G. Herring, Draughtsman, Consumers' Gas Co., Toronto.
J. Herriott, General Storekeeper, Canada Foundry Co., Toronto.
A. E. Till, Foreman, C.P.R., Toronto.
H. G. Fletcher, Representative, Garlock Packing Co., Toronto.

W. Newman, General Superintendent, Polsons's Iron Works, Limited, Toronto.

Secretary,—

It has been the custom for the retiring president to become a member of the Executive Committee. This matter was brought up at the last Executive Meeting, and it was decided that this was a mistake, as it is only a matter of time when the Executive Committee would consist entirely of past presidents.

Mr. Jefferis, who was president last year, stated that he thought it would be better if the rank and file of the Club should select from amongst themselves officers for the ensuing year, and that it would be better for past presidents to become honorary presidents, and that their names should appear as such on the front page of the book.

My idea is that, as near as possible, every large concern represented in the Club should have a representative on the Executive Committee. We want you to elect men who will take an interest in the welfare of the Club, and devote some of their time to the same.

Chairman,—

I would ask the members of the Nominating Committee who have been appointed to-night, to stay after this meeting for a few minutes, and arrange with Mr. Worth when they will hold their meeting.

Proposed by Mr. Keith, seconded by Mr. Neild that the meeting be adjourned. Carried.