See Alphabetical Index to Advertisements on page 145

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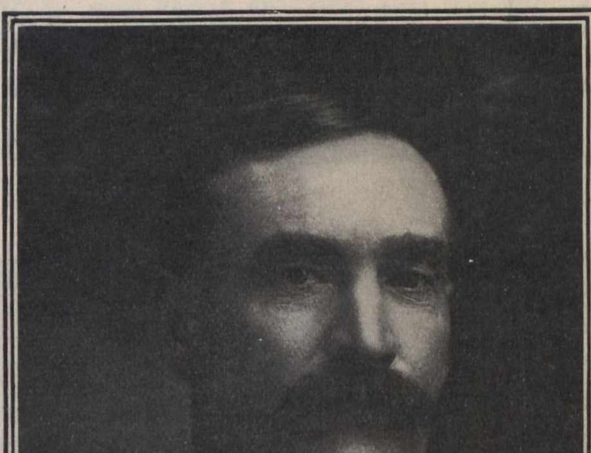
The Efficiency of Tools and Economy in Manufacture of Same.

By W. M. Townsend, Supervisor of Tools, Montreal Locomotive Works Ltd

I will endeavor to bring out, in the following, a few points relative to the making of cheap and efficient tools. Various kinds of milling machines are rapidly making their way prominent in removing surplus stock from machine and locomotive parts, hence the necessity of having durable milling cutters. To obtain an efficient milling cutter there are two points which are essential, namely, high speed steel and a spiral or helical cutting edge. The latter quality may not appeal to some, due to the fact that an inserted tooth cutter made from a mild steel body with a high speed steel blade inserted at an angle of about 12 degrees, answers fairly well. This, however, is a great mistake. To obtain a clean cut it is necessary to have a certain and constant angle of rake or lip to the milling cutter. This can be obtained only by having a helical or spiral cutting edge. To construct the milling cutter that will give the best results and still adhere to the principle of strict economy (the point which I wish to emphasize mostly in this paper), we must first of all consider its diameter. We will first speak of cutters having a diameter of over 6 ins. Keeping close to our principle of economy, we apply to the scrap heap for material; there we will find crop ends of billet steel sawn from the ends of driving axles, which make an ideal body for an inserted tooth high speed steel milling cutter. The scrap value of these crop ends is very small, hence the low cost for the body of the cutter. Now, to procure high speed steel for the blades in an economical manner (which if cut from the steel bar would cost 50c a pound), we collect all the broken and short high speed tools that cannot be further used on planers, shapers, lathes, etc. These are hammered into blades ⅝ x 1¼ x 5 ins. long. The cost of material for the blades is covered by the cost of labor in hammering out the steel plus its scrap value which is very small. So much for the economy in procuring material.

We will now turn our attention to the design, upon which depends the efficiency. The bodies, after having been bored, turned and faced, are milled with slots ⅝ in. wide, ¾ in. deep, 1½ in. apart, at an angle corresponding to a predetermined helix or spiral. The blades are then fitted and slightly caulked. The cutter is then set up on a universal milling machine, and the front of the blades milled spiral. This gives a constant angle of rake or lip from one end to the other. This insures an equal strain along the whole length of the blade. On the other hand, if the blades are merely put in on an angle and not milled spiral, the lip or rake of the cutter is irregular. It can readily be seen that from one end of the cutter to the centre there will be a decreasing lip, while from the centre to the other end of the cutter there will be an increasing drag. This causes an unevenness in the cut and also a tendency to break and pull out the blades on the drag side. So much for cutters having a diameter over six inches.

Inserted tooth cutters with a diameter much less than six inches are not practical, due to the fact that slot cut at an angle across the top of the cutter body would be very irregular in depth, hence the impossibility of holding the blade. Take for example a blank cutter body 5 ins. diameter 10 ins. long, cut a slot through the top at an angle of about 15 degrees, you would have a depth of about ¾ in. in the centre, while at either end there would be no depth to speak of. This can be avoided, however, by dividing the cutter into short sections, thereby lessening the unequal depth caused by cutting a slot at an angle to the axis of the cutter, but the high cost of this method does not warrant its adoption. The general practice, in making cutters of smaller dimensions, is to use carbon steel costing about 14c. a pound. This is altogether unnecessary and extravagant. Billet crop ends selected from high carbon billets such as are used for driving axles, pistons, and side rods, carefully hammered, outclass in every way the ordinary tool steel. In the first place, the cost, hammered to size, is about 1½c. a pound, as compared with 14c. a pound for tool steel. Secondly, they are tougher, and the teeth will not break when a heavy cut is put on, such as is the case with tool steel, and the cutting edge stands up equally as well. The success of this method of course depends upon the treatment of hardening. This, however, is very simple, and consists of carefully packing the tools to be hardened in a mixture of salt and raw bone, placed in an airtight box, which should be brought and kept to a heat of 1,-00 deg. Fahr. from 24 to 48 hours, according to size, then drawn from the box and quickly immersed in running clear water. There is no need whatever of drawing the temper, the cutting edge has the correct hardness, while the body of the cutter remains very tough. The question that you would naturally raise at this point would be: How deep can cutters be hardened in this manner? A depth of ⅜ in. can be reached, or in other words, the cutter may be ground until the tooth is almost ground away, leaving no space for the chips to get away. When a cutter reaches this stage, it can be annealed, recut, and rehardened, as often as the thickness of material will allow, without affecting the quality of the cutter.



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Some three years ago a test was made at our works to determine the advantage of using high speed steel cutters for a certain class of work, namely—milling out jaws of side rods, transmission bars, radius bars, combination levers, etc. It was found that the high speed steel cutters broke from the vibration and pressure brought to bear upon them, whilst cutters of the same design, made from billet steel case hardened, did the work very satisfactorily without breaking, running at the same speed and feed. What I have said so far regarding milling cutters refers to cutters used for straight milling. Cutters used for milling gears, taps, reamers, and irregular shapes should, in my opinion, be made from high speed steel.

In studying the efficiency and economy of tools, we must not forget to consider the quality and quantity of work required of them. We now come to tools such as are used on lathes, planers, shapers and slotters. There are many brands of high speed steel on the market at the present time, and I have tried almost all of them, but will no' express my opinion regarding their mer its, as it would make this paper appe