Fig. 1.—Illustrating depth to which cutter teeth may be ground, still retaining their proper hardness.

as an advertisement. I believe, however, that if we wish to ascertain which is the most efficient steel, we should give every brand an extensive trial, making an individual record of each, and determining which is the best, as compared to the price paid for it. Different shops have different materials to contend with and the formulæ used in the composition of steel differ, so that some brands are better for cutting one class of material, while other brands are better for cutting other classes of material. This is why I contend that each shop should test out every brand and see which is best adapted for its requirements.

High speed steel is an immense item in large machine shops, and great care should be exercised in order to avoid waste. A great saving may be made, by observing the following practice. In making finishing tools, instead of using a piece of high speed steel, say 1¼ x 2¼ x 15 ins. long, costing about $6, we go back to the old reliable, and use a piece of billet steel, leaving it as large as the tool post will admit, and weld a tip to it made of high speed steel. The finished cost of this tool is about one-eighth of the solid high speed steel tool and is just as efficient for these reasons: the billet steel is sufficiently strong to withstand the pressure brought upon it for a finishing cut. It does not require dressing any oftener than the solid tool, but it does require a little more care. I will explain a little more clearly how this tool is made. As stated before, we take a piece of high carbon billet from the scrap heap, and draw it out to the required dimensions. One end is then scarfed ready to receive the high speed steel tip which is wedge shaped. The toolsmith fits the two parts fairly well together before welding to ensure a neat weld. The parts after having been prepared are then heated, the tip being allowed to heat longer than the body, owing to the necessity of the former being of a much higher temperature than the latter to allow for welding. When both are at a welding heat they are quickly withdrawn, a piece of Lafitte welding compound is placed between them and hammered lightly together. The tool is then reheated, care being taken to place the nose of the tool in such manner that it will be most exposed to the fire. When the required heat is reached the tool is quickly withdrawn and placed between a former under a steam hammer and given a light sharp blow. In case of the tip being displaced it will not do to try and knock them into place again. The tip must be cut away and refitted, and a fresh piece of the compound used. The tool is then treated in the same manner as a high speed steel tool. These tools have been used until the tip has been ground right down to the weld. I would not advise making heavy roughing tools in this manner, as the billet steel body would not stand the pressure required by a roughing tool such as is used on a heavy planer. A tool of this description however, answers well when used on a lathe where the point does not project far from the tool post, also where the cut is continuous and not intermittent, as is the case on a planer. You can readily see where the saving comes in, if this method is only applied to finishing and lathe tools. Fig. 2 illustrates the preparation of parts for welding tool with high speed steel tip.

Twist drills made from carbon steel, with the exception of jobbers' drills, that is, drills up to ½ in. diameter, are almost a thing of the past, high speed steel drills having taken their place. The original design of the high speed drill was exactly the same as the ordinary carbon drill with the exception of the material used. This, however, has proven to be inefficient and expensive due to the following reasons: In the first place, to obtain proper results from a high speed drill, it is necessary to have adequate space to allow the chips to free themselves from the drill, as the flutes will soon choke up owing to the increased feed and the speed of the drill. The fluted high speed drill has not this advantage. It is expensive for this reason. To make a drill of this design, it is necessary to use a round bar of solid steel, cutting away 50% of it to form the flutes. Yet there are men who will tell you that this design of drill is the best and cheapest on the market.

I will now give my opinion as to which is the best high speed drill and the reasons why. A high speed steel drill with the twisted section about half way between the flat twisted section and the

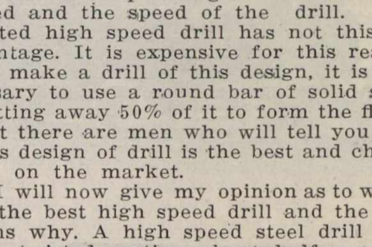

Fig. 2.

standard milled drill is the most efficient and economical, from the fact that it takes just one-third of the steel to make it, and efficient because of the adequate space for the chips to clear, thus preventing clogging and choking. The feed can be doubled, due to this advantage. I have found in my endeavor to reduce the cost of tools that in the average shop where locomotives and heavy machines are built, they have sufficient equipment to make efficient high speed drills with a saving from 10 to 50%. The same may be said of all kinds of taps, especially those used in boiler construction.

A few words may be said regarding reamers. There are many styles of straight reamers, all of which have their advantages, which leaves me nothing to say regarding them. Taper reamers are different in their action, however, inasmuch as the whole part of the reamer that comes in contact with the work is cutting equally, whereas, in the straight reamer, the extreme end is the only part that cuts, the rest of the reamer only acting as a guide. It is this difference of action that I now wish to discuss. In all railway shops there is a great amount of taper reaming to be done; this calls for a different class of reamer. Having visited some of the large locomotive works and enquired from others, I find that their practice is to use the straight fluted taper reamer—some of them have the teeth staggered, others equally spaced. I beg to state that this style of reamer is decidedly wrong. Reamers that are required to cut equally their full length of flute should be milled with a left hand spiral cutting edge, having an angle of about 20 deg.; the pitch or distance between the teeth should be about ¾ in., leaving ample space for the chips to clear, thus preventing clogging and tearing of the hole. The advantages of this style of reamer are: It takes about 30% less power to drive it; it never chatters; it never digs in; the tang does not twist off; the teeth do not break off; they are easy on crank shafts and can be driven with an air motor, where straight fluted reamers would stick. It may appear that I am claiming a little more than what is true, but these are actual facts that have been tried and proven. There are two reasons for the success of this style of reamer, namely, the spiral cutting edge which gives the reamer a shearing action instead of a straight drag (which must necessarily follow with a straight flute), also to the fact that the line of cut parallel to the length of reamer is divided, due to the angular cutting edge which is not parallel to the line of cut. The even and regular curl of chip made by this reamer will also convince you of the correctness of design. The cost of these reamers is a trifle less than the straight fluted reamers, on account of the fewer number of teeth to be cut. This applies generally to reamers having a diameter of 1½ ins. and under, with a flute of from 14 to 16 ins., standard taper 1-16 in. to 12 ins. Fig. 3 illustrates the difference of straight fluted and spiral fluted taper reamers.

A word or two may be said regarding reamers of large diameter, such as crosshead reamers both for piston and wrist pin fit. For cheapness and durability these may be made in the same manner as solid milling cutters, as mentioned in the previous part of this paper. Select a piece of high carbon billet from the scrap heap, have the forging well hammered, machine and caseharden, and you wil have a tool that is equal to the finest tool steel made. You will find that the cost will be about one-tenth of that of good tool steel.

There are many other items of interest whereby great savings can be made, but as our subject covers such a wide area, I must confine my remarks to one or two thoughts in general. An immense saving can be made by annealing all broken and worn-out tools, immediately they are out of service. This being done, they should be arranged in open bins or racks, so that when the foreman of the tool room requires material, he looks over his stock of annealed scrap (I mention annealed for the reason that very often a piece of scrap material is available, but it is necessary to wait while it is being an-

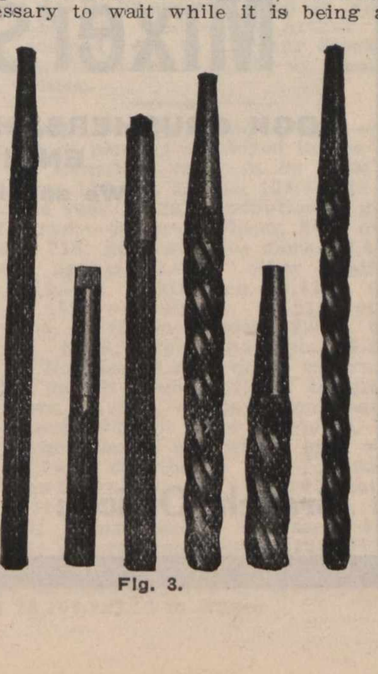

Fig. 3.