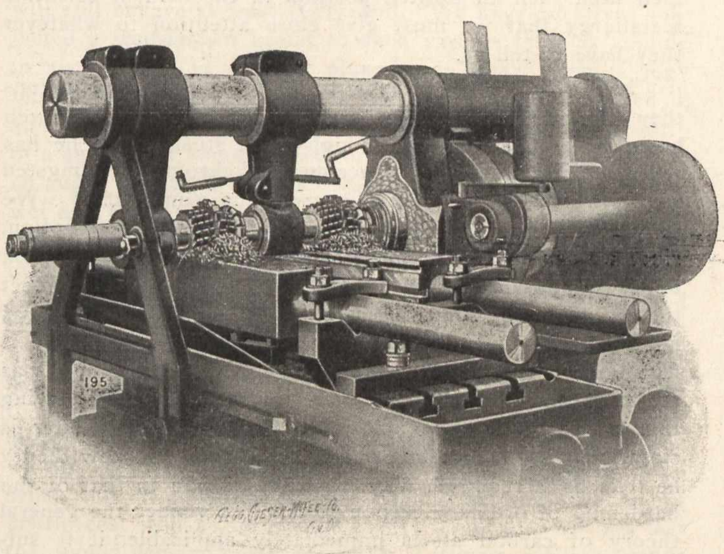
this job quite considerably, and the accompanying illustration shows a method recently adopted by the J. A. Fay & Egan Co., Cincinnati, Ohio. They fasten two of these pieces to the table of a No. 4 Plain Cincinnati Miller, and finish one side of each of the pieces at a single cut. The bars are



4½ in. in the rough, and the cut is ¼ in. deep, added to which are the grooves, one of which is ⅞ in. deep and 21-32 in. wide. The cutters are made of Novo steel, and are 4 in. and 5¾ in. in diameter. The work is fed through the machine 15-16 in. per minute, and the finished surfaces are smooth and accurate.

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The municipality of Kildonan has arranged terms with the Winnipeg Street Railway Co. for the extension of the electric railway from the city to Bird's Hill va Norwood bridge. The company is to get exemption from taxation for twenty years and a franchise—but not an exclusive one—for thirty-five years. Two miles of the road are to be built the first year, operations to be commenced in the spring.

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## HIGH SPEED STEELS.

### Changes in Machine Tool Design.

C. H. BENJAMIN, IN CASSIER'S MAGAZINE.

It has been interesting to watch the changes brought about in the designs of machine tools, as a result of the keen competition in manufacturing and the demand for a greater output per machine. Such a thing as running a lathe or a planer to the limit, even of its former capacity, was once a novelty. For the most part these machines jogged along in a comfortable and contented fashion with the operator also comfortable and contented.

The introduction of the new process steels for tools is a result rather than a cause of the recent awakening and of the endeavor to get out of each machine all that there is in it. Many of the tools built ten or twenty years ago were incapable of getting the best work or the limiting quantity from even the ordinary carbon tool-steels. The belt would slip, the gears would break and the frames and spindles would spring.

Of late, however, machines weigh more, have wider belts, bearings of greater surface, and can stand up to the work required of them. But now comes the high-speed steel and there is more trouble. Not only must the machine have stronger parts, but it must have more power to turn the spindle and to push the carriage. To understand this, it is only necessary to make a few comparisons.

Formerly the lathes, planers, shapers and other tools in an ordinary machine shop consumed from half a horse-power to two horse-each. The writer has seen a 16-inch lathe stalled when doing less than one horse-power.

Recent tests with a lathe of 20 inches swing, turning soft steel, have shown a gross horse-power of from seven to sixteen with one maximum reading of over thirty horse-power. The manufacturer of one well-known turret lathe recently told the writer that a new machine now building for use with high-speed steels would consume twelve horse-power. This will be more easily understood when we consider the enormous amount of metal removed by some of the new machines.

One lathe, when turning soft steel at a speed of 125 feet per minute, removed metal at the rate of 625 cubic inches per minute or about 1,000 pounds per hour. Another lathe, running three tools, cut steel with a speed of 50 feet per minute at the rate of 113 cubic inches per minute or about 1,900 pounds per hour.

A prominent firm making slab milling machines guarantee the removal of 210 cubic inches of cast iron per minute, or about 3,200 pounds per hour.

Now reliable tests of machines in actual service show a consumption of power per pound of metal per hour of 0.03 to 0.07 horse-power under favorable conditions, exclusive of the power required to run the machine itself. Using the smaller value, or 0.03 horse-power, gives the power required in these three instances as 30, 57, and 96 horse-power, respectively.

The cases cited are, of course, extreme ones and examples of what may be called "slaughtering stock," but they nevertheless show what these machines are capable of doing. The rapid reduction lathes, as they are sometimes called, present several points of difference from their immediate predecessors. The steps of the driving cone are fewer in number and have faces suitable for wide belts, sometimes four and sometimes even six inches wide. The speed of the belt is also increased, for it is an axiom that the power of a machine must be measured by the belt and not by the gearing. No complication of double or triple gearing will give power to a lathe which has a narrow, sluggish belt.

Cut spur gears are now used wherever necessary and gear boxes have taken the place of speed cones for controlling the travel of the tool. The mechanism inside the apron has received particular attention, for this is the weak point of many lathes. The use of steel gears and racks and of double bearings for the pinions has remedied this defect.

The tool-post has been strengthened, the head and tail spindles have been enlarged and all the bearings are made wider and longer. Some of these lathes are now capable of melting the points from the new steel tools.

It is rather remarkable that the principal advantage in using high-speed steel has appeared in the turning of wrought iron and mild steel, and that cast iron still remains obdurate. While it is no uncommon thing to-day to see soft steel turned at speed varying from 125 to 250 feet per minute, a speed of over 50 to 60 feet per minute for cast iron is unusual. The peculiar granular character of the casting or perhaps the presence of graphite is fatal to the life of the tool point at high speeds.

Planing machines have not profited by high speeds as have the lathes, probably on account of the intermittent character of the work. Sixty feet per minute is about the highest recorded speed, and this is not recommended for ordinary planing. A cutting speed of 35 feet per minute with a return of two to one is as high as can be economically used. A common mistake which has been made is to increase the return at the same rate as the cutting speed. This is apt to make trouble at the end of the return stroke.

The possibility of doubling the cutting speed without changing the return is excuse enough for the use of the new steel. A good arrangement adopted by our planing machine builder company is to vary the cutting speed from 20 to 40 feet per minute by gears and to keep a constant return of 72 feet per minute.

The power required for reversing a planing machine is so much greater than that ordinarily used in cutting metal that an increase in the latter, due to the use of high-speed steels, has not materially affected the driving power required. What is generally needed is not so much power as flywheel effect.

Some rather remarkable records have lately been made with twist drills of the new steel, but in Great Britain, rather than in America.

The cutting speed of the lip of an ordinary carbon-steel