After the cutter blank X, Fig. 10, has been formed on one side, the quill Z is turned end for end and placed in seat A, the quill gear then being driven from the right-hand end of the machine and without changing the position of the circular forming tool relative to the center of the lathe, the other side of the cutter blank is formed, so that both sides are uniform. The cutter is then ready to be notched, which is done in the bench miller shown in Fig. 8, several cutters being notched simultaneously if necessary.

Backing Off Cutter Teeth

The special form of bench lathe in Fig. 10, shown for making formed cutters, is also adapted for backing off the teeth. For this purpose a reciprocating attachment is operated from the gearing at the left-hand end of the bed, which gives the necessary lateral movement as the cutter is rotated, causing it to be backed off uniformly tooth by tooth.

Grinding Formed Milling Cutters

In Fig. 11 is illustrated another bench machine, which is used for sharpening formed cutters. The wheel in this case is a bevel-edged steel disk, charged with diamond dust and with one face straight for grinding the radial faces of the cutter teeth. The cutter is placed upon the vertical spindle, and the bracket carrying this spindle is oscillated to pass the straight face of the lap across the face of the tooth. As the lap rotates, the bracket in which its spindle is mounted is given a slight oscillating motion in the plane of the wheel face by means of the connecting rod B, which is operated from an eccentric on the countershaft fixture placed on the bench, from which the spindle of the lap is driven. This movement of the lap helps preserve the truth of the lapping face and produces satisfactory results upon the cutter teeth.

When desired a notched wheel is placed at the bottom of the work spindle to facilitate uniform indexing for the sharpening of each tooth face. In the illustration this index disk is not shown in position.

Application to Involute Teeth

The general principles involved in this method of producing special cutters for certain classes of gears have been covered sufficiently in the foregoing description to indicate that similar means may be adopted by designers and toolmakers wishing to form, say, fly cutters for involute teeth commonly used in machine construction. In the case of such teeth the curve upon the templet which forms the starting point in this process could be traced by means of a scriber in a straight-edge swung about the periphery of the brass disk seen in Fig. 1. That is, for the involute curve which it is desired to lay out to ten times the size of the fly-cutter curve, the straight-edge with the scribing point could be used in place of the scribing disk shown in that illustration.

Locating Indicator for the Miller

By George J. Murdock

A device for locating jigs and other tool work on the milling-machine table in correct position for the boring of holes, each hole center being located from a center punch mark in which the point of the indicator is placed.

Details of construction and methods of applying the indicator to various classes of work in the shop and tool room.

There are a number of well known methods of locating jigs and other tools on the work table of the milling machine, to be operated on with the boring bar, two of the best known being the button system, using a micrometer head located on the spindle for correctly spacing the buttons, and the system of spacing by means of the milling-machine micrometers.

In the endeavor to not only effect a saving of time, but to also eliminate chances of error in locating such work the tool illustrated in Figs. 1 and 2 has been designed, and quite an extensive experience with it has proved that for any of this work it is a superior device while it is also capable of uses that it is believed require this particular design to successfully execute.

In boring holes on the milling machine for the bushings of jigs, or for any similar work three movements of the table are necessary, namely vertical, and horizontal, for locating the center, and the cross-feed movement for boring the hole. It is, therefore, only necessary in a tool of this class to so design and construct it that it will show when the center on the work is vertically correct with the spindle of the machine for the first movement, and horizontally correct for the second.

Details of Construction

A faceplate is therefore used as shown at G, in Fig. 2. It is screwed into the threaded nose K of the arbor H which is made to fit the taper of the milling-machine spindle, and may be used alone or with a collet. The annular rim of the faceplate extends backward over the end of the arbor, and is provided with four holes at equal distances from each other. Hardened, ground, and lapped bushings D are inserted in these holes to receive the pin S which is made a gage fit for the hole in bushing B on the outer end of sector C.

The sector is rigidly secured to the barrel P carrying the 60-degree center spindle O that comes into contact with the center-punch mark on the work that is to be bored, and which, of course, is secured to the milling-machine work table.

The spheroidal base of the barrel P fits into a corresponding concave seat in the nose K of the arbor, and is held in place by the spring E which is connected at one end to the cylindrical stud R that is capable of rotation in the axial hole in the bottom of the barrel P. The other end of the spring is attached to a rod N which terminates near the tang end of the arbor H. A small hole is provided in the end of this rod to draw it through the arbor, and give sufficient tension to hold the connected parts against the nose K of the arbor. When adjustments are properly made the set screw M

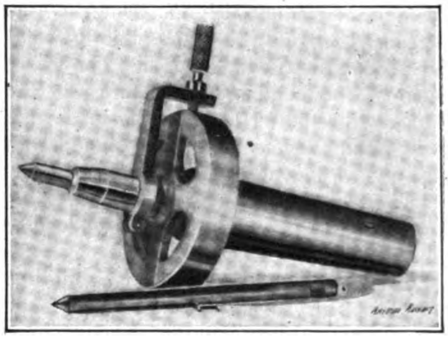


Fig. 1. Indicator for Locating Work on the Milling Machine

is turned up against the rod, holding it and the parts connected to it in place.

Principle of Operation

It will now be seen that if the pin A is removed from the bushing D the point of the spindle O may be made to describe a circle, and somewhere within this circle the center-punch mark is located on the work to be operated on. As the holes D on the faceplate G are all exactly the same distance from an axial line through both the arbor H and the spindle O, it follows that the center on the work must be so located by vertical and horizontal movements of the milling machine table that the pin *A* can be entered freely into all the holes in the rim of the face plate.

When this is done a drill followed by a boring bar will accurately produce a hole at the desired point on the jig or other work as laid out.

Locating the Center Punch Mark

The prick-punch mark should be of slightly greater angle than the point of the spindle *O* as it is not possible to so locate the work that in the preliminary trials the center will be exactly in line, but will invariably be found too high or

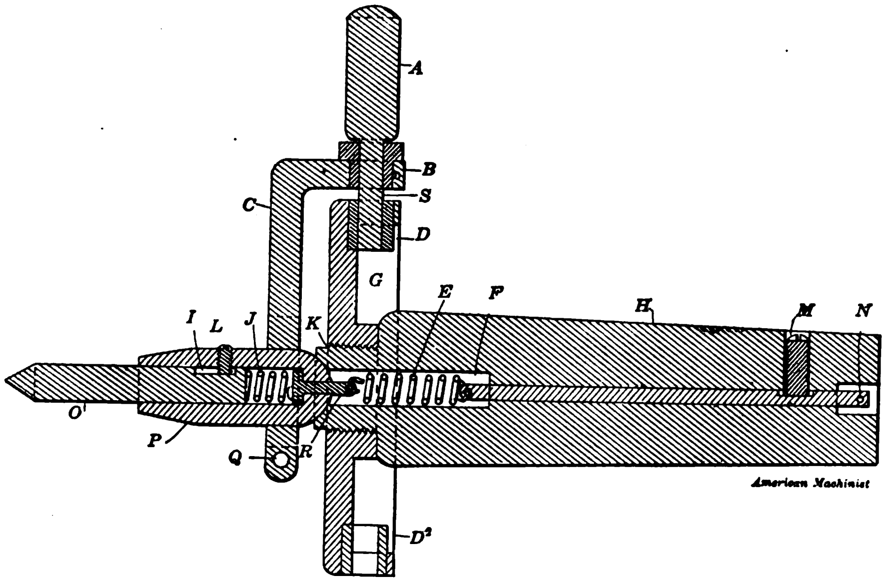


Fig. 2. Sectional View of Indicator

on one side of the correct location. In bringing the work by means of the cross feed into contact with the center *O* the spring *J* should be only slightly compressed which will hold the point *O* against the center-punch mark in the work while the trials are being made that will finally locate the center and permit the pin *A* to enter all four holes in the faceplate.

As the work comes nearer the center the spring *J* will continue to be compressed as the spindle slides back into the barrel. This spring should not be made so stiff as to interfere with the free rotation of the sector *C* bearing the pin *A* around the rim of the faceplate *G*. When the work is finally located, and is ready to bore the cross-feed screw draws the work away from the indicator, and the center spindle *O* is prevented from being thrown from the barrel by the set screw *L* with point located in the flattened recess on the side of the spindle.

Setting the Indicator

In using this tool the milling-machine spindle is not rotated, only the barrel *P* being turned on the nose *K* of the arbor. The spindle of the milling machine is so set, however, in the beginning that a line drawn vertically through bushings *D D* would be at right angles to the work table, while a line drawn axially through the other two holes in the faceplate will, of course, be parallel with the top of the work table.

As the pin *A* projects outwardly and at right angles to the spindle of the machine it is not in the way in locating the work. The center spindles *O* are made of various lengths to suit the varying conditions under which work must be done. All are interchangeable with the barrel *P*, and it will be seen that the longer the spindle is the greater the degree of accuracy attainable. Fig. 1 shows the tool as actually made with one of the long center spindles in the foreground. The pin *A* of the sector is nurled so as to be easily turned with a light wringing motion into the holes in the faceplate rim when the work has been centralized so that it will enter. As one essential of a tool of this character is compactness it will be noted that the faceplate unscrews from the spindle in such a way as to leave the calibration correct when again assembled, at the same time allowing the parts to be made in such a form as to lie flat in a drawer of the toolbox.

Other Uses of the Tool

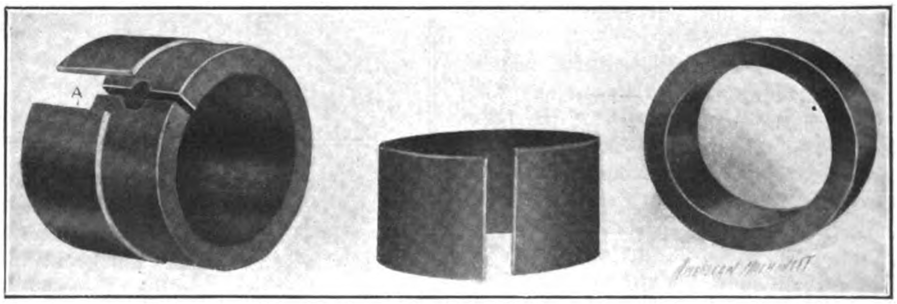
Other applications may be considered besides the one herein specifically described, such as setting an engine lathe tailstock center in line with the headstock spindle so the lathe will turn parallel. This is commonly effected by turning an arbor between the centers until the micrometer shows it to be of the same diameter at each end, and is quite a tedious proceeding. Equally good results may be attained by using an indicator as described fitted to the tailstock spindle taper. In such cases the center spindle *O* is made female to bear against the center of the headstock spindle of the lathe. In adjusting, the tailstock is set over until the pin will enter the two holes that are in the same plane as the top of the lathe shears. As the tailstock spindle is nearly always higher, especially in new lathes, the vertical members of the quadrant of the faceplate are not used, the lathe, however, turning parallel.

When this instrument is thus fitted to a lathe it may (after the lathe is set to turn parallel) be used to locate work on the faceplate, and a saving of time over the button method as heretofore practised result, while if the indicator is accurately made cqually satisfactory work may be done if uptodate methods are followed in laying out the exact locations for the holes to be bored.

The boring mill is of substantially the same character as the engine lathe so far as its relation to this tool is concerned, and many classes of work may be done by the use of this tool quicker, with less liability of mistakes, and with greater accuracy than by the methods commonly followed.

Repairing Rod Bushings

They have a very simple way of giving solid-end rod bushing a new lease of life at the New York Central shops at Depew, N. Y. When a rod bushing has become worn beyond the running limit, it



Repairing Solid-end Rod Bushing

is simply forced out of the rod end and a slot milled through the oil hole at the top, as shown at *A*. Then a liner of sheet metal is cut just long enough to wrap around the box and not cover this hole. The liner and box together are then forced back into the rod and the bushing is ready to be bored and go back into service with the probability of securing as much mileage as when new.