Feb. 2, 1960 C. GRAGE 2,923,181

COMBINATION REAMING AND BURNISHING TOOL

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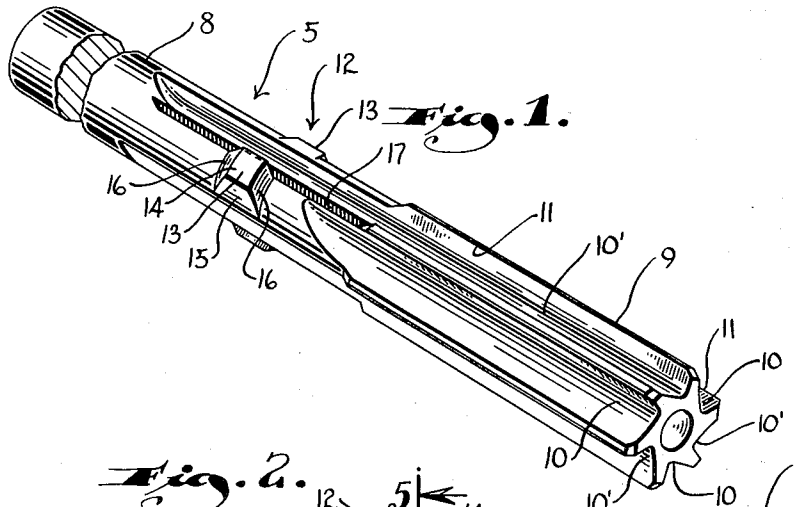


Fig. 1.

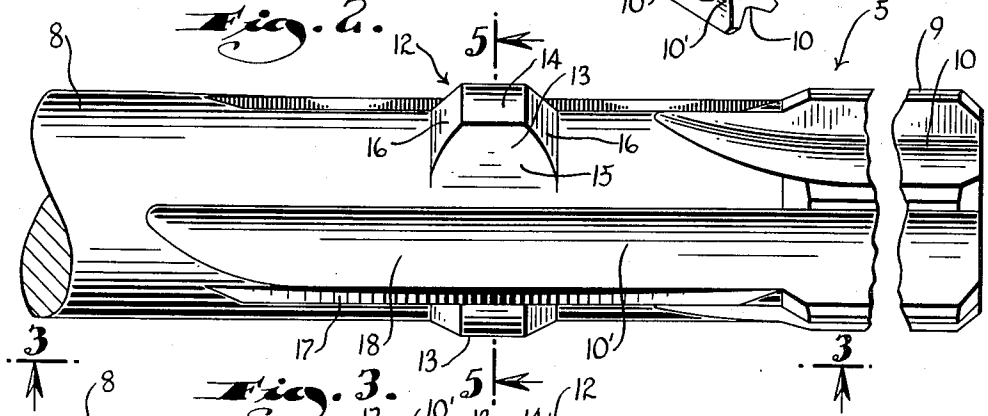


Fig. 2.

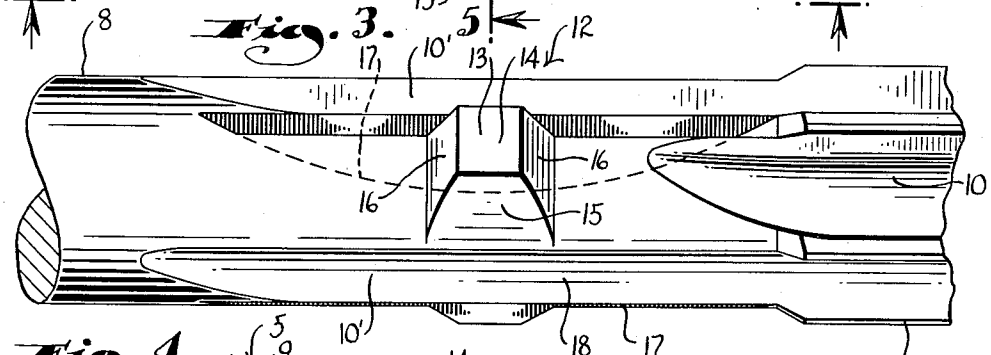


Fig. 3.

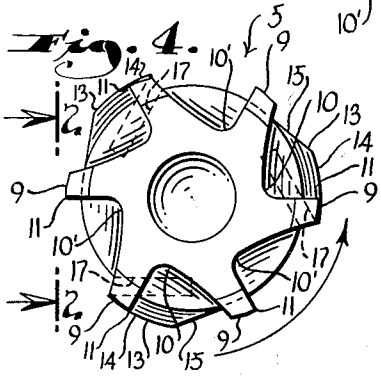


Fig. 4.

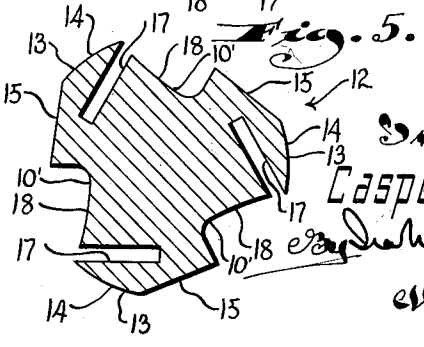


Fig. 5.

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Fig. 6.

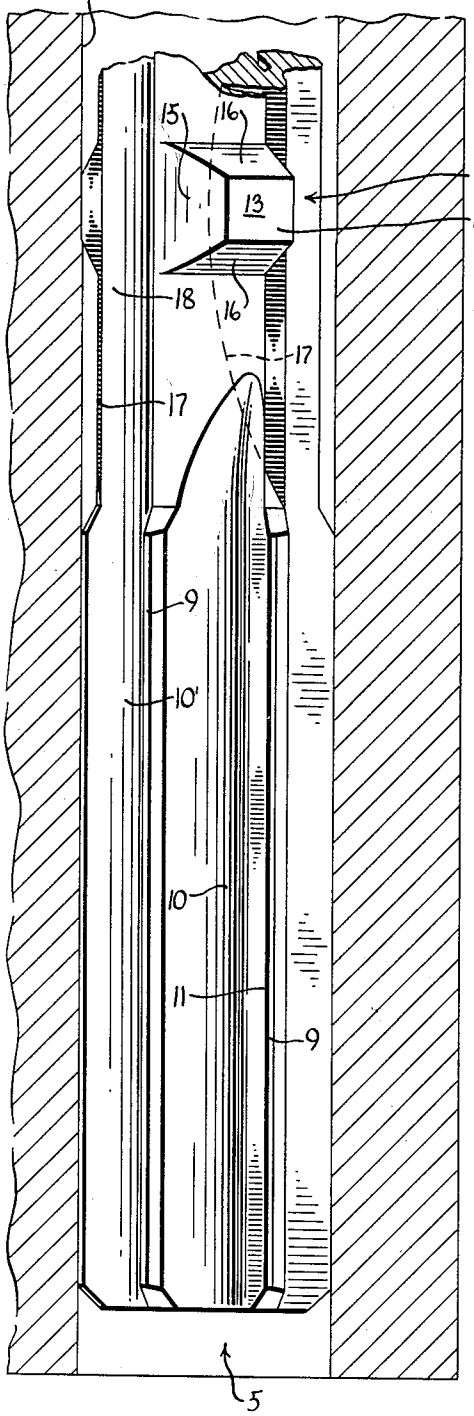
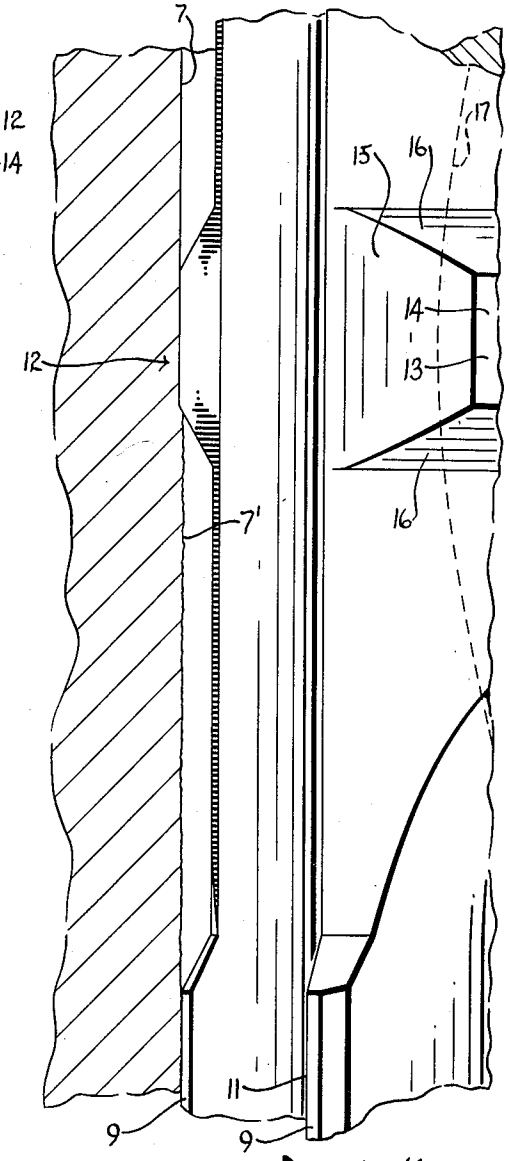


Fig. 7.



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United States Patent Office 2,923,181
Patented Feb. 2, 1960

2,923,181

COMBINATION REAMING AND BURNISHING TOOL

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Application October 31, 1958, Serial No. 771,009

6 Claims. (Cl. 77—72)

This invention relates to the metal machining art, and refers more particularly to the finishing and sizing of drilled holes.

The conventional method of finishing and sizing holes by reaming may be satisfactory for ordinary work, but where very close tolerances must be met and a smooth surfaced, truly round hole is required, reaming will not suffice. This is especially so if the holes to be finished are in the newly developed alloys which do not respond very well to machining by means of the bascially designed tools conventionally employed.

With a view toward improving conventionally reamed holes, the reaming operation was often followed by a burnishing operation, but heretofore, even this failed to produce a truly round axially straight hole.

The present invention overcomes the deficiencies of past methods and tools for reaming and burnishing holes and, to that end, has as its object and purpose to provide an improved method and tool for reaming and burnishing a hole in one operation.

Another object of this invention is to provide a combination reaming and burnishing tool which is extremely simple in design and construction.

A further object of this invention is to provide a combination reaming and burnishing tool, which may have its reamer portion resharpened several times and still produce holes of the intended size.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a perspective view of a combination reaming and burnishing tool embodying this invention;

Figure 2 is a side elevational view of the tool illustrating particularly its burnishing section and the adjacent portion of its reamer section, said view being taken on the plane of the line 2—2 in Figure 4;

Figure 3 is a view similar to Figure 2, but with the tool rotated 90° and viewing the same on the plane of the line 3—3 in Figure 2;

Figure 4 is a bottom end view of the tool;

Figure 5 is a cross sectional view through the burnishing section of the tool taken on the plane of the line 5—5 in Figure 2;

Figure 6 is a view at an enlarged scale illustrating how the tool is used to practice the method of this invention; and

Figure 7 is a view similar to Figure 6 but at a still larger scale and showing only a portion of the tool, to better illustrate the difference in result accomplished by the reaming and burnishing steps.

Referring now particularly to the accompanying drawings, the numeral 5 designates generally the tool of this invention, which, as shown in Figure 6, may be used to ream and burnish the surface of a drilled hole 7 in one operation. In many respects the tool resembles a conventional reamer. It has the customary shank 8 at its upper end and elongated reamer teeth 9 at its lower end. The reamer teeth 9 are formed in the usual way by flutes 10 and have the customary cutting edges 11.

Every other flute 10' extends a substantial distance beyond the upper end of the reamer teeth to define a burnishing section, indicated generally by the numeral 12. The lands between the extended portions of the flutes 10' have raised burnishing pads 13 formed integrally thereon. These pads, as best shown in the cross sectional view Figure 5 have arcuate extremely hard working faces 14 which are truly concentric to the axis of the tool, and inclined approaches 15 leading to these working faces. The sides 16 of the pads are also inclined, but the angle of their inclination is unimportant.

A saw slot 17 extends into each of the lands between the flutes 10' from the wide trailing side of the flute, with the outer edge of the slot meeting the junction of the curved face 14 and the wide side 18 of the flute. The angle at which these saw slots are formed is such that if projected the slots would break through the adjacent narrow side of the next flute 10', and the maximum depth of these slots is sufficient to extend beyond the leading edges of the arcuate or curved working faces of the burnishing pads. For convenience of manufacture the bottoms of the slots are arcuate.

By virtue of the saw slots 17, the burnishing pads are resiliently or yieldably maintained in their positions, the yieldability provided by the slots being an important factor in the attainment of the objectives of this invention.

In the operation of the tool its reamer section functions in the customary manner, its teeth removing metal and sizing the hole to the extent that any reamer is capable of doing so. But the reamer section or portion of the tool has an additional and very important function—it serves as a pilot and guide for the burnishing section. Because of the length of the reamer section, the tool is firmly and rigidly held exactly coaxial with the hole, and accordingly as the burnishing section enters the hole and moves helically down into it, it is held against shifting laterally so that the finished hole is straight and true. The individual pads, however, can yield slightly to localized high spots and, in so doing, prevent the metal galling or seizing on the faces of the pads. Such yielding of the individual pads, however, does not affect the accuracy of the hole size or its straightness as would be the case if the burnishing pads were not firmly and positively guided in their motion down through the hole.

Obviously, of course, the radius of the working faces on the burnishing pads is slightly greater than that of the reamer teeth, and determines the size of the finished hole.

Inasmuch as the diameter of the finished hole is determined by the burnishing pads, the reamer section of the tool can be resharpened several times without loss of accuracy in the size of the finished hole. To illustrate, three 31/64 inch holes were drilled in a piece of SAE–2 cold rolled steel. Three one-half inch reaming and burnishing tools of this invention were selected, with the radii of the burnishing pads on each of the three tools measuring exactly alike. The reamer sections of the three tools, however, were of different diameters—one was ground to minus .001, the second was

ground to minus .002, and the third to minus .003. Each tool was used in one of the three holes, and the three holes identified with the tools used in them. The proper speed and feed was selected for reamers of this type, size and the specified material, and each hole was reamed and burnished at the same speed and feed. When all holes were thus reamed and burnished, a plug gage and inside bore gage were used to determine the actual size of the holes and from this it was found that the three holes measured exactly alike.

Although this invention provides a new and improved tool, it also presents a new method of finishing holes in metal, which is quite apart from the operation or use of the tool. This aspect of the invention resides in the concept of firmly and solidly guiding the burnishing pads as they are fed down into the hole to perform their function. Burnishing the surface of holes is by no means new, but heretofore no effort was made to support the burnishing tool in such a way that it moved straight down the axis of the hole. Accordingly, with past methods it was not uncommon for a burnished hole to be crooked, though at any given point the hole would have its expected size. With this invention the means employed to burnish the sides of the hole is accurately and solidly guided, as can be understood from Figures 6 and 7.

In addition to providing rigid guidance for the burnishing pads by pilot means moving in advance of the pads and supported by the sides of the hole, it is also important to the method of this invention to have the pads resiliently or yieldably maintained in their operative positions.

Succinctly stated, the method contemplates the steps of:

(1) Simultaneously moving a plurality of circumferentially spaced hard surfaced burnishing pads helically down through a hole;

(2) Yieldingly maintaining the burnishing pads at a predetermined maximum radial distance from the axis of rotation as they are moved through the hole; and

(3) Positively guiding the movement of the pads through the hole by supporting the same from the surface of the hole for a substantial length thereof ahead of the areas of engagement between the pads and the surface of the hole.

With this method, the microscopically uneven surface 7' (see Figure 7) produced by a conventional reamer will be burnished to a smooth finish of exactly the correct diameter and, in addition, the hole will be absolutely straight throughout its length.

As can be appreciated, while it is desirable that the guidance for the burnishing pads be obtained by having them part of a combination reamer and burnisher, as described hereinbefore, so that the reamer teeth serve as the pilot and support for the pads, where burnishing alone is to be done, the pads could be guided by any suitable pilot connected with the burnishing pads and having sufficient length to adequately support the pads.

From the foregoing description taken in connection with the accompanying drawings, it will be readily understood that this invention provides a greatly improved method of finishing drilled holes, and that it also presents the industry with a valuable tool capable of finishing drilled holes to tolerances heretofore rarely if ever satisfied, and that, in addition, the tool of this invention may have its cutting portion resharpened without affecting the diameter of the finished hole.

What is claimed as my invention is:

1. A combination reaming and burnishing tool comprising: a unitary stem having a fluted end portion defining elongated reamer teeth, alternate flutes extending along the stem beyond the reamer teeth; and burnishing pads on the lands between the extended portions of the flutes so as to be spaced axially from the reamer teeth and circumferentially from one another, said burnishing pads having hard, smooth arcuate faces which collectively have an outside diameter slightly greater than that of the reamer teeth.

2. The combination reaming and burnishing tool of claim 1, further characterized by the fact that the burnishing pads have inclined approaches leading to their arcuate faces.

3. The combination reaming and burnishing tool of claim 1, further characterized by the provision of slots formed in the lands radially inwardly of the faces of the burnishing pads so that the pads are slightly yieldable radially inwardly and are resiliently maintained in their operative positions.

4. The combination reaming and burnishing tool of claim 3, further characterized by the fact that said slots extend into the lands from one face of each flute extension.

5. A tool for finishing the surface of a cylindrical hole, comprising: an integral stem having a shank portion at one end thereof by which the tool may be gripped in a chuck; a pilot portion at the other end of the stem, said pilot portion having elongated circumferentially spaced guide surfaces at a uniform distance from the axis of the tool, and collectively having an outside diameter slightly smaller than the desired diameter of the finished hole; and a plurality of circumferentially spaced burnishing pads on the stem between its shank portion and its pilot portion, said pads having hard, smooth arcuate faces which collectively have an outside diameter exactly that of the desired diameter of the finished hole, the stem being cut away radially inwardly of the arcuate face of each burnishing pad so that each pad is yieldably maintained in its normal operative position and is capable of yielding slightly inwardly during operation to prevent seizing and galling of the metal on the working faces of the pads.

6. A combination reaming and burnishing tool comprising a stem made from a single piece of metal and having a shank portion at one end thereof and reamer teeth defined by longitudinal flutes at the other end portion thereof; and a plurality of circumferentially spaced burnishing pads on the stem between its shank portion and its reamer portion, said pads having hard, smooth arcuate faces which collectively have an outside diameter slightly greater than that of the reamer teeth, and having inclined side approaches leading substantially tangentially from the stem to said arcuate faces, the trailing sides of the pads being formed mainly by extensions of said flutes.

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