Dec. 8, 1953 E. W. BRINKMAN 2,661,663

PUNCHING METHOD AND TOOL

Filed March 30, 1948

Fig. 1

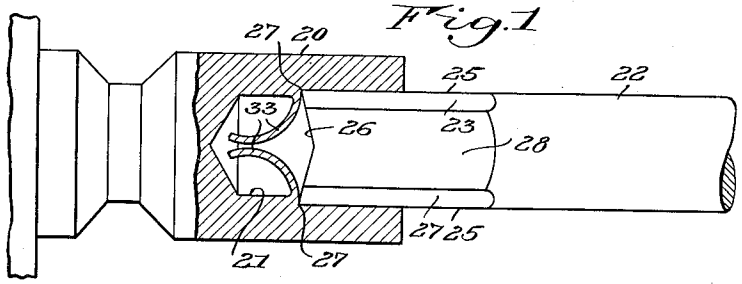


Fig. 2

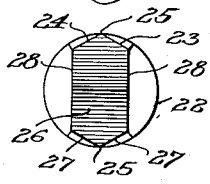


Fig. 3

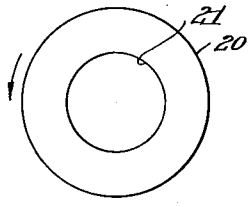


Fig. 4

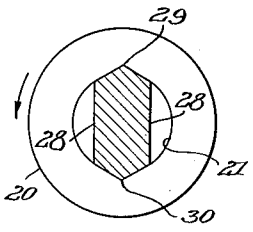


Fig. 5

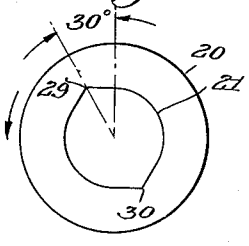


Fig. 6

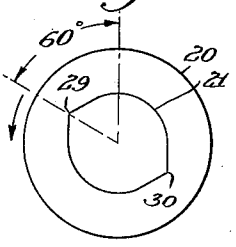


Fig. 7

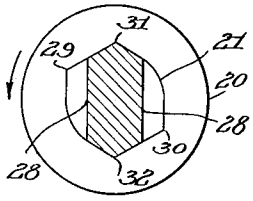


Fig. 8

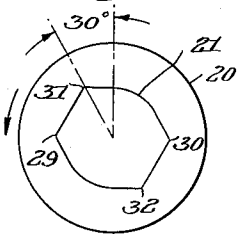


Fig. 9

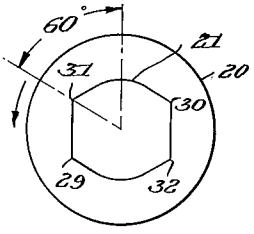


Fig. 10

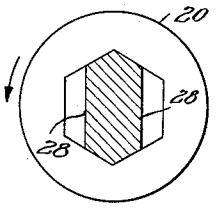


Fig. 11

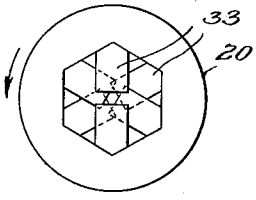


Fig. 13

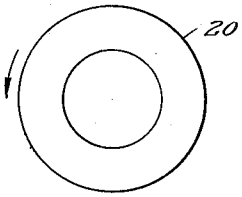


Fig. 14

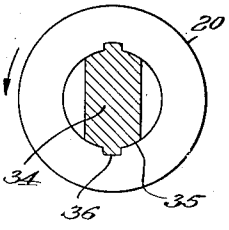


Fig. 15

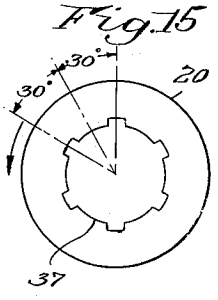
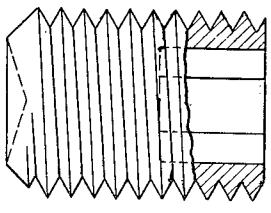


Fig. 12



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UNITED STATES PATENT OFFICE

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PUNCHING METHOD AND TOOL

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9 Claims. (Cl. 90—24)

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This invention relates to methods and tools for punching an opening of desired shape in a workpiece such, for example, as the hexagon or the spline type of socket in a set screw head. The ordinary method of producing such a socket is to first rough it out with a drill and then shape it with a punching tool having the full shape of the non-circular socket to be produced. This method has the disadvantage, however, that the entire punching operation is performed in a single stroke of the tool requiring such excessive force that it has been practicable to punch only screws of relatively small size in the usual multiple or single spindle screw machine. It has been proposed to punch such openings by a progressive method in which the workpiece and tool are rotated in engagement while held with their axes inclined to each other, but this method requires simultaneous rotation of the work and tool with an unbalanced engagement of the tool at one side only with the work, so that this method has not proven satisfactory.

One object of the present invention, therefore, is to provide an improved punching method of a more simple and practical nature, as well as a more efficient tool for carrying out such method.

Another object is to provide an improved method of the character described requiring materially less force for its performance, and capable of use for punching a wide range of screws, or the like, in the usual automatic screw machines.

Another object is the provision of an improved method having the above advantages and adapted to be accomplished by straight reciprocating punching strokes of a tool in the usual automatic screw machine, with the work and tool either held against rotation or both rotated simultaneously at the same speed.

Another object is to supply a single tool for accomplishing the above advantageous method, requiring the application of less cutting force, while operating with a balanced pressure on opposite sides and having a more efficient cutting action.

To these and other ends the invention resides in certain improvements and combinations of parts and method steps, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a view of a screw blank and punching tool, with the blank in section and showing the construction of the tool and its punching operation to punch the screw socket;

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Fig. 2 is a view of the free or cutting end of the tool as viewed from the left in Fig. 1;

Fig. 3 is an elevation of the blank drilled to rough out the socket opening;

Fig. 4 is a similar view of the blank and tool showing the first punching cut;

Fig. 5 is a view of the blank as shown in Fig. 4, but with the tool withdrawn and in a partially indexed position;

Fig. 6 is a similar view showing the blank fully indexed;

Fig. 7 is a view similar to Fig. 4 showing the second punching operation of the tool;

Fig. 8 is a view of the blank as shown in Fig. 7, but in partially indexed position;

Fig. 9 is a view similar to Fig. 8, but with the blank fully indexed;

Fig. 10 is a view showing the third punching operation of the tool on the blank;

Fig. 11 shows the blank with its opening completely shaped;

Fig. 12 is a side elevation, partly in section, showing a completed screw;

Fig. 13 shows a screw blank drilled to rough out an opening for a modified punching operation;

Fig. 14 shows the blank and a modified tool in cutting engagement therewith for forming a spline type of socket, and

Fig. 15 shows a splined socket as completed by three operations of the tool, with a relative indexing of the blank and tool through an angle of 60° between successive operations.

In a preferred manner of carrying out the present method, herein disclosed by way of illustration, the head 20 of a screw or similar work blank is first drilled to rough out an opening 21 having a diameter equal substantially to the distance between opposite faces of a hexagonal socket to be formed therein. The forming of the opening to produce a hexagonal shape is accomplished by three successive punching operations of a single tool, with intervening relative indexing of the work and tool through an angle of 60° between operations. The tool has cutting edges on opposite sides and each operation serves to form two opposite corners of the hexagonal socket together with the portions of the hexagon faces adjacent to each corner, so that three such operations serve to complete the hexagonal shape. Further details of the method are best understood in connection with a disclosure of the construction of the punching tool, which will now be described.

The punching tool preferably comprises a bar

22, the free or cutting end of which is formed at diametrically opposite sides with pairs of intersecting plane surfaces, 23 and 24. These surfaces of each pair are substantially parallel with the longitudinal axis of the bar and intersect each other along a longitudinal line 25, making with each other an angle of 120° corresponding to the angle at each corner of the hexagon. Surfaces, 23 and 24, also intersect the transversely extending free end 26 of the bar, forming at such intersections the cutting edges 27. The reactions from the cutting pressures exerted at the cutting edges on opposite sides of the tool bar tend to equalize and counterbalance each other and so facilitate the accurate guidance of the tool during the cutting action. The end of the bar is slightly recessed, as shown, to provide the cutting edges with a rake, which accomplishes a shearing type of cut instead of a punching action, thereby materially improving the efficiency of the cutting action and reducing the amount of force required. The faces, 23 and 24, of each pair are each slightly wider than one-half the width of a face of the hexagon for a purpose which will presently be described, and the sides of the bar between these pairs of faces are reduced, as at 28, to clear the sides of the opening.

In operation, the set screw or other workpiece is formed on the end of a bar of stock chucked in a screw machine or other machine tool, with its axis parallel with the axis of the tool bar 22, and both may be either rotated simultaneously or held stationary during the broaching operation. The workpiece or blank having been drilled to rough out the opening 21, as described, the blank and tool are brought together by a relative coaxial reciprocating movement, as shown in Figs. 1 and 4, and the cutting edges 27 at the opposite sides of the tool cut two opposite corners, 29 and 30, of the hexagon to be formed. The tool faces, 23 and 24, also operate to cut the portions of the hexagon faces adjacent each corner, thus forming slightly more than one-half the width of each hexagon face, so that successive broaching cuts will overlap and thereby complete each face.

After one punching stroke, as shown in Fig. 4, the tool is retracted and a relative indexing movement is effected between the work and tool. Where, as in the present disclosure, the operation is carried on in an automatic screw machine, with simultaneous rotation of the work and tool, as indicated by the arrows in the drawing, such indexing may be advantageously accomplished by the mechanism described and claimed in my copending patent application, Serial No. 17,870, filed March 30, 1948, now Patent No. 2,572,909, granted October 30, 1951, Indexing Mechanism for Machine Tools. In such a rotary indexing mechanism, the tool spindle, while maintained in continuously interlocked relation with the mechanism, is indexed in a step-by-step manner, first through one-half of the indexing movement, or 30° in the present case, as shown in Fig. 5, and then through the second half of the movement, so as to complete a positively controlled indexing movement of 60°, as shown in Fig. 6.

After thus cutting two opposite corners of the hexagonal socket, with subsequent indexing as described, the work and tool are again brought into cutting relation to form a second pair of opposite hexagon corners, 31 and 32, and adjacent face portions as described above in connection with the first operation and as shown in Fig. 7. Thereafter, the work and tool are again indexed by 30° steps through an angle of 60°, as shown in Figs. 8 and 9. In this relation of the parts, the third and final cutting cut is effected to shape the remaining opposite corners of the hexagon, as shown in Fig. 10, from which it will be seen that all of the corners are formed and all of the faces completed by the overlapping cuts made by the cutting edges 27 of the tool faces, 23 and 24.

During the cutting actions of the tool, the rake with which the cutting edges are provided operates efficiently to shear the chips 33 from the side walls of the opening, as shown in Fig. 1, and curl them over in the bottom of the opening, as shown in Fig. 11. The successive cutting strokes are preferably reduced slightly in depth to compensate for the accumulation of such chips.

It is apparent from the above description that each of the three cutting strokes of the tool cuts only two opposite corners and a little over one-half of the flats adjacent each corner, so that each cutting strokes requires only one-third of the force ordinarily required where the whole opening is broached by a single stroke of the tool. By this method and the use of a tool with cutting edges having an efficient shearing action, the cutting force is greatly reduced. It has been found, for example, that by the present method and tool, a $\frac{3}{16}$ inch hexagon socket may be punched with a force of 600 pounds pressure, whereas the punching of the same socket by the ordinary method, in a single punching stroke, requires a pressure of 6500 pounds. As a result, the present invention makes it possible to broach set screws of practically any size on automatic screw machines, as a part of the automatic process of forming the set screw, thus eliminating the secondary operations or secondary handling heretofore required for large screws.

In the use of the present method and tool, the tool is readily indexed on a screw machine for the three positions required, and advanced and retracted, to accomplish the broaching cuts, so as to produce a very accurate socket at pressures well within the limits of ordinary screw machines.

Figs. 13, 14 and 15 show the use of the method with a modified tool 34 having opposite sides formed with arcuate faces 35 on opposite sides of a rib 36 for cutting spline grooves in a spline type of socket 37, as shown in Fig. 15, the method being the same as described above and the tool having a similar form with a balanced cutting action on each of opposite sides for forming the opposite spline grooves two at a time. Three such punching cuts, with intervening indexing of the tool and work through an angle of 60°, serve to complete the socket in the same manner and with the same advantages described above. The invention is similarly applicable to the punching of sockets of a variety of other shapes, and to the punching of such openings in a wide variety of work blanks, in addition to the set screws herein described.

It will thus be seen that the invention accomplishes its objects and while it has been herein disclosed by reference to the details of preferred embodiments, it is to be understood that such disclosure is intended in an illustrative, rather than a limiting sense, as it is contemplated that various modifications in the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention and the scope of the appended claims.

I claim:

1. The method of punching an opening in a workpiece comprising the steps of roughing out said opening, punching oppositely spaced portions of said opening simultaneously with a unitary punching tool while said tool and workpiece are held against relative rotation, separating and indexing said workpiece and tool and repeating said punching step at contiguous points spaced around said opening to progressively form the shape thereof.

2. The method specified in claim 1 in which said oppositely spaced portions are punched simultaneously by punching edges located at the free extremities of opposite sides of the tool.

3. The method specified in claim 1 in which said oppositely spaced portions are punched to form at each portion thereof an angular intersection between adjacent sides of a non-circular opening and including at least the adjacent one half of each of said sides.

4. The method specified in claim 1 in which said oppositely spaced portions are punched simultaneously with a single tool having spaced cutting edges at the free extremities of opposite sides thereof shaped to form at each of said portions an angular intersection between adjacent sides of said opening.

5. The method specified in claim 4 in which said opening is a polygon having an even number of sides.

6. A tool for punching a non-circular opening in a workpiece comprising a bar having cutting edges formed by the intersections with its transversely extending free end of spaced angular surfaces extending longitudinally along opposite sides of said bar, said bar having its sides between said surfaces reduced to clear the sides of said opening and having said free end thereof formed with a cutting rake, for simultaneously forming opposite angular side portions of said opening at each punching stroke of said tool.

7. A tool for punching a non-circular opening in a workpiece comprising a bar having cutting edges formed by the intersections with its transversely extending free end of spaced pairs of longitudinally extending side faces with the faces of each pair intersecting each other along a longitudinal line of said bar, said intersecting lines being disposed at diametrically-opposite sides of said bar and each of said faces being at least one-half as wide as a side face of said opening and being arranged to punch an adjacent portion of a side face of said opening, for simultaneously forming the angular intersections and adjacent face portions on opposite sides of said opening at each punching stroke of said tool.

8. A tool as specified in claim 7 in which the sides of said bar between said pairs of intersecting side faces are reduced to clear the sides of said opening and the free end of said bar is formed with a cutting rake.

9. The method of punching an opening in a work piece comprising the steps of roughing out said opening, punching spaced, diametrically opposite portions of said opening simultaneously by punching edges located at the free extremities of opposite sides of a punching tool, separating and indexing said tool and work piece and repeating said punching operation to shape said opening.

EARL W. BRINKMAN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
376,136	Burrowes	Jan. 10, 1888
1,028,824	La Pointe	June 4, 1912
1,148,065	Warren	July 27, 1915
1,233,373	La Pointe	July 17, 1917
1,482,110	Bolesky	Jan. 29, 1924
1,549,309	Howe et al.	Aug. 11, 1925
1,695,955	Prayer	Dec. 18, 1928
2,169,460	Broughton	Aug. 15, 1939
2,255,948	Swanstrom	Sept. 16, 1941
2,393,646	Markstrum	Jan. 29, 1946

FOREIGN PATENTS

Number	Country	Date
23,335	Great Britain	Dec. 18, 1913