April 28, 1953 C. A. REES 2,636,253

MEANS FOR AND METHOD OF PRODUCING SHEET METAL LOCK WASHERS

Filed Feb. 20, 1948 2 SHEETS—SHEET 1

Fig. 1.

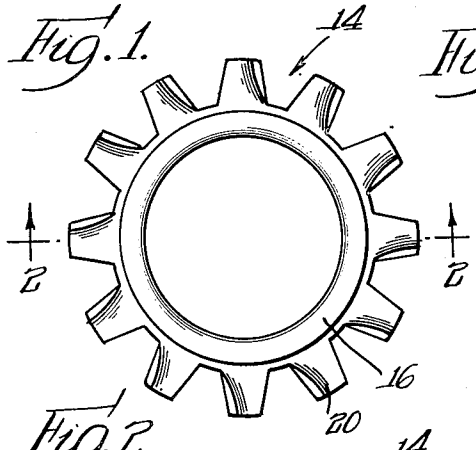


Fig. 2.

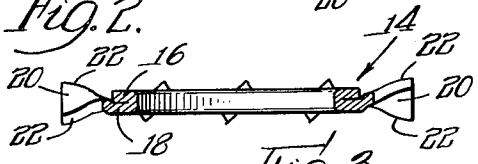


Fig. 3.

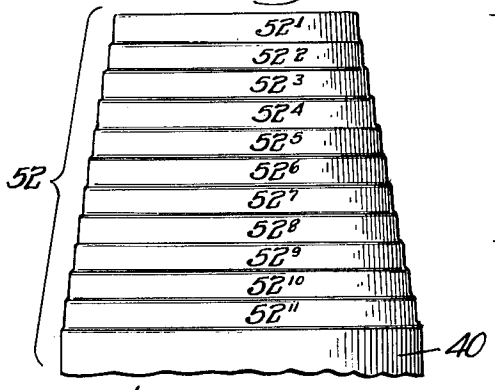


Fig. 4.

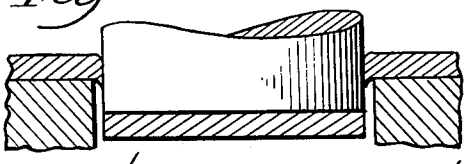


Fig. 5.

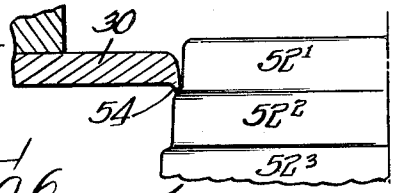


Fig. 6.

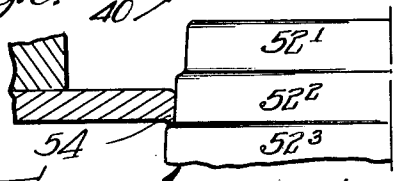


Fig. 7.

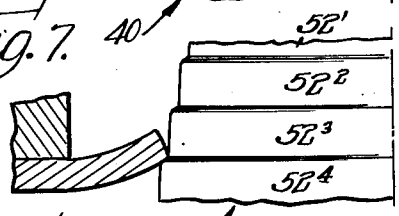


Fig. 8.

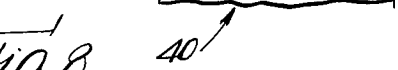


Fig. 9.

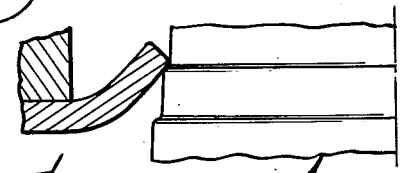


Fig. 10.

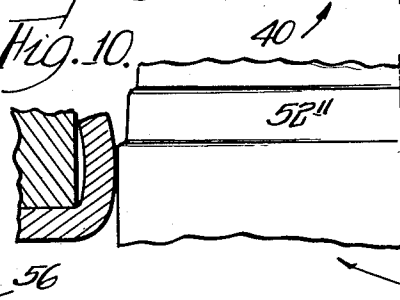


Fig. 11.

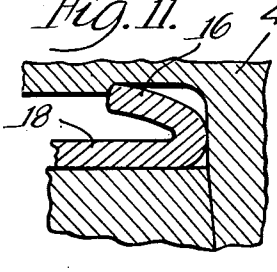
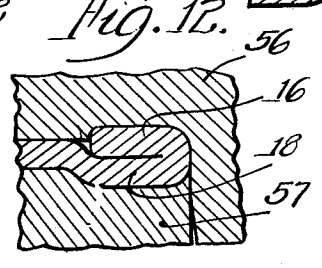


Fig. 12.



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MEANS FOR AND METHOD OF PRODUCING SHEET METAL LOCK WASHERS

Filed Feb. 20, 1948 2 SHEETS—SHEET 2

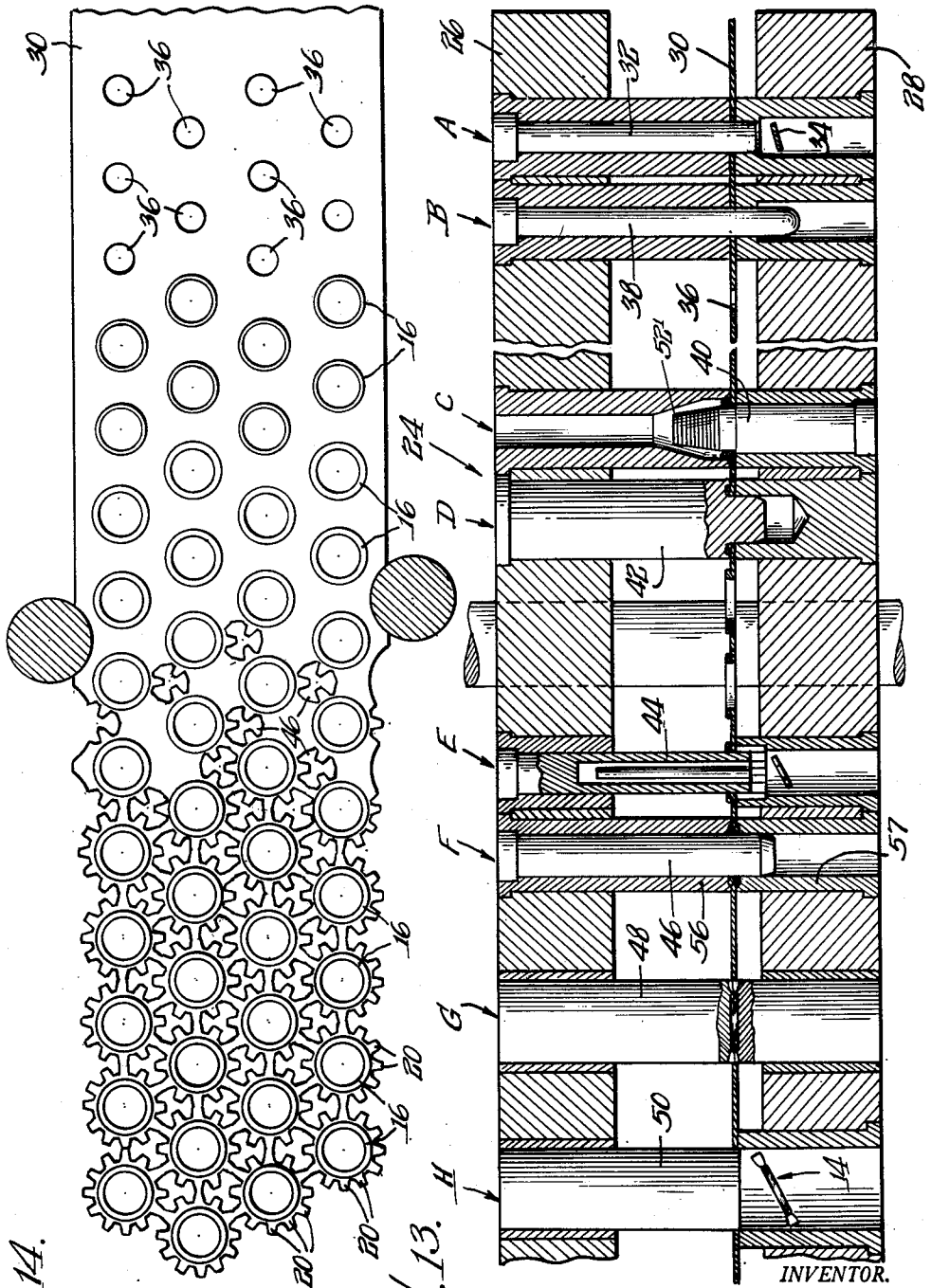


Fig. 14.

Fig. 13.

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MEANS FOR AND METHOD OF PRODUCING SHEET METAL LOCK WASHERS

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Application February 20, 1948, Serial No. 9,788

7 Claims. (Cl. 29—148)

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This invention relates generally to means for and method of producing lock washers from sheet metal stock and, more particularly, to apparatus for and methods of producing lock washers having folded marginal body portions which provide a thickened rim to prevent complete flattening of locking teeth.

One of the problems incident to the manufacture of lock washers having folded over or thickened rim portions is that of preventing fractures. For example, when the annular internal margin of sheet metal normally employed in the manufacture of lock washers is drawn axially and then bent into overlapping relationship with the remainder of the stock, said stock is subjected to severe strains and stresses which have a tendency to encourage fractures. It is, therefore, one of the important objects of the present invention to make possible the manufacture of the lock washers mentioned above without experiencing the impairment or fracture of the metallic sheet stock.

More specifically, the invention contemplates the provision of means whereby sheet stock may be progressively fed past a series of stations for perforating and subsequently forming the metal stock into a toothed lock washer having a folded rim construction.

To facilitate the practice of the methods of the present invention, the provision of a tool or mechanism of novel design is contemplated, which is adapted to extrude the material of the stock defining a pre-formed aperture in such a manner that the extruded material may finally be folded back against the remaining material in the form of a continuous, unbroken annular body. To this end, the aforesaid mechanism is designed to progressively engage the material with diameters of increasing size until the required amount of stock has been extruded.

It has also been found that during the initial perforating operation prior to the aforesaid extrusion step, it is not uncommon for a burr or fin to be formed at the underside of the stock immediately adjacent the aperture. The presence of this fin, and particularly minute scorings or cracks therein, tends to enhance stock fracture during the subsequent extrusion process. It is a further object of the present invention to overcome this difficulty by so working the material of the aforesaid burr or fin that the tendency for fracture in this vicinity is precluded.

The foregoing and other objects and advantages will be more apparent from the following detailed description when considered in connection with the accompanying drawings, wherein

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Figure 1 is a plan view of a lock washer having a folded over inner rim capable of being produced by employing a mechanism and practicing methods contemplated by the present invention.

Figure 2 is a central sectional view of the above-mentioned lock washer, taken substantially along the line 2—2 of Figure 1.

Figure 3 is a side elevational view of one of the tools employed in practicing the present method, the primary function of which is to so condition sheet metal material in the vicinity of a preformed aperture that said material may be extruded and completely folded back upon itself without danger of fracture.

Figure 4 is an enlarged transverse view illustrating the first or perforating step in the process of manufacture contemplated hereby.

Figures 5 to 10, inclusive, illustrate the progressive metal working or forging action of the tool illustrated in Figure 3.

Figure 11 is a sectional view of the work similar to the sections shown in Figures 4 to 10, inclusive, after the extruded stock has been folded back toward the remaining portion of the stock.

Figure 12 is a sectional view similar to Figure 11, showing the results of a subsequent step in the process wherein the single thickness of the external area of the washer is centralized with respect to the folded over or thickened inner rim of the washer.

Figure 13 is a vertical sectional view of a die mechanism for progressively stamping and forming sheet material in accordance with the teachings of the present invention; and

Figure 14 is a plan view of sheet metal stock as it is fed through the progressive die of Figure 11, said view illustrating the successive stamping and forming operations to which the sheet stock is subjected as it moves step by step through said die.

Referring now to the drawings wherein like numerals have been employed to designate similar parts throughout the various figures, it will be seen that Figures 1 and 2 disclose a lock washer of the type capable of being produced by practicing the present invention, said lock washer being designated generally by the numeral 14. This lock washer 14 consists of an internal annular body portion comprising an annular flange portion 16 folded over a complementary annular flange portion 18 so as to provide a double thickness of washer stock. Suitable prongs 20 formed integral with and extending radially outward from the body portion 18 present work engaging

or locking teeth 22 positioned on opposite sides of the bounding planes of the combined body portion 16—18. The combined body portion 16—18 presents a thickened washer rim which cooperates to prevent complete flattening of the washer prongs 20 when the lock washer is tightened beneath a screw head or nut. The present invention is not concerned with the lock washer per se, but is primarily directed to improved practical methods and mechanisms for producing the washer from sheet stock and, more particularly, to that portion of the method which relates to the extrusion of the material in the vicinity of the washer aperture. For more detailed information concerning this type of lock washer, reference is made to the patent to Poupitch, No. 2,321,155.

In the process of stamping and forming parts, such as washer elements and the like from flat sheet stock, it is not uncommon to employ a mechanism known to those skilled in the art as progressive die mechanisms. In Figure 13, a vertical sectional view of such a die mechanism is shown. This die mechanism or set is designated generally by the numeral 24 and consists of an upper vertically shiftable punch holder 26 and a lower stationary die block 28. For the purpose of illustrating one practical embodiment of the present invention, a die mechanism is disclosed which is capable of simultaneously producing a plurality of lock washers from a single strip of sheet metal stock 30. The stock 30 is progressively moved from right to left, Figures 13 and 14, by any suitable work shifting means (not shown). The advancing end of the sheet material 30 is initially positioned beneath a station indicated by the letter A, said station consisting of a plurality of punches 32. As the punch holder 26 descends, the punches 32 function to punch out blanks 34, Figure 13, leaving apertures 36 in the work sheet. Upon subsequent or upward movement of the punch holder 26, the sheet 30 is advanced to the next station B, which consists of a group of pilot pins 38. As the punch holder 26 again descends, these pilot pins 38 register with the previously formed apertures 36 and thus serve as the stock continues to advance in step by step fashion through the die mechanism to accurately position the stock for all punching and forming operations.

Eventually, the stock is advanced to a forming station C. At this station is located a material extruding tool 40, which functions to force the material of the stock in the vicinity of the apertures 36 axially into an unbroken flange, as indicated in Figure 13. The structural and functional characteristics of this station C will be described more in detail in a latter portion of this specification. From the station C, the stock then shifts to a station D, where a tool 42 moves into engagement with the annular flange previously extruded by the tool 40. This causes the flange to be folded over the remaining portion of the stock. As the stock continues to advance, it ultimately reaches the station E, where a group of punches 44 produce clover leaf apertures 46. These apertures in the aggregate form a plurality of connected tooth elements or partly formed lock washers. A second set of pilot or centering pins 46 at a station F functions to maintain accurate alignment of the washer stock and also serves to maintain the hole sizes. At the next station G, the external prongs of the partially formed washers are twisted by suitable forming tools 48, and at the final station H, these washers are completely severed from each other by punches 50.

Referring now more specifically to the stock extruding tool 40, Figs. 3 and 13, it will be seen that this consists of a frusto-conical upper extremity included within the bracket 52 of Fig. 3. Particular attention is directed to the fact that this frusto-conical upper extremity or head 52 is made up of a plurality of work engaging sections, each section slightly increased in external diameter as these sections progress from the upper or centering extremity of the head 52. For purposes of convenience, the uppermost section is designated as 52^{1} and the lower largest section by the numeral 52^{11}. All of the sections interposed between the section 52^{1} and 52^{11} slightly increase in diameter and each section is preferably formed with a peripheral surface having a slight taper of approximately 1°. Also, the upper and lower margins of each sections are rounded for purposes about to be described.

When the punches 32 produce the apertures 36 in the work piece 30, the shearing action of the punches has a tendency to form an annular burr or fin 54, illustrated in Fig. 4. Not infrequently these annular fins have minute tool marks or scorings which must be ironed out if further fracture is to be prevented. Experience has shown that if the material of the stock 30 in the vicinity of this fin 54 is extruded axially, there is a tendency for the aforesaid minute scorings to develop into longer fractures. The tool 40 has been designed to obviate this difficulty. At this point in the description, it should be understood that the sheet material 30 moves upwardly as a unit with the punch holder 26 due to the frictional engagement of the punches 32 within the apertures formed thereby. As the material 30 rises to a level which is sufficient to clear the upper extremity of the extruding tool 40, a conventional stripper mechanism (not shown) functions to strip the stock from the punches 32 and the pilot pins 38, thereby enabling the stock to be advanced to a position immediately above the tools 40. As the punch holder 26 again descends, the previously formed apertures 36 make initial telescopic association with the uppermost section 52^{1} of the extruding tool 40. The upper margin of the section 52^{1} is rounded, and the diameter of the section is slightly smaller than the aperture 36. Figure 5 discloses the initial forging or cold working action on the fin 54. The bottom curvature of the section 52^{1} and the upper curvature of the section 52^{2}, Figure 5, cooperate initially to engage the fin 54 in cold working or forging the material of the fin. As the work 30 continues to be forced downwardly over the tool 40, the tapered periphery of the tool section 52^{2} exerts radial outward pressure against the inner periphery of the work, and ultimately the partially worked fin 54 moves into engagement with the lower curved portion of the tool section 52^{2} and the upper merging curved surface of the section 52^{3}. By this time the fin or burr 54 has been kneaded or cold worked so as to materially reduce it in cross sectional size, thereby reducing materially any tool scorings or the start of fractures in the fin. By the time the work piece is pushed downwardly over the tool section 52^{3}, Figure 7, the annular portion of the stock begins to experience outward bending. In this connection it will be understood that the outward bending of the stock does not begin until the fin 54 has been cold worked to such an extent that no tool scorings

or breaks in the stock exist. It will be noted from Figure 7 that the burr or fin has been "kneaded away," and in place of the fin this annular corner of the stock is being rounded. In Figure 8 the work has been advanced to the point where an appreciable bend has occurred and the annular sections of the tool **40** are beginning to exert a burnishing action. This burnishing action will be more clearly understood from Figure 9, at which time the inner upturned flange of the work is being burnished by the peripheral surfaces of the tool sections. Finally, when the work is moved to the position shown in Figure 10, the entire inner surface of the bent up flange has been subjected to a polishing, cold burnishing or burnishing action.

It will also be noted from Figure 10 that the action of the tool **40** is such as to cause the upturned or bent flange to partake of a reverse curve or bend. This is of importance because after the stock has been moved upwardly and stripped from the tool **40**, and then advanced to a position beneath the tool **52**, it must be in readiness to be folded over. As the tool **42** descends, the flange **16** readily bends outwardly because of the initial curl imparted thereto by the tool **40**, as illustrated in Figure 10. Obviously, the free margin of the flange **16**, Figure 11, is subjected to severe strains and stresses as it is folded against the complementary annular portion **18** of the body. If this outer or free margin of the flange **16** is not completely free from small fractures during the folding over process, said margin will not maintain its peripheral continuity. In other words, at this point in the process of manufacture, the avoidance of slight cracks or fractures of the most minute form of the margin of the extruded portion of the stock is extremely important. In folding over the material in this manner, increase in external diameter of the outer margin of the flange **16** occurs, thereby increasing quite materially the tendency for stock fracture in this vicinity.

After the flange **16** has been folded over and against the complementary marginal portion **18** of the stock, Figure 11, it is stripped from the tool **42** and advanced into position beneath a sleeve-like tool **56** which surrounds the pilot pin **46**, Figures 11 and 12. This tool **56** cooperates with a complementary tool member **57** positioned therebeneath to centralize the single thickness of washer stock with the double thickness presented by the folded over annular sections **16—18**. Thus, the plane of the single thickness of washer material is centrally positioned with respect to the bounding planes of the combined sections **16—18**.

During a subsequent cycle of reciprocation, the work is advanced to the Station G, where the washer teeth are twisted. Subsequently, the work is advanced to the Station H, where the completely formed washers are severed from each other in readiness to be heat treated.

From the foregoing it will be apparent that the present invention contemplates improved, practical extrusion methods and apparatus. These improved methods and apparatus may be used in the manufacture of thick rim lock washers and the like. The invention particularly lends itself for use with progressive die mechanisms in which sheet material may be advanced step by step past the various stations. Cracks, fractures, tool marks and abrasions in sheet stock initiated during the blanking operation do not develop into more extensive cracks or fractures when the above described invention is employed. The stepped forming or extruding tool heretofore described serves to bend or extrude the stock in a direction normal to the plane thereof, and contemporaneously to forge or cold work and burnish the edge of the stock which usually presents a burr formed during the previous blanking operation. The action of the extruding tool is such as to forge the annular section of the work, including the marginal edge thereof, so as to iron out minute irregularities of the stock and to strengthen the surface layers. This ironing out process tends to strengthen the critically stretched or stressed fibers of the stock. By thus strengthening the surface fibers which are to be critically stretched in the subsequent folding over operation, tendencies for fracture are reduced to a minimum. By subjecting the edge of the stock to compression and contemporaneously forging one corner of said edge by beveled or rounded extruding shoulders of the tool, the danger of stock fracture when the material is subsequently folded over is eliminated. The method and apparatus herein contemplated make it possible to produce thick rim lock washers without increased cost in material by reason of the fact that the portion of the stock which is extruded would, under ordinary circumstances, be discarded as scrap. That is to say, the marginal portion of the sheet metal stock defining the aperture produced by the first punch would be removed in following conventional methods of lock washer manufacture. The present invention makes it possible axially to displace this hitherto unused annular section of stock surrounding the aperture into an annular flange or neck, and contemporaneously to work, knead or forge said annular section including the marginal edge so as to counteract tendencies for stock fracture during the final folding over step in the process of extrusion.

While for purposes of disclosure specific die structures have been disclosed herein, it will be apparent that the invention contemplates other modifications and changes without departing from the spirit and scope of the appended claims.

The invention is hereby claimed as follows:

1. The method of forming an annular flange in sheet metal stock which consists in punching an aperture in the stock resulting in a stamped burr along the corner of the stock defining the portion of the punched aperture adjacent the side of the stock from which the punched blank is ejected, forging said burr and bending the marginal area surrounding the aperture into an annular flange substantially free from fractures by initial engagement of said burr with an annular working surface of a diameter substantially equal to the diameter of the whole defined by the burr, and subsequently engaging the burr and marginal portion of the stock in the vicinity of said burr with a succession of annular working surfaces including curved shoulder areas of progressively and gradually increasing diameters.

2. The method of forming an annular flange in sheet metal stock as set forth in claim 1, including the step of engaging the inner periphery of said flange at a point spaced from the flange margin by a working surface of increased diameter whereby to dispose the flange substantially normal to the plane of the stock.

3. The method of forming an annular flange in sheet metal stock as set forth in claim 1 including the step of folding said flange against a com-

plementary remaining portion of the sheet stock.

4. The method of forming an annular flange in sheet metal stock as set forth in claim 3 including the step of axially shifting the folded flange and adjacent underlying complementary stock portion so as to position the opposed outer surfaces thereof substantially equidistant beyond the bounding planes of the single thickness of stock extending radially outwardly therefrom.

5. Apparatus for forming an annular flange in an apertured sheet metal work piece including annular abutment means for annularly contacting said work piece, and a shank-like tool disposed coaxially with respect to said annular abutment means and consisting of a plurality of relatively minutely stepped annular working surfaces designed to act upon the marginal area of stock with defines a work aperture, the annular working surface of minimum diameter being located at the entering end of the tool with succeeding annular working surfaces gradually increasing in diameter, adjacent annular working surfaces being joined by curved shoulder areas for forging apertured sheet stock, the space between the periphery of said annular tool surfaces and the internal periphery of said annular abutment means diminishing from at least twice the thickness of the work piece at the entering end of the tool to a space not less than the work piece thickness when the working surface of maximum diameter is in operative position with respect to said internal periphery.

6. In an apparatus of the type described in claim 5 wherein each of said annular working surfaces is frusto-conical with their smaller diameters extending toward the entering end of the tool.

7. In an apparatus of the type described in claim 5 wherein the axial extent of each annular working surface is at least twice the radial extent of its adjacent curved shoulder portion.

CLARENCE A. REES.

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