April 13, 1937. J. C. LEMMING 2,077,336

APPARATUS FOR FORMING CIRCULAR BUSHINGS

Filed Jan. 7, 1935 3 Sheets-Sheet 1

Fig. 1

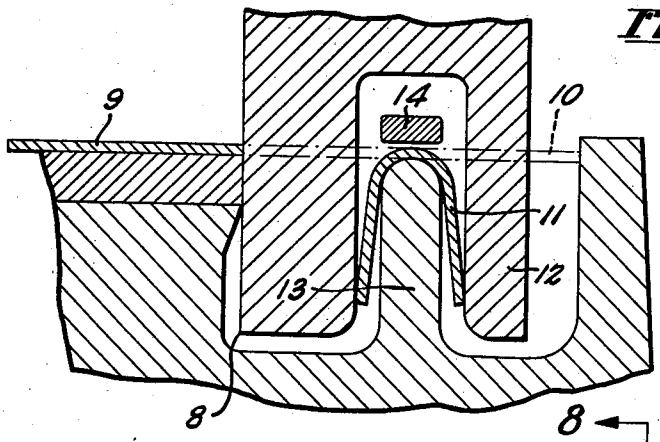

Fig. 2

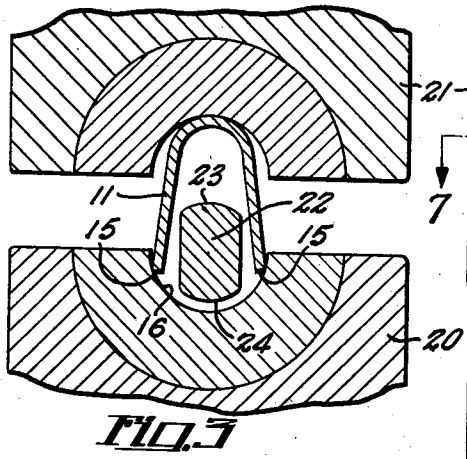

Fig. 3

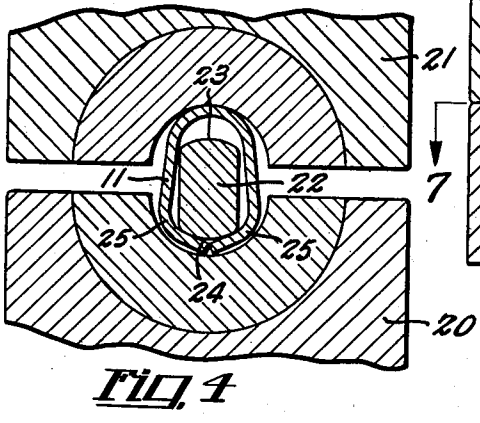

Fig. 4

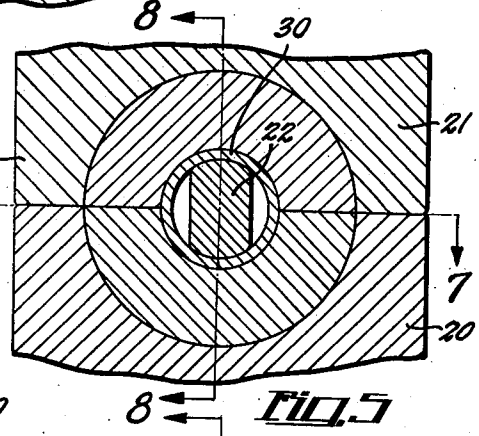

Fig. 5

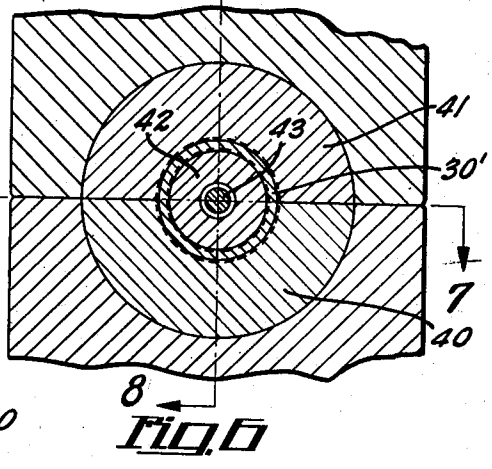

Fig. 6

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APPARATUS FOR FORMING CIRCULAR BUSHINGS

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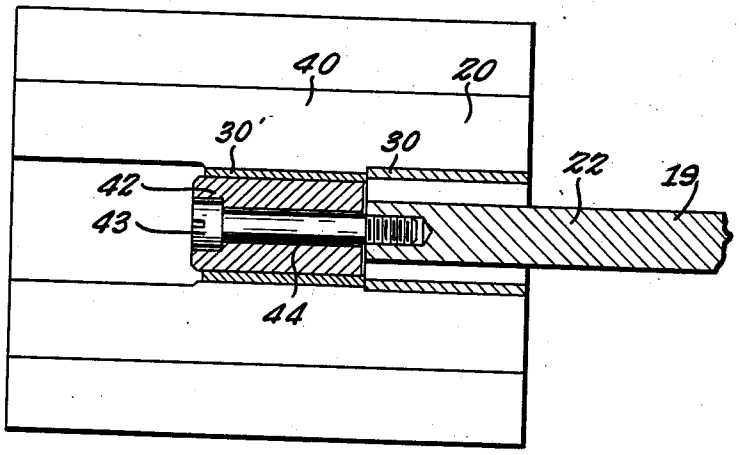

Fig. 7

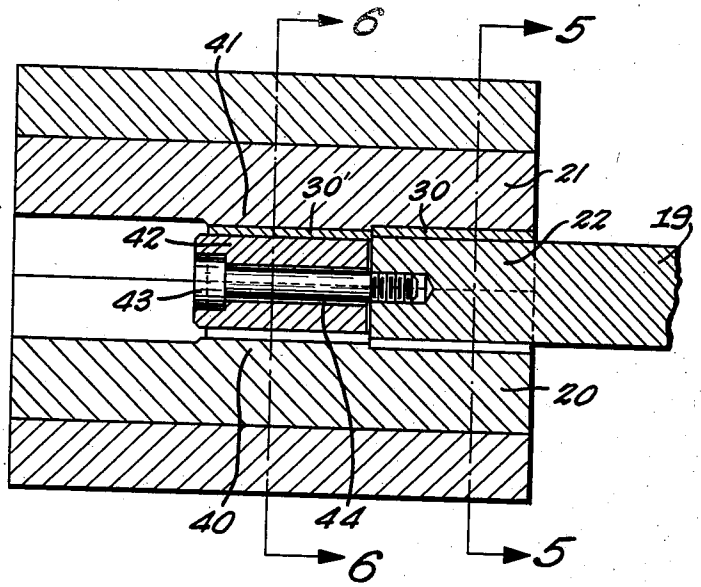

Fig. 8

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APPARATUS FOR FORMING CIRCULAR BUSHINGS

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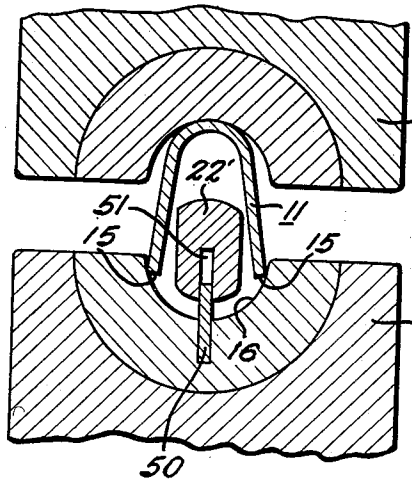

Fig. 9

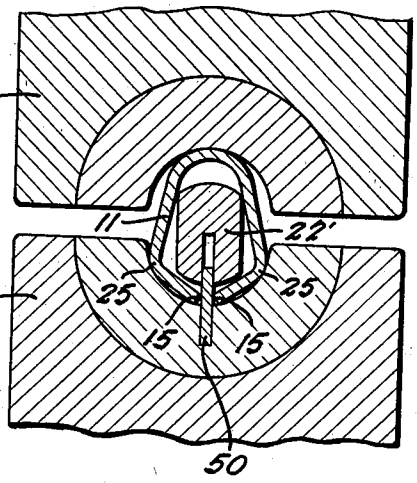

Fig. 10

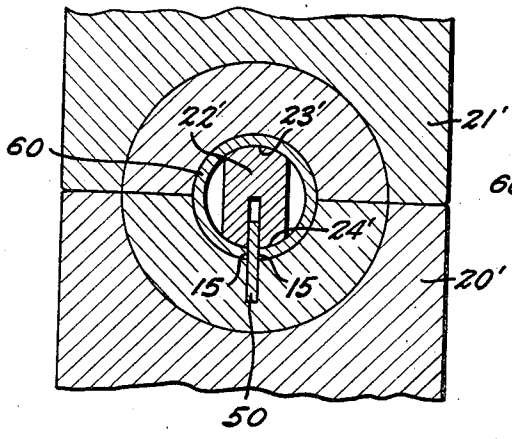

Fig. 11

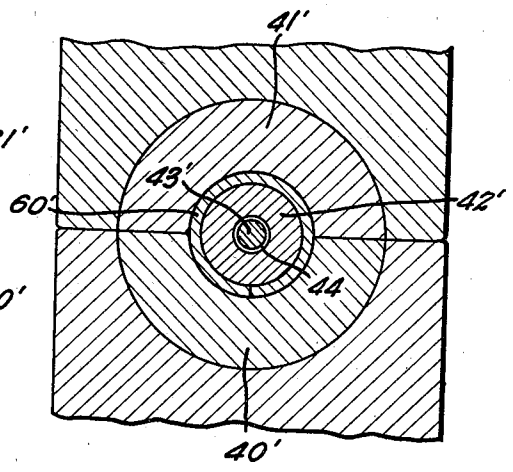

Fig. 12

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Patented Apr. 13, 1937 2,077,336

UNITED STATES PATENT OFFICE

2,077,336

APPARATUS FOR FORMING CIRCULAR BUSHINGS

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Application January 7, 1935, Serial No. 588

5 Claims. (Cl. 153—49)

This invention relates to an apparatus for forming circular bearing bushings or similar forms from flat metal stock.

An object of the invention is to provide an improved means for making bushings having uniformly exact finished dimensions and which will have uniformly smooth and efficient interior bearing surfaces.

This application is a continuation-in-part of my copending application Serial No. 577,246, filed November 25, 1931.

In making bushings according to the disclosure of said prior application, the opposed ends of the U-form blank directly abut each other with a high pressure while said U-form blank is being buckled outwardly into circular form by the approaching semi-cylindrical dies. Such direct abutment of the ends of the U-form sometimes causes one or the other of the end surfaces of these ends to be scored or grooved at or below the inside surface of the formed bushing. Then when the formed bushing has its inside surface cut away slightly by the usual reaming or other suitable finishing operation, a small axially extending score or groove will be exposed on the inside or bearing surface of the finished bushing. Any such axially extending groove in the bearing surface is objectionable since it has been found to often be the cause of vibration of the shaft running in the bearing, or more rapid wear of the bearing. Such an axial groove in the finished bushings often occurs when the material used for the blank is quite soft, such as ordinary bearing bronze stock.

An improvement included in the disclosure of the present application is the longitudinal inwardly projecting web or key in one of the semi-cylindrical dies against which the opposed ends of the U-form abut during the buckling operation, thus preventing any objectionable scoring or grooving of the end surfaces of the ends of the U-shaped blank. This eliminates the above described axial groove at the seam of the finished bearing in all cases whether or not the material of the blank is quite soft.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figs. 1 to 8 are substantially identical with Figs. 1 to 8 of my said copending application Serial No. 577,246.

Fig. 1 shows a flat blank of strip bronze or other metal from which the bushing is to be formed.

Fig. 2 shows the flat strip being sheared off and bent into U-form by a reciprocating die.

Fig. 3 shows the U-form in position between two exterior half-dies and an interior floating arbor, just prior to the descent of the upper half-die.

Fig. 4 shows what happens during the first portion of the down stroke of the upper half-die. Here the bottom ends of the U-form have been bent inwardly under the floating arbor and caused said arbor to be raised somewhat to permit the ends of the U-form to come together easily.

Fig. 5 shows the completion of the down stroke of the upper half-die shown in Figs. 3 and 4. Here the U-form has been buckled out into approximately circular form by the dies and the central floating arbor has been forced to its down position and aids in causing the bushing to buckle out into substantially circular form though this circular form is not exact.

Fig. 6 shows another station where the bushing is being reformed to a more exact circular form and to slightly smaller inside and outside diameters which are its final dimensions. The dotted lines indicate the original size before reforming but the reduction in diameter is exaggerated to enable it to be shown. Here the metal of the bushing walls is flowed slightly under the high pressure of the exterior half-dies to form the bushing to exact dimensions and give the metal a permanent set.

Fig. 7 is a section on line 7—7 of Fig. 6 and Fig. 5 and shows the successive forming operations of those two figures.

Fig. 8 is a section on line 8—8 of Fig. 6 and Fig. 5.

Figs. 9 to 12 illustrate the improvements herein disclosed but not disclosed in said prior application.

Fig. 9 is similar to Fig. 3 but shows the inwardly projecting abutment key fixed to the lower half-die.

Fig. 10 is similar to Fig. 4 and shows what happens during the first portion of the down stroke of the upper half-die.

Fig. 11 is similar to Fig. 5 and shows the completion of the down stroke of the upper half-die shown in Figs. 9 and 10. Here the U-form has been buckled out into approximately circular form but the thin abutment key holds the opposed ends of the bushing spaced apart slightly at the seam.

Fig. 12 is similar to Fig. 6 and shows the final

forming of the bushing by an interior cylindrical arbor and the final closing of the spaced seam shown in Fig. 11.

Similar reference characters refer to similar parts throughout the several views.

First there will be described the means and method illustrated in Figs. 1 to 8.

The flat metal blank 10 is preferably sheared off from the end of a continuous strip 9 of flat stock of bronze or other suitable bearing metal by the edge 8 of the reciprocating die 12. If desired, oil grooves, holes and/or trade-marks may be stamped in the blank 10 by suitable dies prior to the stroke of the die 12 which shears off blank 10. The blank 10 is then bent into the U-form 11 by the continued down-stroke of the reciprocating die 12 over the stationary central die 13. 14 is a stationary stripper bar which aids in guiding the flat blank 10 into proper position between dies 12 and 13, and prevents the next following up-stroke of die 12 from dragging the U-form 11 up with it, all as will be clearly understood from viewing Fig. 2.

The U-form 11 next is passed endwise from its position on die 13 to the position shown in Fig. 3 where its lower ends 15 rest by gravity upon the curved surface 16 of the stationary lower half-die 20, the upper half-die 21 being at that time at a higher position than as shown in Fig. 3 to provide proper clearance between it and the top of U-form 11. An interior floating arbor 22 is suitably supported in the position shown in Fig. 3 by a projecting end shank 19 (see Figs. 7 and 8) so that it may be easily moved vertically upward a small distance by the ends 15 of the U-form 11 as they are forced together as shown in Fig. 4. Floating arbor 22 has cylindrical surfaces 23, 24 and flat sides to enable it to properly clear the sides of U-form 11 which at this time are much closer together than the full inside diameter of the bushing to be formed. Now when the upper half-die 21 descends it compresses the U-form 11 between dies 21 and 20 and causes the lower ends 15 of the U-form to first cam inwardly on the semi-cylindrical surface of die 20 until they pass under the freely floating arbor 22 and raise it upwardly by buckling at the points 25, all as clearly shown in Fig. 4. From this point, further down movement of the upper half-die 21 rounds out the U-form 11 into the nearly circular form 30 as shown in Fig. 5. During this forming, the cylindrical surfaces 23 and 24 of arbor 22 aid materially in rounding out the top and bottom portions of the U-form 11 and this causes the flat sides of the U-form to always and uniformly buckle outwardly rather than inwardly even though said flat sides are spaced some distance from the interior arbor 22. Another very important function of the floating arbor 22 is to prevent the formation of a raised internal bead in the formed bushing 30 where the two ends 15 of the U-form 11 abut at high pressure when die 21 descends as described above. The diameter of the circular surfaces of arbor 22 is preferably several thousandths of an inch less than the inside diameter of bushing 30, formed as above described, to permit said formed bushing 30 to be easily slipped endwise from arbor 22 after the upper half-die 21 moves up again on its up-stroke. Since arbor 22 is floating, that is, it is not held in fixed position but may be moved upward freely for a short distance, the pressure of bushing 30 upon the lower half-die 20 is immediately released when die 21 starts on its up-stroke and hence this feature also permits easy endwise movement of bushing 30 from arbor 22.

For the final forming operation shown in Fig. 6 the bushing 30 is slipped endwise from the flatted arbor 22 onto the slightly smaller but full cylindrical arbor 42. This cylindrical arbor 42 is mounted upon a bolt 43 screwed into the end of floating arbor 22 and hence arbor 42 is also floating (see Figs. 7 and 8). Preferably there is a small clearance 44 between the central aperture in arbor 42 and bolt 43 so that arbor 42 can move slightly relative to arbor 22, in order that the forming operation of Fig. 6 will be substantially independent of that of Fig. 5 even though the exterior half-dies 40 and 41 are formed integral with the half-dies 20 and 21 as clearly shown in Figs. 7 and 8. During this final forming operation of Fig. 6 all small bumps or irregularities in bushing 30' are smoothed out and the walls of said bushing are compressed under high pressure between the half-dies 40, 41 and the central arbor 42 to such an extent that the metal thereof is flowed slightly to cause it to permanently set in its formed exact dimensions. The cold working given the metal by the described reduction in diameter of the bushing at the station shown in Fig. 6 also improves the bearing qualities of bronze metal. At the next up-stroke of upper half-die 41 the finally formed bushing 30' is slipped endwise from the end of arbor 42 by the movement to the left (as seen in Figs. 7 and 8) of the succeeding bushing 30 as it is moved to its position on arbor 42. Since arbor 42 is slightly smaller in diameter than the cylindrical portion of arbor 22, bushing 30 slides easily to its position upon arbor 42. This movement to the left (as seen in Figs. 7 and 8) of both bushings 30 and 30' is done by automatic means not shown since it forms no essential part of this invention.

It is to be understood that the operations described above preferably are continuous, that is, the U-form 11 is made at one station, the initial forming of bushing 30 is done at a second station, and the final forming of bushing 30' is done at a third station, all at one down stroke of the punch press carrying the dies corresponding to these three stations.

The bushings coming from the third station, that is, from arbor 42 may later have their ends cut smooth or chamfered in a suitable trimming machine if it is so desired, but otherwise these bushings are ready to be mounted as bearings in the machine in which they are to be used.

The operation of the means shown in Figs. 9 to 12 will now be described. In Figs. 9, 10 and 11 the lower half-die 20' has a longitudinally extending flat key 50 fixed thereto and extending up into the forming cavity as clearly shown. The flattened floating arbor 22' has a longitudinal slot 51 therein which fits snugly upon key 50 with an easy slip fit. Thus clearance for key 50 is provided when dies 20' and 21' close (as shown in Fig. 11) and also key 50 serves as a suitable guide for the small vertical motion of the floating arbor 22'. Otherwise the parts shown in Figs. 9 to 12 are exactly as described above for Figs. 3 to 6.

In operation, the U-form blank 11 is first passed to the position shown in Fig. 9 where its lower ends 15 rest by gravity upon the curved surface 16 of the stationary lower die 20'. The upper die 21' is shown partly descended in Fig. 9 until it engages the upper curved end of the U-form 11. Further downward movement of die 21' now causes the ends 15 of U-form 11 to first cam in-

wardly on the cylindrical surface 16 until they pass under the floating arbor 22' and raise it upwardly a slight amount by buckling at the points 25, as shown in Fig. 10. The end surfaces 15 of U-form 11 abut against opposed sides of the inwardly projecting flat key 50 (rather than against each other as in the form of the invention described above) and are thus prevented from scoring or grooving each other. Further downward movement of die 21' rounds out the bushing blank into the nearly circular form 60 shown in Fig. 11. During this forming the cylindrical surfaces 23' and 24' of arbor 22' aid materially in rounding out the top and bottom portions of the blank 11 and thus cause the flat sides of the U-form to always buckle outwardly rather than inwardly. Also an important function of arbor 22' is to prevent any thickening of the ends 15 by a flow of the metal due to the high pressure with which they abut the flat key 50 during the forming shown in Fig. 11.

The circular form 60 with the spaced seam therein (due to the ends 15 being spaced apart by the thickness of key 50) is easily slipped endwise from the arbor 22' and onto the circular arbor 42' after the upper die 21' moves up again on its up-stroke in the same manner as described above for the bushing 30. The final forming of bushing 60' is done by the floating circular arbor 42' and the two half-dies 40' and 41' as shown in Fig. 12, the operation being substantially the same as described above for the final forming of bushing 30' shown in Figs. 6 and 8. During this final forming of the bushing the spaced seam shown in the form 60 in Fig. 11 is fully closed by the dies since the flat key 50 extends only throughout the length of the forming surface of die 20'. Of course the diameters of the dies 40' and 41' and of circular arbor 42' are sufficiently smaller than the diameters of dies 20' and 21' and of arbor 22' to provide for the complete closing of the open seam in bushing 60. Such reduction of diameters of the dies in the final forming stage readily permits the partially formed bushing 60 to be easily slipped endwise from the arbor 22' to its final forming stage where it surrounds circular arbor 42'. Floating arbors 22' and 42' are attached by pin 43' and both move upwardly together a short distance by a yielding spring action to the position shown in Fig. 9 immediately upon the up-stroke of the integral upper dies 21' and 41'. This floating action of the arbors greatly facilitates the endwise movement of bushing 60 to its final forming position and also the endwise ejection of the final bushing 60' from the end of the circular arbor 42', as described above.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In an apparatus for making a circular bushing from a U-form metal blank, in combination, two relatively reciprocating dies having coacting concave semi-cylindrical forming cavities which engage and compress said U-form blank therebetween and force same to buckle outwardly into substantially circular form, and a longitudinal key projecting into the forming die cavity and rigidly fixed to one of said dies and forming an immovable abutment for the opposed edges of said U-form blank during the forming operation.

2. In an apparatus for making a circular bushing from a U-form metal blank, in combination, two relatively reciprocating dies having coacting substantially semi-cylindrical forming cavities which engage and compress said U-form blank therebetween and force same to buckle outwardly into substantially cylindrical form, and a thin longitudinal key fixed to one of said dies and projecting inwardly at the center line of one of said semi-cylindrical cavities and forming an immovable abutment for the opposed edges of said U-form blank during the forming operation, and a central arbor located within said die cavities when in closed position and having a cut-out recess for clearing said inwardly projecting key.

3. In an apparatus for making a circular bushing from a U-form metal blank, in combination, two relatively reciprocating dies having coacting forming cavities which engage and compress said U-form blank therebetween and force same to buckle outwardly into substantially circular form, and a longitudinal key projecting into the forming die cavity from one of said dies and forming an abutment for the opposed edges of said U-form blank during the forming operation, and a floating arbor positioned between said coacting cavities and having a reduced width such that said U-form blank may pass thereabout prior to being formed into circular shape, said floating arbor having a slot therein for receiving the inner portion of said key projecting beyond the wall thickness of the formed bushing.

4. In an apparatus for making a circular bushing from a U-form metal blank, in combination, two relatively reciprocating dies having coacting forming cavities which engage and compress said U-form blank therebetween and force same to buckle outwardly into substantially circular form, and a longitudinal key projecting into the forming die cavity from one of said dies and forming an abutment for the opposed edges of said U-form blank during the forming operation, and a floating arbor located between said coacting dies and movable relative to both of said dies to permit the opposed ends of said U-form blank to pass therearound while being bent into circular shape, said arbor having a slot therein for receiving the inner portion of said key.

5. In an apparatus for making a circular bushing from a U-form metal blank, in combination, two relatively reciprocating dies having coacting forming cavities which engage and compress said U-form blank therebetween and force same to buckle outwardly into substantially circular form, and a longitudinal key projecting into the forming die cavity from one of said dies and forming an abutment for the opposed edges of said U-form blank during the forming operation, and a floating arbor located within said die cavities when in closed position and having surfaces which engage the inside surfaces of the bushing and aid in forming the bushing into circular shape, said arbor having a cut out portion for clearing said inwardly projecting key.

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