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2,877,546

METHOD FOR FORMING TUBULAR METAL ARTICLES

Filed June 9, 1953

3 Sheets-Sheet 1

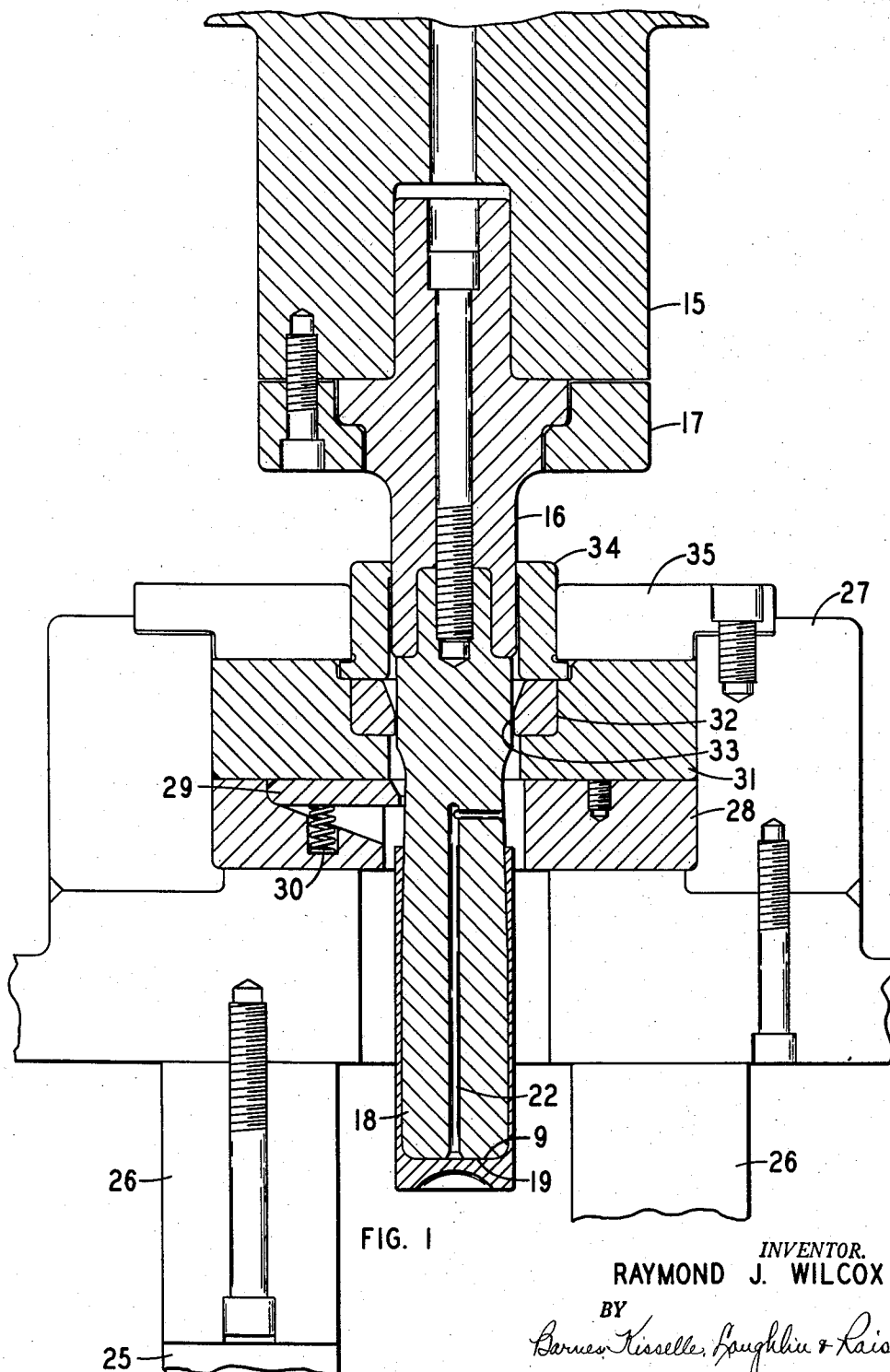


FIG. 1

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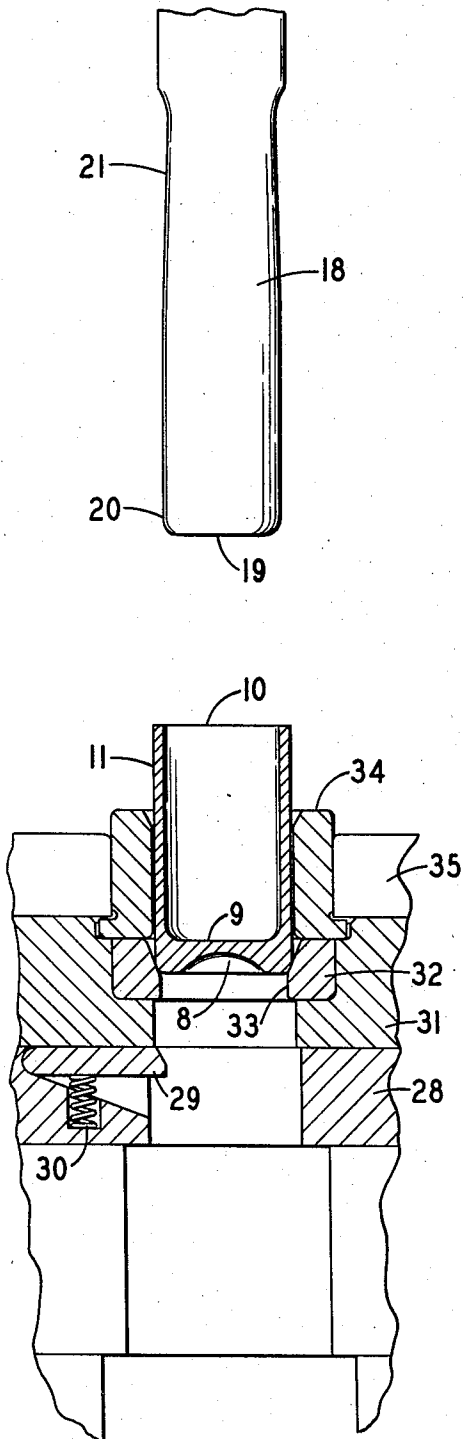


FIG. 2

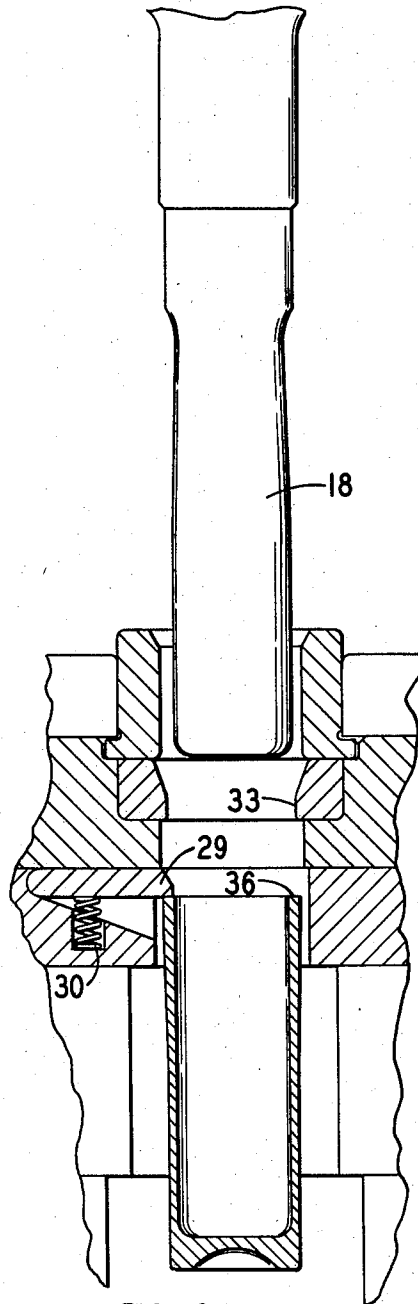


FIG. 3

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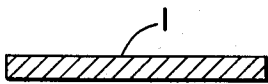


FIG. 4

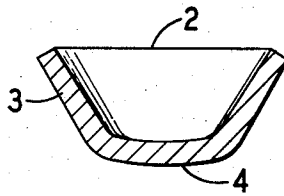


FIG. 5

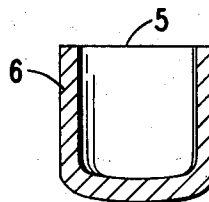


FIG. 6

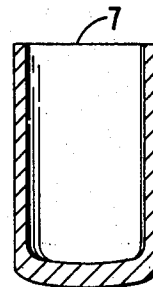


FIG. 7

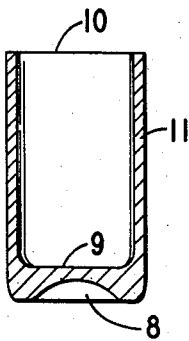


FIG. 8

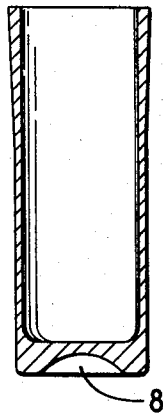


FIG. 9

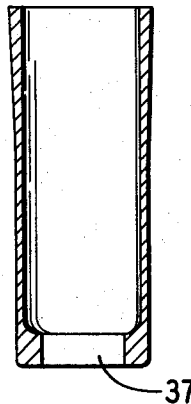


FIG. 10

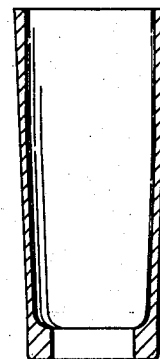


FIG. 11

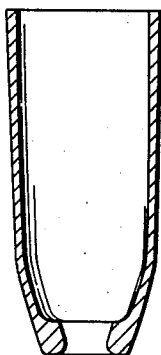


FIG. 12

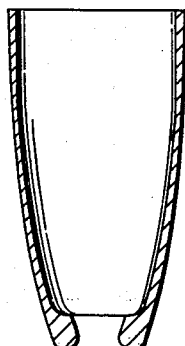


FIG. 13

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METHOD FOR FORMING TUBULAR METAL ARTICLES

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3 Claims. (Cl. 29—544)

This invention relates to a method for forming tubular metal articles by fashioning and shaping flat metal stock. The making of ordnance shells and particularly rocket heads exemplifies the invention, although it may be employed in making other tubular metal articles.

A rocket head is generally tubular and has a tapered shape, being smallest at its nose or leading end and largest at its trailing end. In accordance with the invention the metal blank is first formed into a substantially cylindrical tubular shape and is thereafter subjected to a radial expansion to provide the tapered shape. The extent of the expansion varies axially of the hollow blank and the thickness of the wall of the blank, because of the flow requirements of the metal, is reduced to an extent generally proportional to the extent of the expansion. Expansion of the cylindrical blank without intermediate conditioning would therefore result in the wall being relatively thick at the end of the lesser expansion and relatively thin in zones of greater expansion.

It is an object of the invention to provide a method for so working the cylindrical tubular workpiece as to prevent undue variation of wall thickness between regions of maximum and minimum expansion. To this end, the cylindrical tubular workpiece is subjected to a punch and die operation wherein its tubular wall is simultaneously elongated and varied in thickness in a manner keyed to the nature of the radial expansion to which the workpiece is to be subjected, so that the expanded article may have, as desired, a wall thickness which is substantially uniform from one end to the other or which is non-uniform. If, for example, the article to be formed tapers substantially uniformly in shape from one end to the other, the thickening of the wall preparatory to the radial expansion may also be substantially uniform. One embodiment of the invention is shown in the accompanying drawings:

Fig. 1 is a view largely in section showing a punch press and a reverse tapered punch with a blank or workpiece thereon, the press being shown at the bottom of the work stroke.

Fig. 2 is partly in section showing a blank positioned to be forced through a die by the reverse tapered punch shown in elevation.

Fig. 3 is similar to Fig. 2 but showing the workpiece after it has been passed through the die and stripped from the punch.

Fig. 4 is in section showing a blank from which the rocket head may be fashioned.

Fig. 5 shows the blank after a coining operation.

Fig. 6 shows the blank after a cupping operation.

Fig. 7 shows the blank after a first reduction.

Fig. 8 shows the blank of Fig. 7 with the nose indented and the interior bottom wall flattened by a pressing operation.

Fig. 9 is in section showing the blank of Fig. 8 after it has been drawn and expanded by the method of this invention, and showing the tapered wall structure.

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Fig. 10 shows the blank of Fig. 9 after the upper end has been trimmed and the nose has been pierced.

Fig. 11 shows the blank slightly expanded.

Fig. 12 shows the blank after the nose has been tapered inwardly.

Fig. 13 shows the expanded completed rocket head.

A blank 1 (Fig. 4) is coined into a dish like shape 2 (Fig. 5) having sloping sides 3 and a generally flat bottom portion 4. The blank 2 is then cupped, giving it the form shown at 5 in Fig. 6 wherein the side wall 6 is cylindrical. The blank 5 is subjected to a first reduction which elongates the cylindrical wall to the form shown at 7 in Fig. 7. In a pressing operation the exterior of the bottom portion of the blank 7 is indented as shown at 8 (Fig. 8) and the interior bottom surface is flattened as shown at 9 thereby forming the workpiece shown at 10 which has a cylindrical wall 11. The operations thus far described are performed by conventional processes and by suitable apparatus.

The workpiece 10 is then subjected to a second reduction and an expansion by the method of this invention which is best illustrated by the reference to Figs. 1, 2 and 3.

A punch press, shown in Fig. 1, has a movable head 15 with a punch holder 16 secured thereto by means of a retainer ring 17. A punch 18 is secured to the punch holder as shown. The lower or leading end 19 of the punch is adapted to fit the interior end 9 of the workpiece 10. The punch has a round cross section and has a reverse taper, being largest at a location generally indicated at 20 near its leading end and being smallest at a location indicated at 21 near its upper end or base. The punch may have a vent 22 opening to the atmosphere to facilitate stripping of a workpiece therefrom.

The punch press table 25, by means of a support 26, supports a frame 27 upon which is mounted a member 28 embodying one or more strippers 29. The strippers are hinged as shown and yieldably held into position by springs 30 so that they may be moved to one side during the down stroke of the punch and so that they will snap back into stripping position after the workpiece has cleared them.

A die ring 31 is mounted on the member 28 and holds the die 32 in proper position. The drawing surface of the die is shown at 33. A guide ring 34 is provided for guiding the punch and the various members are secured in place by a clamp plate 35.

In operation, a workpiece 10 is disposed within the guide bushing 34 and in axial alignment with the annular die 32 as shown in Fig. 2. In the downstroke of the punch the end 19 thereof engages the interior end surface 9 of the workpiece and draws the workpiece through the die thereby elongating the wall 11 of the workpiece. Because of the reverse taper of the punch, the interstice between the surface thereof and the drawing surface 33 of the die gradually increases during the down stroke of the punch. The metal of the wall 11 is forced by the die to flow into and fill the interstice and thus forms the thickening wall of the workpiece as shown, which in the form shown is thickest at the upper end portion. As shown in Fig. 1, the workpiece has a cylindrical exterior while the interior surface tapers inwardly, fitting the taper of the punch.

During the work stroke of the punch, the workpiece pushes the hinged strippers 29 out of its path. The work stroke continues until the workpiece has cleared both the die and the strippers, whereupon the strippers snap back into horizontal position under action of the springs 30. The strippers are prevented by the die ring 31 from rotating beyond the horizontal. During the up stroke of the punch the strippers catch the upper end face 36 of the

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workpiece and prevent its further upward movement, whereby it is stripped from the punch 18.

After the drawing operation and before the stripping operation the lower end portion 20 of the punch has a diameter greater than the inner diameter of portions of the workpiece above it. Hence the stripping expands the wall of the workpiece, thereby forming the workpiece shown in Fig. 9 which has a generally cylindrical interior surface and an exterior surface which tapers outwardly toward the upper, or trailing, end (Fig. 9). The interior surface may not be exactly cylindrical because the wall of the workpiece will tend to spring back somewhat following the expansion.

The workpiece in the form shown in Fig. 9 may now be fashioned into a finished article by a number of steps such as those indicated in Figs. 10, 11, 12 and 13. After the open end of the workpiece has been trimmed and the closed end has been pierced to provide the opening 37 (Fig. 10), the workpiece may be expanded to the form shown in Fig. 11 with a consequent thinning and axial shortening of the walls thereof because of the flow requirements of the metal. The nose portion of the workpiece is then tapered inwardly as by a swaging operation to the form shown in Fig. 12. Finally the workpiece is subjected to an expanding operation, which is again attended by a shortening and thinning of the walls, to give it the form shown in Fig. 13. The workpiece is annealed whenever necessary during the course of being worked.

While the finished article may have a wall thickness substantially uniform from one end to the other, the thickness may be varied as required to give it the necessary strength in desired zones. As shown in Fig. 13, for example, the side wall of the article is slightly thicker adjacent the flared open end than at the portion spaced approximately midway between the ends of the article. More generally, it is to be appreciated that by varying the shape of the punch, the extent, shape and location of the taper of thickness of the wall of the workpiece may be varied; hence, by the method of this invention workpieces may be made which are adapted to be expanded or otherwise fashioned into articles of many and varying shapes.

Such terms as "up," "down," "horizontal," etc. are used herein merely as convenient terminology and not as delimitations.

What I claim is:

1. In a method of forming from a cup-shaped work piece having a side wall of substantially uniform thickness and having a bottom wall, a tubular article having tapered form and also having a side wall of substantially uniform thickness, the steps of subjecting the work piece to a drawing operation to elongate the work piece and vary the thickness of the side wall axially of the work piece so that said side wall is thicker adjacent the open end of said work piece than adjacent said bottom wall, and after said drawing operation trimming said open end of said work piece, forming a central opening in said bottom wall, tapering the closed end portion of the work piece inwardly so that the diameters of said bottom wall and said opening are reduced, and expanding the open end portion of the work piece into tapered form with the extent of expansion varying generally proportionally to the variation of the thickness of the side wall whereby the side wall provides metal to compensate for the thinning thereof incident to expansion.

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2. In a method of forming, from a tubular work piece having a wall of substantially uniform thickness, a tubular article having tapered form and also having a wall of substantially uniform thickness, the steps of subjecting the tubular work piece to a drawing operation to elongate the work piece and decrease the inner diameter of at least a portion of the work piece to an extent varying axially of the work piece while maintaining the outer diameter of the work piece substantially uniform, then subjecting said work piece to a first radial expansion in which the interior of said portion of the work piece is expanded to substantially cylindrical form of a diameter substantially equal to the largest diameter of said portion following said drawing operation, and then subjecting said work piece to additional radial expansion to expand the work piece both internally and externally to tapered form with the extent of the radial expansion varying generally proportionally to the variation of the thickness of the wall resulting from said first radial expansion, whereby the wall provides metal to compensate for the thinning thereof incident to said second expansion step.

3. In a method of forming, from a tubular work piece having a wall of substantially uniform thickness and having an open end and a closed end, a tubular article having tapered form and also having a wall of substantially uniform thickness, the steps of subjecting the tubular work piece to a drawing operation to elongate the work piece and decrease the inner diameter of at least a portion of the work piece to an extent varying axially of the work piece while maintaining the outer diameter of the work piece substantially uniform so that said wall is thicker adjacent said open end than adjacent said closed end, and after said drawing operation subjecting the work piece to a first radial expansion in which the interior of said portion of the work piece is expanded to substantially cylindrical form of a diameter substantially equal to the largest diameter of said portion following said drawing operation, trimming said open end of said work piece, forming a central opening in said closed end, tapering said closed end inwardly so that the diameters of said closed end and said opening therein are reduced, and subjecting said portion of said work piece to additional radial expansion to expand the work piece to tapered form with the extent of expansion varying generally proportionally to the variation of the thickness of the wall whereby the wall provides metal to compensate for the thinning thereof incident to expansion.

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