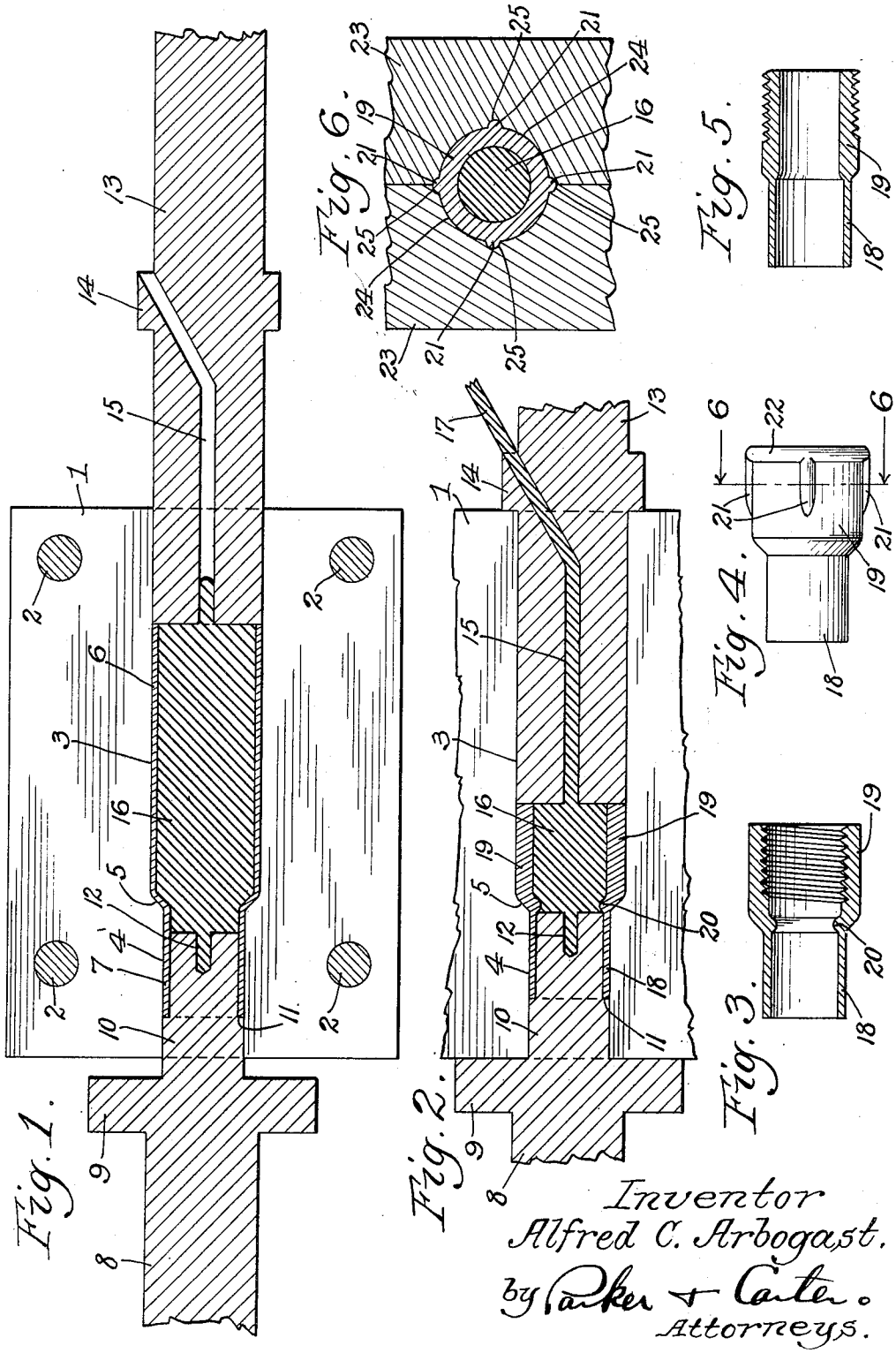
May 14, 1940. A. C. ARBOGAST 2,200,664

METHOD OF FORMING HOLLOW METAL MEMBERS

Filed Oct. 22, 1937




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Patented May 14, 1940 2,200,664

# UNITED STATES PATENT OFFICE

2,200,664

## METHOD OF FORMING HOLLOW METAL MEMBERS

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Application October 22, 1937, Serial No. 170,415

2 Claims. (Cl. 29—157)

This invention relates to a process of forming metallic articles and particularly to a process of increasing the thickness of the section of a metallic member. It has for another purpose to provide a process for increasing the thickness of a section and changing the shape of a metallic member by pressure. Other objects will appear from time to time in the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawing, wherein:

Figure 1 is a plan view of one part of a die for carrying out the process of the present invention with parts of the die and the product shown in section before the operation has been carried out;

Figure 2 is a generally similar view after the forming operation has been carried out;

Figure 3 is a section showing an adaptor which is formed by the apparatus of Figures 1 and 2 and subsequent machining;

Figure 4 is an elevation showing a modified form of adaptor having ribs made by the apparatus and the process of the present invention;

Figure 5 is a sectional view generally similar to Figure 3, illustrating a further modified form of adapter;

Figure 6 is a transverse sectional view taken at line 6—6 of Figure 4 illustrating the part of Figure 4 after the forming operation is complete and while it remains in the die.

Like parts are designated by like characters throughout the specification and drawing.

The numeral 1 is one of the die members. In Figures 1 and 2 it is shown in plan. There will ordinarily be two such die members and they may be of identical shape. 2—2 are guiding and positioning parts engaged by both of the die members which serve to keep the proper alignment of the parts.

The shape of the die depends of course, upon the product that is to be made. For the product illustrated herewith each die has two generally semi-cylindrical cavities 3 which may be reduced as at 4. When the two die members 1, 1 are put together they form a cylindrical cavity 3, and 4 having two main diameters and connected by the shoulder 5.

In the particular form illustrated herewith a tube 6, which has a reduced portion 7 is inserted in the die cavity and the die 8 having a shoulder 9 and a reduced portion 10 is inserted in the open end 7 of the tube. The reduced portion 10 is preferably shouldered as at 11 and this shoulder is brought into contact with the open end of the reduced portion 7 of the tube. The portion 10 may have a perforation or depression 12 formed in it.

A second die member 13, having a shoulder 14 and a passage or conduit 15, is then inserted in the open end of the die member 1. The outer diameter of the die 13 is greater than the inner diameter of the portion 6 and hence abuts against its end and does not penetrate it.

At a suitable state in the process used, the interior of the tube 6, 7 is filled with a body of material 16. This material may be of any desired nature. For one purpose soft metal may be used. Any material which will sufficiently resist compression but is also sufficiently free for deformation may be used.

When the parts are all in the position of Figure 1 and both of the dies 1, 1 are in place the two die members 8 and 13 are further compressed to collapse the tube on itself and to force its two ends together toward each other. The tube being filled with the material 16 cannot be collapsed laterally and hence the material of the tube flows and the tube is shortened to the form of Figure 2 and its walls thickened. As this takes place the material is discharged or extruded through the passage 15 in the die 13 and may emerge as a wire or rod 17. The size of the passage 15 is made such that the material 16 is discharged through it sufficiently rapidly to permit the dies 8 and 13 to move inwardly from the position of Figure 1 to that of Figure 2, but it is discharged sufficiently slowly to prevent collapsing of the tube 6, 7 and thus the material of the tube is constrained to flow longitudinally in the main, so that the walls of the tube as they are shortened are correspondingly thickened. Thus the tube at the completion of the movement of the dies, as shown in Figure 2 comprises a narrower portion 18, which may be somewhat shorter than the original narrow portion 7, and a thickened and shorter portion 19 which is correspondingly much shorter and much thicker than the original wider portion 6. During the same operation an annular ledge or projection 20, may be formed within the tube. Its formation depending upon the shape and amount of travel of the die members 8 and 13.

The form shown in Figure 4 differs from that of Figure 3 by the fact that there are ribs 21 formed on the larger portion 19 and by the further fact that an enlarged lip or flange 22 is formed on the outer end of the portion 19.

Dies suitable for making the form of Figure 4 are illustrated in Figure 6 and they comprise two dies 23, 23 generally similar to the dies 1, 1 having each a semi-cylindrical cavity 24 shaped as at 25 to produce the ribs 21.

The member shown in Figure 5 is substantially the same as that of Figure 3 except that the inner annular shoulder 20 is not present and the device is threaded exteriorly.

The use and operation of the invention are as follows:

To carry out the invention, dies are prepared

of proper shape and size to give to the article to be manufactured its desired shape. The particular shape shown is an adaptor and in the form shown it may be made of copper. One end is relatively thin and may be readily joined to another copper or similar member.

The other portion is thickened to receive a thread which may be internal or external and thus may be readily secured to a member of any material by means of corresponding threads formed on the member to which it is joined. The particular tubular member 6, 7 which is here shown as being formed into the adaptor, may be initially made as shown with a reduced neck-like portion, or may originally be made of a tube having a uniform diameter, a portion of which is subsequently reduced to produce the neck.

Assuming that the dies are prepared, a member such as the tube 6, 7 which may be made by drawing, electrolytically or in any other manner, is put into the dies 2, 2. Suitable material 16 is put inside the member which is to be shaped. This material may be metal or any other material which is of such nature that it will support the tube during the forming operation without permitting undesired distortion of the tube, such as collapsing, folding, and the like, and at the same time it must be sufficiently ductile to be able to escape through the passage 15 readily enough to permit the desired inward movement of one or both of the dies 8, 13. The size of the passage 15 is proportioned to the nature of the material 16, to the travel which is to be given the dies and to the shape which it is desired to give finally to the piece which is being worked upon, and the nature of the material 16 and the size of the passage 15 are thus related to each other and the result must be such that the material 16 escapes sufficiently rapidly from within the tube 6, 7 to permit proper reforming of the latter and to permit proper movement of the movable die members and at the same time sufficiently slowly to furnish adequate support to the tubular member and to prevent undesired distortion of the latter. The material 16 is thus for all practical purposes preferably non-compressible, and at the completion of the operation, as for example as shown in Figure 2, a large proportion of the material 16 has been extruded through the passage 15 from which it may emerge as a wire or rod-like member 17.

This invention is not limited to any particular type of material 16 nor to any particular shape of die or of article to be finally manufactured. The so-called die or mold within which the tubular or hollow member is positioned may be made in any desired manner of one part or more than one part. As shown, it is indicated as made of two parts clamped together, but this arrangement may be altered.

In carrying out the method of the present invention, the entire tubular portion may be thickened. As shown, however, the portion 7 is not thickened. It is merely compressed and given a greater density of structure, but if desired, this portion might be compressed and thickened just as the portion 6 is thickened and compressed into the portion 19.

During the forming operation carried out in the present invention, the crystals of the metal reorient themselves into a more homogeneous mass and the strength and general physical properties of the article are very much increased because of the pressure exerted upon them during the forming operation. The material 16, which is ordinarily soft metal, is under pressure and prevents the tube from wrinkling or buckling, and at the same time exerts pressure on the interior of the tube 6, 7, so that the entire body of the tube is subjected to great pressure during the forming operation which, as above noted, not merely reforms the tube but causes a rearrangement of the particles of the metal of which it is formed, which results in a great improvement of the physical properties of the metal. Obviously, machining operations, such as threading, may be readily carried out and the dies may, if desired, be so shaped as to produce ribs, ears and the like, as shown in Figures 4 and 6.

I claim:

1. The method of cold forming a metallic hollow article having walls of varying thickness, which includes forming a tubular member, positioning said member in a zone of compression, providing a rigid limiting support for the exterior of said member, positioning in a portion of the interior of said member a supporting body of a material more extrudable than the material of which the tubular member is formed, rigidly supporting a portion of said tubular member from within, whereby no change within the thickness of said supported portion is possible, subjecting the opposite ends of said tubular member while cold to endwise pressure and simultaneously subjecting said supporting body to pressure, and thereby substantially shortening and uniformly thickening that portion of the tubular member which is supported by said supporting body while holding it against lateral expansion and, in the course of the subjection of said tubular member and supporting body to such pressure, removing by extrusion a portion of said extrudable supporting body, and controlling said extrusion in such fashion as to maintain at all times a predetermined and adequate support to and pressure against a portion of the interior of said tubular member, while permitting endwise shortening and simultaneous thickening of the portion of said tubular member supported by said supporting body.

2. The method of cold forming a metallic hollow article having walls of varying thickness, which includes forming a hollow member having walls of generally uniform thickness, positioning said member in a zone of compression, providing a rigid limiting support for the exterior of said member to prevent lateral expansion, said support conforming to the desired exterior form of the finished article, positioning in the interior of said member, a supporting body of a material more extrudable than the material of which the hollow member is formed, directing endwise pressure against an end of said hollow member while cold and against the extrudable material contained therein, and thereby shortening said hollow member substantially, and thickening substantially a major portion of the hollow member which is supported by said body of extrudable material, and controlling the escape of said extrudable material and thereby permitting a predetermined and substantially uniform thickening of the portion of the hollow member supported by said material, while preventing any buckling or distortion of said member, other than the shortening and thickening of said portion.

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