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APPARATUS FOR FORMING ANNULAR BODIES

Filed Feb. 28, 1952

3 Sheets-Sheet 1

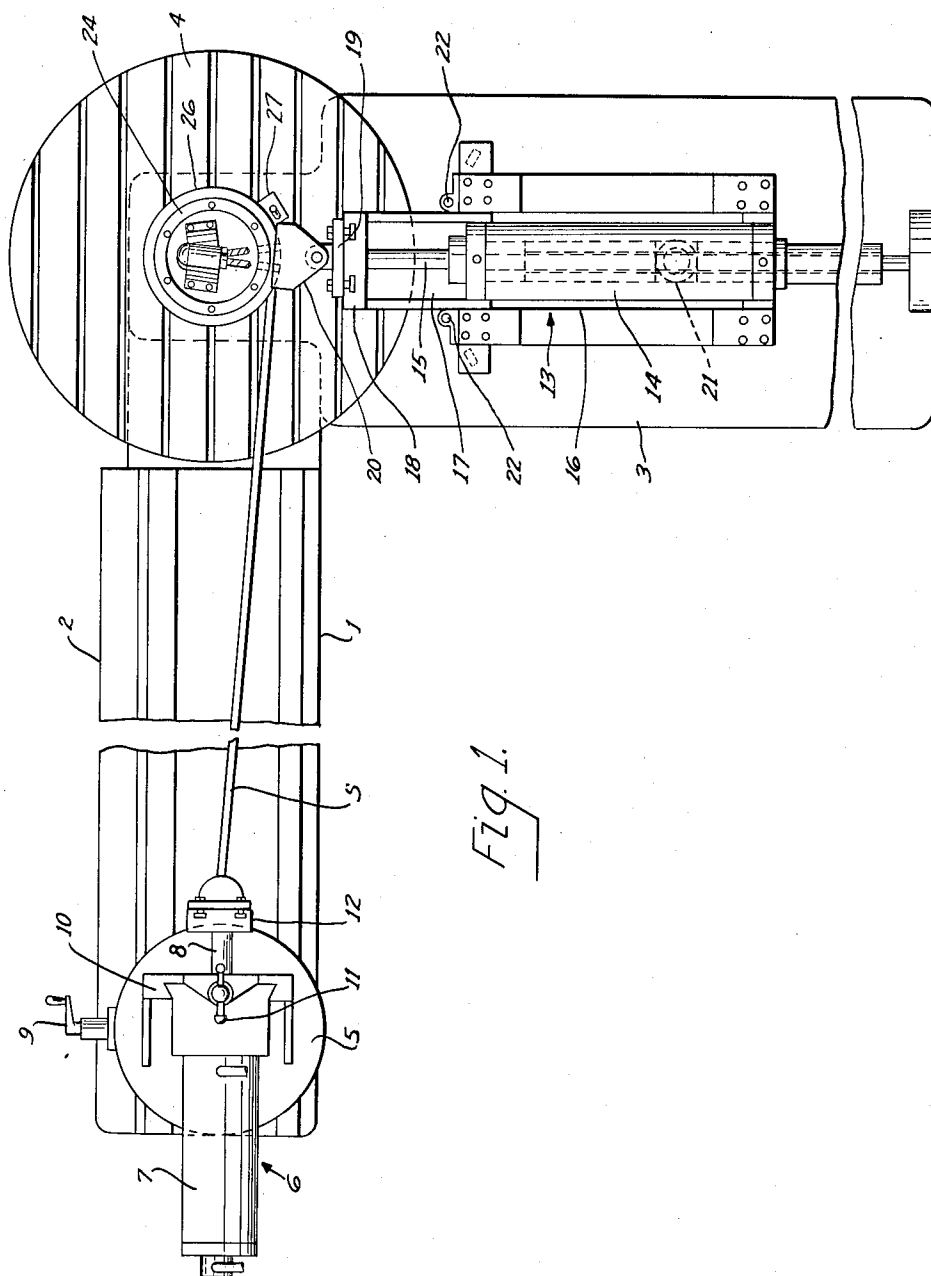


Fig. 1.

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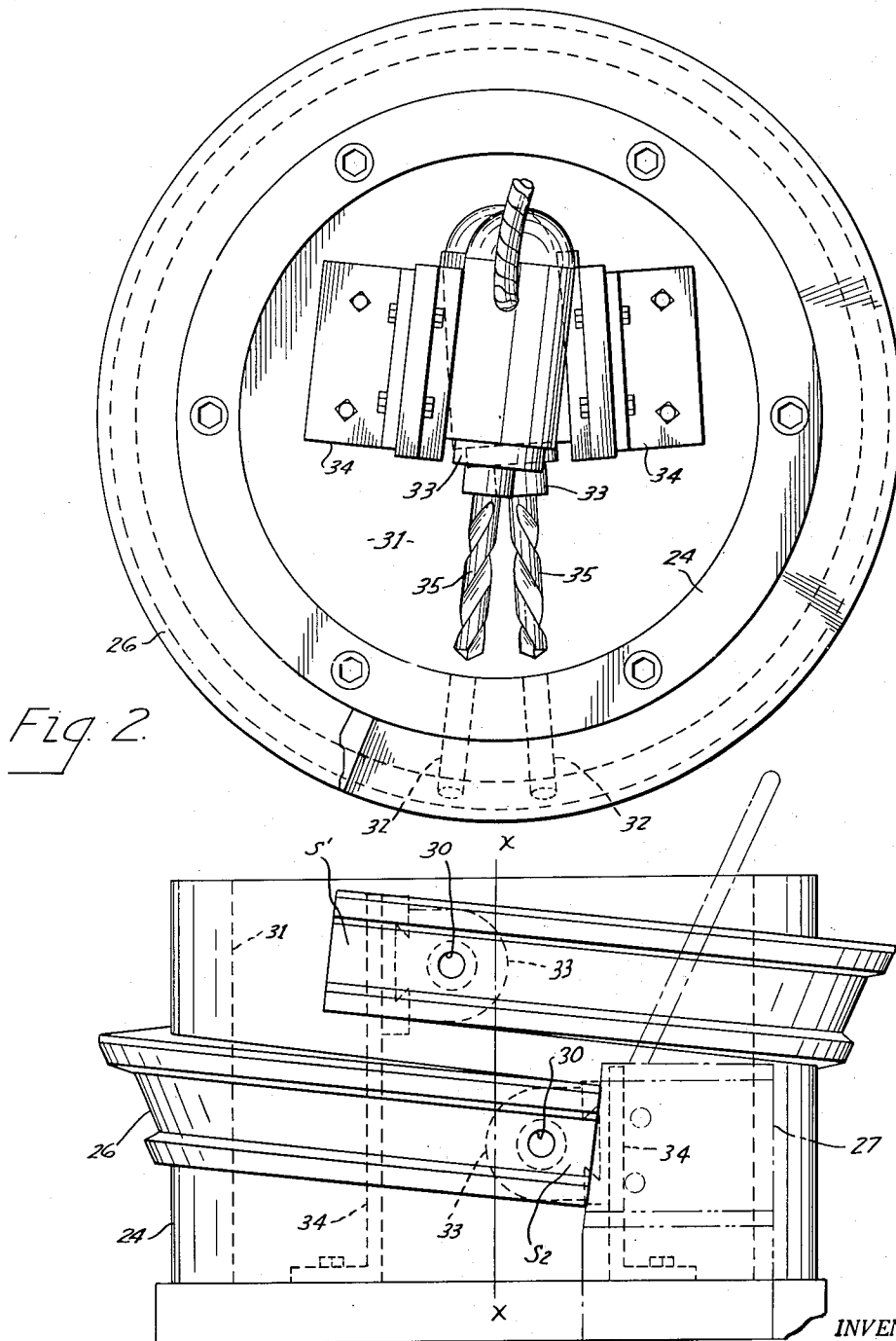
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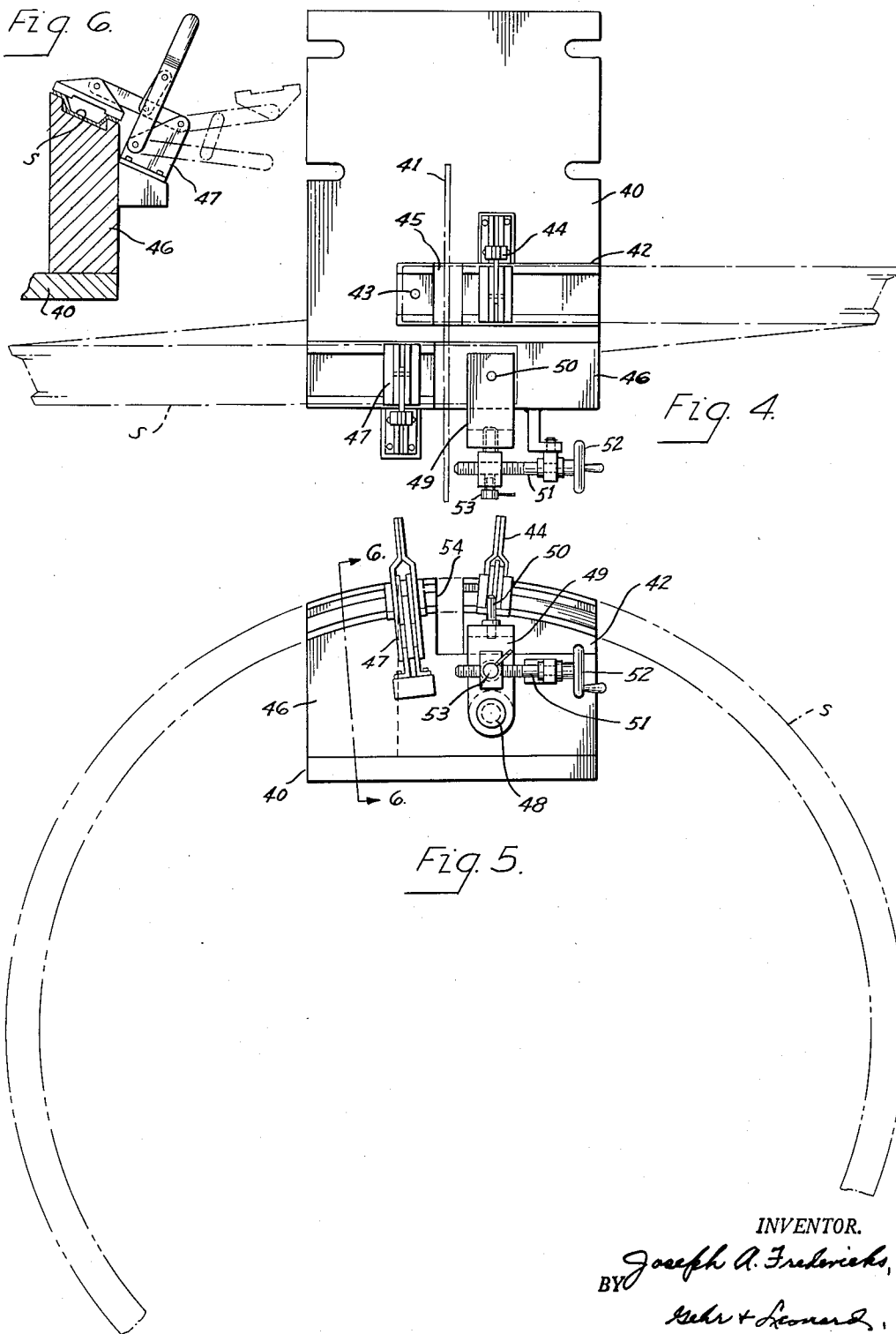
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APPARATUS FOR FORMING ANNULAR BODIES

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2 Claims. (Cl. 153—2)

This invention relates to apparatus for forming curvilinear members from elongated strip stock and particularly to apparatus for providing on the formed stock suitable locating shoulders for the purposes of locating it in cutting-off apparatus so that the formed pieces, after cutting off the excess end portions, are substantially identical.

For the purposes of illustration, the invention is disclosed as applied to the formation of annular members, particularly frusto-conical annuli.

In the formation of annular members from elongated strip stock, as more fully described in the copending application of Cyril J. Bath, Serial No. 262,016 filed December 17, 1951, now Patent No. 2,713,376 granted July 19, 1955, it has been found that frusto-conical annuli can readily be formed in machines such as described in United States Letters Patent 2,514,830, issued July 11, 1950 by stretch forming, wipe forming, or combined concurrent stretch forming and wipe forming.

In forming such annuli in machines of this character, a length of stock which may or may not be precontoured in cross section is formed, while held under tension about a side face die, into a spiral extending more than 360° about the axis of the forming face. The resultant spiral closely approximates the final shape of the annulus but has excess end portions which extend a short distance past each other peripherally of the die face and which are off-set from each other laterally of the stock, that is, parallel to the axis of the spiral. These excess end portions are then cut off transversely of the stock leaving a length of spiral stock substantially equal to the length of the periphery of the final annulus.

The end edges resulting from cutting operation are then moved laterally of the stock into alignment by a slight flexure of the stock which is distributed generally uniformly of the entire length of the stock. The aligned ends are then butt-welded together, thus providing the finished annulus.

By allowing in the forming die for the slight spring back of the metal when it is released from the forming die, any number of annuli which are essentially exact duplicates of each other and are accurate in dimension in shape can be provided assuming that the excess end portions are cut off at the proper location in each instance. However, the spring back of each formed piece, when it is released from the side face of the forming die, varies somewhat from the spring back of other pieces. It is very difficult, after release of the stock from the die, to locate accurately the line at which the excess end portions must be severed. Even when the stock, after having been released from the forming face of the die, is reclamped about a templet or form which is essentially a duplicate of the forming face and then cut off, variations occur in the length of the piece and hence in the shape and diameter of the finished annulus.

In accordance with the present invention, consistently accurate results can be obtained if, while holding the stock in conformance with the forming face of the die after its original final formation thereabout and before

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releasing the stock from the forming face, there are formed on the stock suitable locating shoulders which can be engaged by a holding jig with which a cut-off tool is properly aligned. While it is possible to relieve some of the tension on the stock before forming the shoulders, sufficient tension must be maintained to prevent any spring back of the metal from the die face about which it is originally formed.

Furthermore, it has been found that in the forming of other types of curvilinear members from elongated stock with the prior machines and methods described, even though all portions of the formed piece are parallel to a common plane, as distinguished from spiral shape, the same difficulty is experienced in cutting off the excess end portions at the proper location so that, if the pieces are to be joined to other members by bolting and the like, they will fit consistently.

The present apparatus is equally applicable to the latter types of pieces for holding them in proper position for either cut-off, or perforation or both.

Though the present invention is described specifically as applied to frusto-conical annuli made by first forming the stock into a spiral with its ends off-set laterally from each other, its application to other types of pieces or members will be readily apparent from the illustrative example.

Various advantages and applications of the present invention will become apparent with the following description wherein reference is made to the drawings, in which:

Figure 1 is a top plan view of an apparatus for forming curvilinear members with locating shoulders thereon;

Figure 2 is an enlarged top plan view of the side-face die and shoulder forming tool used in connection with the machine illustrated in Figure 1;

Figure 3 is a front elevational view of the die and shoulder forming tool illustrated in Figure 2;

Figure 4 is a front elevation of a suitable jig for holding the formed stock and cutting off the end portions thereof;

Figure 5 is a front elevation of the structure illustrated in Figure 4;

Figure 6 is a fragmentary cross-sectional view taken on the line 6—6 of Figure 5 and illustrating one of the clamping means used for clamping the stock to the jig.

Referring first to Figure 1, the machine which is more fully described in the above identified patent and copending application comprises generally a base 1 having a main portion 2 and a side extension 3. Mounted on the base 1 for rotation about an upright axis is a turntable 4 which is rotatably driven by suitable power means, not shown, the power means being adapted to drive the table in either direction, selectively.

Mounted on the main portion 2 of the base for rotation about an upright axis is a supporting plate 5 on which is secured a suitable piston and cylinder assemblage 6 comprising a cylinder 7 and a piston 8 which is reciprocable in the cylinder. The plate 5 may be adjusted to selected positions endwise of the main portion 2 of the frame by means of a suitable hand crank 9 and locked in the position selected.

In the form illustrated the piston and cylinder assemblage is connected to the plate 5 by means of a suitable upright guideway 10 so that it may be adjusted to different elevations by means of a hand crank 11.

Mounted on the piston 8 is a gripping head 12 which is arranged to be connected to one end of a length of stock S which is to be formed. If desired, the piston and cylinder assemblage may be mounted in fixed vertical position on the plate 5 and the head 12 arranged on the piston for vertical movement, as more fully described in the above identified copending application. The piston

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and cylinder assemblage described is preferably used for stretch forming.

Since the machine is to be used for either stretch forming or wipe forming or for concurrent stretch forming and wipe forming, another piston and cylinder assemblage, indicated generally at 13, is provided on the extension 3. This assemblage comprises a cylinder 14 which is mounted in fixed position on the extension 3 and a piston 15 which is reciprocable in the cylinder. Secured in fixed position relative to the cylinder is a slideway 16 in which a slide 17 is mounted for reciprocation parallel to the axis of the piston. The slide 17 is provided at its outer end with a pedestal 18 to which the forward end of the piston is connected. The pedestal in turn carries a vertically movable slide 19 on which is mounted a wipe forming shoe 20. If desired, the cylinder 14 and the slideway 16 which is rigidly affixed thereto can be secured to the extension 3 by means of a pivot 21. This assemblage can be constrained from rotation about the pivot 21 by means of shear pins 22 which are adapted to shear off and release the piston and cylinder assemblage for rotation about the pivot 21 to prevent damage by excessive lateral thrusts on the piston.

Both of the pistons 8 and 15 are arranged with their axes extending parallel to the top surface of the turntable 4. Mounted in fixed position on the turntable 4 is a side-face die 24 about which the stock is progressively formed. This die may be of any shape desired depending upon the configuration of the finished piece to be formed thereabout.

In the illustrative example, the die 24 is shown as provided with a spiral forming face 26 which extends for more than 360° about the upright axis of the die and of which the pitch is such that the end portions of the stock beyond the 360° limit, extend endwise of the stock past each other and are off-set edgewise of the stock, that is, parallel to the axis of the die from each other.

Mounted for rotation with the die 24 is a suitable clamp 27 which is adapted to be clamped to one end of the length of stock S to be formed for holding the clamped end in a fixed position relative to the starting end of the working face. The clamp is shown as secured directly on the die 24 but may be fixed in position on the turntable 4 adjacent the die.

If the length of stock is to be stretch formed only, then the end thereof opposite to the end engaged by the clamp 27 is connected to the piston 8 by clamping head 12. Operating pressure fluid is then admitted to the cylinder in front of the rod end of the piston so as to place the stock under tension, preferably near to the elastic limit of the stock. Since assemblage 6 is mounted for oscillation about the upright axis of the plate 5, the assemblage 6 automatically aligns itself so that its line of pull on the stock S is tangential to the instantaneous line of contact of the stock with the die. If, as illustrated, the forming face of the die is a spiral of uniform pitch, the height of the cylinder can be set and fixed prior to the rotation of the turntable so that the stock follows the spiral. If, on the other hand, the spiral is of variable pitch, the assemblage 6 must be raised and lowered as necessary during the forming operation so that the stock will follow the spiral at all times. When the stock is thus gripped and pressure fluid is admitted to the cylinder 7, the turntable is rotated while the pressure is maintained, thus laying the stock about the lateral face of the die while the stock is held under tension throughout its length.

On the other hand, if wipe forming alone is to be used for forming the stock, the assemblage 16 is operated so as to force the wiping shoe 20 against the stock. While this pressure is maintained, the table is rotated as before, the end of the stock opposite the clamp 27 being left free. In this operation all of the stock between the clamp 27 and the instantaneous point of contact of the stock with the lateral face of the die is maintained under

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tension by the frictional drag of the wiping shoe 20. Thus, when the stock has been formed entirely about the face of the die, it is held under tension throughout its entire length due to the frictional drag of the shoe 20.

In many instances, particularly where the strip stock is contoured relatively deeply normal to its face as illustrated and has relatively deep lateral flanges, combined stretch forming and wipe forming is preferred. In the latter case the stock is concurrently stretch formed by means of the assemblage 6 while the wipe forming shoe 20 is held applied in the same manner as heretofore described in connection with wipe forming alone to assure that the flanges do not become wrinkled.

As mentioned, when the stock is released by the clamp 27 or the gripping head 12 after stretch forming, the stock springs back from the forming face of the die. The same is true if either the clamp 27 or the wiping shoe 20 is released after wipe forming, or if both the head 12 and shoe 20 or the clamp 27 are released after combined stretch forming and wipe forming. It is very difficult to locate the cut-off line once the spring back occurs as the spring back varies from piece to piece and there is no effective starting point for measuring.

In order to assure proper positioning of the stock for subsequent cutting off operations or for perforating for bolts and the like, it is necessary that locating shoulders be formed on the stock prior to release from the lateral face of the die after the final original formation thereof about the die. Accordingly, means are provided for forming shoulders on the stock before the stock is released from the forming face and tension occasioned either by the wiping shoe 20, or the gripping head 12, or both.

In some instances, prior to forming the shoulders, the tension may be reduced somewhat, particularly when the shoulders on the stock are to be formed by perforation of the stock and the stock is of relatively small cross-section. This is necessary only because, since the stock may be held during forming under tension near to its elastic limit, the reduction in cross-sectional area by the perforation of the stock may result in the stock being stressed beyond its elastic limit at the perforated portion and thus being torn in two.

However, enough tension must be maintained on the stock after its original final formation about the face of the die and before it is released from the forming face of the die to maintain it under tension accurately in conformance with the lateral forming face without any spring back.

If the tension is released completely and reapplied, the formed stock will not re-engage the forming face in exactly the same position in which it originally engaged when originally finally formed thereabout under tension.

In accordance with the present method, therefore, the locating shoulders are formed while the stock, between the clamp 27 and the clamping head 12, or wiping shoe 20 as the case may be, is held under tension in conformance with the lateral face of the die following its stressed formation and before release of the tension.

A convenient manner of forming the locating shoulders on the stock is illustrated in Figures 2 and 3. This is effected by perforating the stock, the edge wall defining each perforation thereby becoming the locating shoulder. However, instead of perforating, the metal may be distorted normal to its width.

In the illustrative example, in which the frusto-conical annulus is shown as the final article being formed, the stock, while so held under tension in conformance with the lateral face of the die, has end portions which extend beyond that portion of the stock which is to form the finished annulus. For example, in Figure 3, the proper cutting line is indicated as XX, this being a single or common cutting line extending through both of the off-set end portions so that the formed stock, beginning at the line XX at the bottom end extending about the

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periphery of the die back to the line XX at the top extends substantially 360° about the axis of the forming face whether the forming face be of uniform diameter throughout its peripheral extent or of varying diameters. The end portions, indicated at S1 and S2, thus extend beyond each other endwise of the stock and to opposite sides of the line XX from the remainder of the stock which is to form the finished annulus. It is in these portions S1 and S2 that the locating shoulders are formed so that both end portions of the stock can be cut off along the line XX by a single stroke of a suitable cutting disc or saw.

The shoulders shown in Figure 3 are formed by providing perforations or drill holes 30 in the portions S1 and S2, respectively. The peripheral edges of the holes 30 provide suitable shoulders. Since these holes or shoulders are to be formed before release of the stock from the die and while it is held under tension, a suitable shoulder forming tool is provided and is mounted for rotation with the die in fixed position peripherally relative to the forming face thereof. While the tool may be mounted directly on the table, it is preferable to mount it within the die itself. In such instances, the die 24 is provided with a central cavity 31 with radial passages 32 extending outwardly therefrom and opening through the lateral forming face of the die. Mounted within the cavity 31 is a pair of electric drills 33. Each drill is mounted on a suitable standard 34 for movement radially with respect to the axis of the die. The drills are preferably self-propelled drills which, when electric power is applied move in one direction a predetermined distance and then reverse and return to starting position. Such drills are well known in the art and readily available on the market and specific details thereof form no part of the present invention. Each drill is provided with a bit 35, the bit 35 being aligned with its associate, one of the passages 32 and being reciprocal therein consequent upon the self-propelled reciprocation of the drills. The drills are so positioned that the bits are projected through the passages 32 to and beyond the surface of the lateral forming face of the die 24. Thus when the stock is finally originally formed and held under tension about the die and before it is released, the drills 33 are operated to form the holes 30, the edges of which provide locating shoulders on the stock.

It is to be noted that the "forming" face portions where the passages 32 are provided are not necessarily accurately finished. Continuations of the portion of the forming face, which is to form the length of stock incorporated in the finished article, need not be shaped accurately as these excess end portions are removed.

It is to be noted also that if bosses are to be formed on the stock by distorting the metal from one face, punches or forming pins can be substituted for the drills 33. For example, pneumatic cylinders which can be operated to project the punch or pin may be provided in fixed position on the turntable outside of the die in which case the passages 32 do not have to extend entirely through the die but may be only deep enough to accommodate the end of the punch or pin when it is projected against the stock from outside of the die inwardly.

Having formed the locating shoulders in either manner, the stock is then released from the clamp 27 and the head 12 or shoe 20 of the piston and cylinder assemblies and is placed in a suitable jig for cutting off.

Various types of jigs may be provided. However, the one illustrated in Figures 4 and 5 is satisfactory for annular or peripherally continuous members.

Referring next to the apparatus for cutting off the excess end portions of the finished piece while it is held in the proper position by virtue of the locating shoulders, an apparatus such as illustrated in Figures 4 to 6 is satisfactory. This apparatus is in the form of a jig comprising a metal base plate 40 which is adapted to

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be secured by any suitable means in fixed position on the table of a cutting tool, such as a rotary saw or abrasive cutting disc 41.

Mounted on the plate 40 is an upright support 42 which is provided at one end with a locating pin 43 and, in spaced-relation to the pin 43, with a suitable toggle operated clamp 44. Intermediate the pin 43 and clamp 44 is a suitable slot 45 in which the saw or grinding wheel may be accommodated during the cutting operation. Also mounted upon the base plate 40 is another support 46 which likewise is provided with a toggle operated clamp 47 which is similar in form and function to the clamp 44. Pivottly mounted on the support 46 by means of the pivot 48 is a movable arm 49 on which is provided a pin 50. An adjusting screw 51 operated by handwheel 52 is connected to the arm 49 for swinging the arm in opposite directions about the pivot 48 to different adjusted positions. A suitable locking bolt 53 is provided for locking the arm 49 in the desired position in which it is moved by the screw 51. The support 46 is also provided with a notch 54 aligned with the groove 45. The top faces of supports 42 and 46 are contoured in cross-section and curved circumferentially, as best illustrated in Figure 6, so that the stock can be laid thereagainst and clamped tightly thereto. Preferably this cross-section and curvature are substantially the same as that of the lateral forming face of the die on which the stock has been formed.

In using the device, one end of the stock is positioned with its hole 30 fitting the pin 43, the clamp 44 being utilized to hold the stock down in conformance with the top face of the support 42. The other end of the stock is positioned so that its hole 30 fits the pin 50, this end of the stock being secured in this position by means of the clamp 47. While the two ends are held in this position, the excess end portions are cut off by single movement of the saw or cutting disc 41 transversely of the supports. After cutting off the excess end portions, the length of stock is then flexed transversely to bring the off-set cut edges into alignment with each other after which the end edges are welded. If the resultant article is not accurately shaped or of accurate diameter, the pin 50 is adjusted and a second piece is mounted and cut. Usually two or three such cuts are all that is necessary to find the proper position for the pin 50 for a given shaped member from a given kind, size and quality of stock. Thereafter the arm 49 is locked in position and all pieces thereafter are then cut without shifting the pin 50. While held by the clamps 44 and 47 and located by the holes 30 and pins, the excess end portions are cut off by the single stroke of the saw or cutting disc. Since the locating shoulders have been formed while the stock has been held under tension in conformance with the die and before release of the stock from the die, after its original final formation thereabout, all pieces cut off with a given setting of the pin 50 are identical in length and can be formed into identical annuli as described.

In the foregoing description, and in the claims, reference has been made to annular members. The word "annular" is used in the description and claims in its broader sense to include not merely true ring-like members of constant radius, but any peripherally continuous curvilinear member even though the radius in various off-set planes normal to the axis may be different, as in the frusto-conical members described, or even though the radius in a single plane normal to the axis is different at different angular locations about the axis. Typical examples of such latter may be oval or elliptical members or even those of irregular shape, such as odd shape window frames for automobile bodies, loading doors for cargo planes in which the door frame is not only non-circular but also is warped flatwise of the frame as a whole out of a normal plane.

Furthermore, the invention is equally adaptable to members that are not circumferentially continuous but

of which the end portions adjacent the cutting line are to be joined to other members in close fitting relation.

Having thus described my invention, I claim:

1. An apparatus for forming curvilinear members to be formed into annular members, and comprising a turntable, a side face die mounted thereon for rotation therewith and having an elongated spiral forming face, means for clamping one end of a length of stock to be formed for rotation in fixed position with the die, a stretch forming piston and cylinder assemblage adapted for connection at the other end of the length of stock and operable to apply tension endwise of the stock from the end to which connected during laying of the stock onto the forming face of the die progressively from the anchored end toward the other end of the stock during rotation of the turntable, a pair of shoulder forming tools rotatable with the die, one of said tools being at a different distance from the plane of the table than the other of said tools, said tools being positioned beyond opposite ends of the forming face portion, respectively, so that the portion of the forming face therebetween extends at least about 360° about the axis of the die, each of said tools, on its forming stroke, being movable laterally of the die, power means for operating said assemblage so as to maintain tension on the stock endwise during lay-

ing of the stock onto the side face of the die and after completion of the laying on operation, and means for operating said tools while the said power means is active for maintaining said tension, on the laid on stock.

2. An apparatus according to claim 1 characterized in that said die has a central cavity and passages leading therefrom and opening through the outer surface of the side face, and said tools comprise power driven drills located in the central cavity and arranged so that the drills, during operation, can be reciprocated through said passages, respectively, outwardly beyond the outer side surface of the die.

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