Oct. 11, 1949. A. M. HOLM 2,484,032

DIE STRUCTURE

Filed Sept. 14, 1945 2 Sheets-Sheet 1

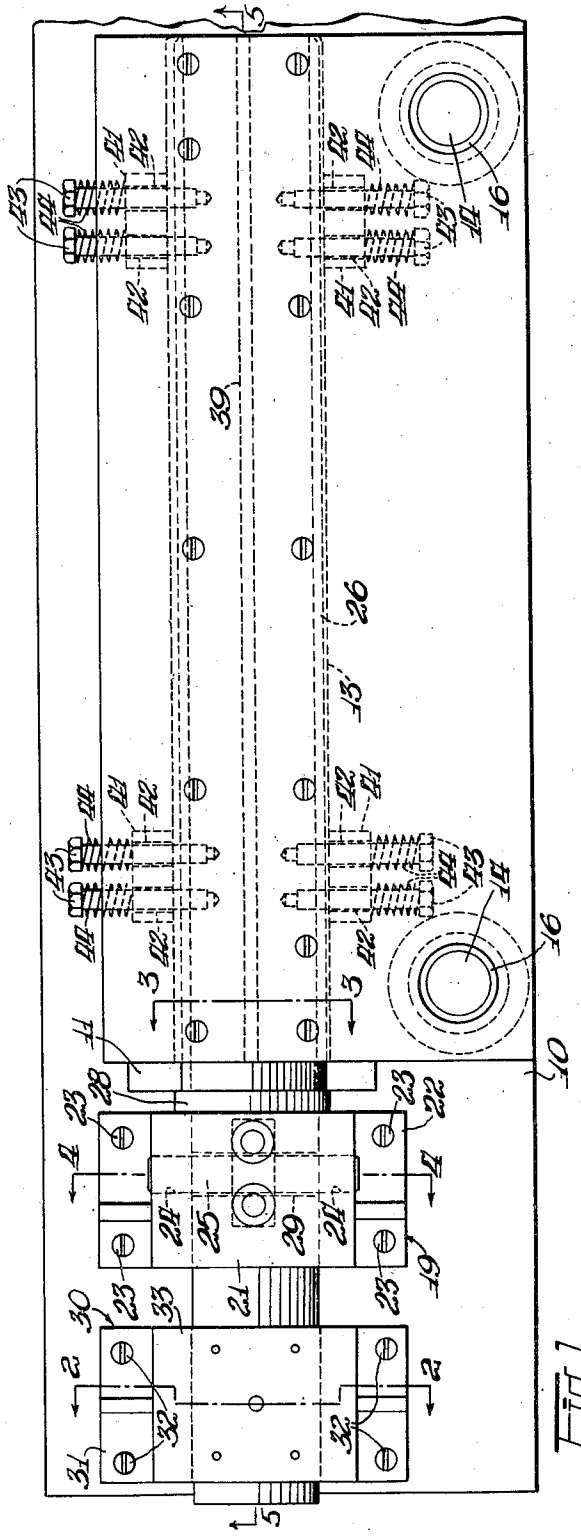


Fig. 1.

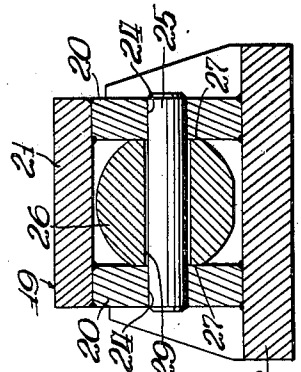


Fig. 4.

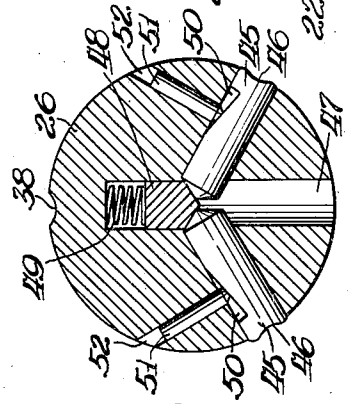


Fig. 3.

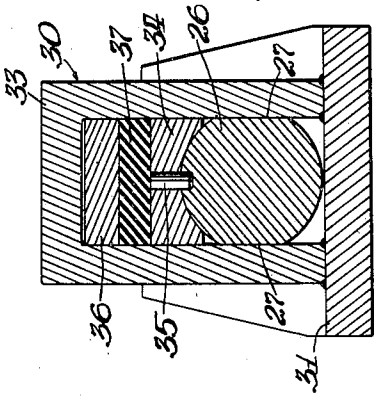


Fig. 2.

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Filed Sept. 14, 1945 2 Sheets-Sheet 2

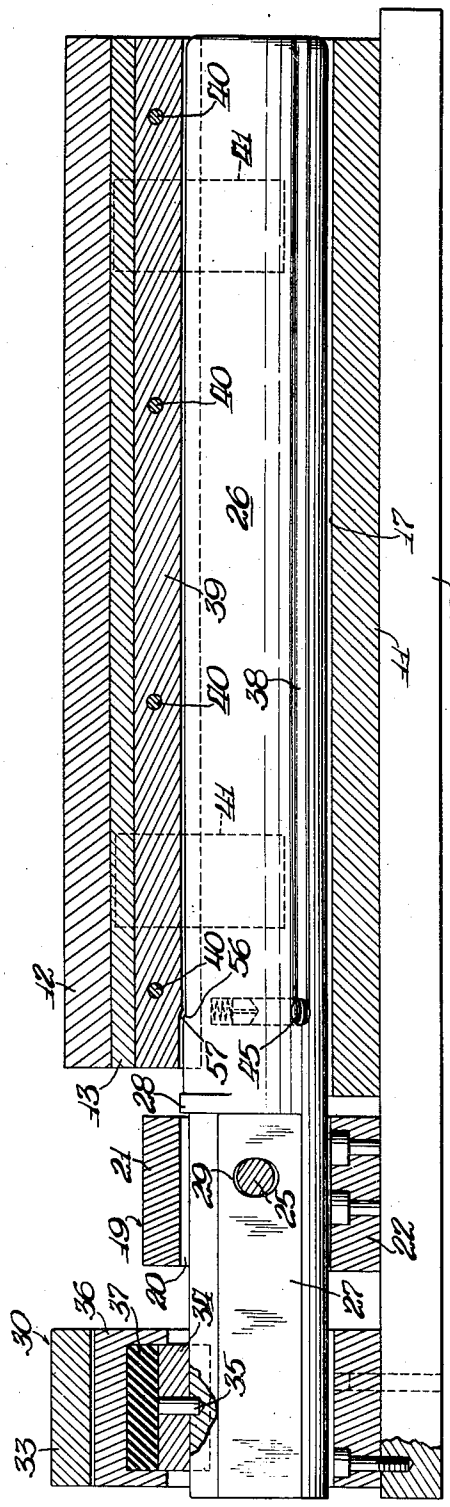


Fig. 5.

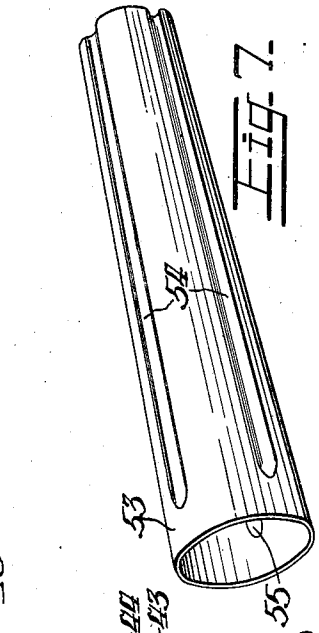


Fig. 7.

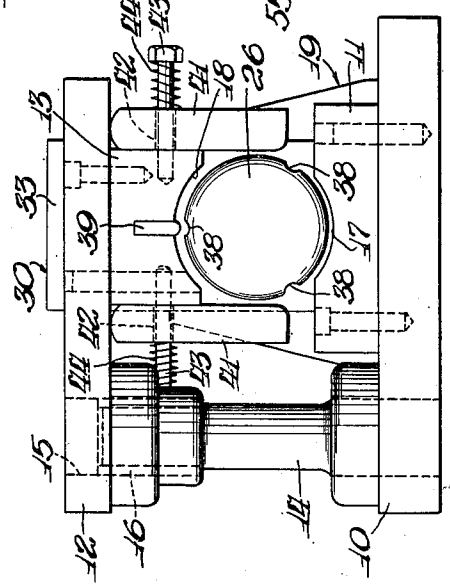


Fig. 6.

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UNITED STATES PATENT OFFICE

2,484,032

DIE STRUCTURE

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8 Claims. (Cl. 153—70)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to die structure. More particularly the invention relates to die structure and apparatus for forming or embossing longitudinal grooves in tubular members.

In many instances tubular members are used as supporting or guiding structures and in these instances it is often desirable that the tubular member be provided with a plurality of circumferentially spaced, longitudinally running grooves to form ribs or rails for a component to be guided.

Such an instance occurs in the design and manufacture of tubes used in rocket launchers of the type currently employed by the military forces. In a weapon of this type it is preferable to provide a plurality of parallel launcher tubes in a series or cluster. The weapon is designed so that rockets may be launched from this cluster of tubes in a definite pattern. Although the rocket launcher is essentially a simple weapon, inasmuch as it requires no expensive rifling of the barrel, recoil mechanism, etc., several minor problems have occurred in the manufacture and use thereof. The problem with which the present invention is particularly concerned is that involving the provision of guide rails on the inner cylindrical surfaces of the launcher tubes so that the rockets may be accurately launched therefrom. It has heretofore been the practice to provide these rails by rather expensive and complicated machining operations. According to the present invention the rails are easily, quickly and accurately formed on the tube from wall sections of the tube itself without any waste of material.

It is accordingly a principal object of the present invention to provide improved die structure and apparatus for the forming of longitudinal grooves or ribs in a tubular member and particularly to apply the apparatus to the fabrication of tubes for rocket launchers.

It is an important object of the invention to provide improved die structure comprising upper member carrying a die, a lower support member dies and an intermediate mandrel, all designed to conform to the shape of the tube to be treated; another object is to mount the mandrel for floating movement between the upper and lower support members.

The invention has for another object the provision of means in the mandrel for easily and accurately locating or piloting the tube in which

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the longitudinal grooves are to be formed or embossed.

And another object is to provide means carried by one of the support members for locating the tubular member on the mandrel.

The foregoing and other objects and important features of the invention will become apparent as the disclosure is more fully made in the following detailed description and accompanying sheets of drawings in which:

Fig. 1 is a plan view of a preferred form of die structure;

Fig. 2 is a transverse sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view, on an enlarged scale, taken on the line 3—3 of Fig. 1;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a longitudinal sectional view taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is an end elevation of the apparatus; and

Fig. 7 is a perspective view of a tube formed on the apparatus.

Although the preferred form of the invention illustrated herein will be described in connection with the formation of longitudinal grooves on a tubular member particularly designed for use in rocket launchers, it will be understood that the several features of the invention are similarly applicable in other instances. Accordingly, the present disclosure should be taken as illustrative and not limiting.

The die structure illustrated herein is especially adapted for use in any conventional type of press and includes means by which it may be supported on the base or table of such press and means that may be operated by the movable member of the press. For these purposes the die structure is provided with a base member 10, including a lower support member 11, and an upper movable member 12, including an upper support member 13. The base 10 is provided with longitudinally spaced vertical slide rods 14 which pass respectively through openings 15 formed in the upper member 12. Each slide rod 14 is provided adjacent its upper end with a bushing 16 so that the upper member 12 may be freely carried thereon. As best shown in Fig. 6, the lower support member 11 is rigidly carried by the base 10 and is provided with a longitudinal arcuate or concave surface 17 that conforms to the outside diameter of a tubular member to be formed in the die structure. As shown in the same figure, the upper support member 13 is rigidly carried by the mem-

ber 12 and is provided with a longitudinal concave or arcuate surface 18 diametrically opposed and complementary to the surface 17 of the lower support member 11.

The base 10 carries adjacent one end thereof a support 19, which, as best shown in Fig. 4, is generally in the form of an inverted U having opposite vertical members 20 and an upper transverse member 21. The support 19 further includes a lower transverse member 22. The members 20, 21 and 22 are rigidly secured together, preferably by welding, and the member 22 is rigidly secured to the base 10 by a plurality of recessed cap screws 23. The members 20 are provided with transversely aligned bores 24 in which is mounted a transverse pivot pin 25. This pin serves to support a longitudinally extending mandrel 26.

The mandrel is cylindrical in cross section substantially throughout its length and conforms generally to the inside diameter of a tubular member to be treated, its outer cylindrical surface being concentric with the concave or arcuate surfaces 17 and 18 in the lower and upper support members 11 and 13 respectively. That portion of the mandrel 26 that projects away from the support structure 11—13 is formed with diametrically opposed flat sides 27. This portion of the mandrel is separated from the cylindrical portion by a circumferential flange or partial collar 28. The portion of the mandrel including the flat sides 27 is provided with a transverse, vertically elongated opening 29 through which the pin 25 passes. As shown in Figs. 4 and 5, the upper and lower surfaces of the mandrel are vertically spaced respectively from the cross members 21 and 22 of the supporting means 19 and from the description thus far it will be seen that the mandrel 26 may have floating vertical movement within limits between the upper and lower support members 11 and 13.

The base 10 is provided at a portion thereof spaced from the supporting means 19 with a second support indicated generally by the numeral 30. As shown in Figs. 1 and 2 this support includes a lower transverse member 31, rigidly secured to the base 10 by a plurality of recessed cap screws 32, and a second member 33 in the form of an inverted U that embraces the free end of the mandrel 26. The cross portion of the U-shaped member 33 is spaced a substantial distance vertically above the end of the mandrel 26. This space is occupied by means resiliently mounting the mandrel 26 on the support 19 so that the floating movement of the mandrel is resiliently opposed. The resilient means serves to maintain the mandrel 26 normally in the position shown in Fig. 5; that is, with the upper and lower surfaces thereof substantially equally spaced from and parallel to the upper and lower support members 13 and 11 respectively. The resilient mounting comprises a first member 34 having an under arcuate surface fitting an upper arcuate portion of the left-hand end of the mandrel 26. A pin 35 pilots the member 34 on the mandrel 26. A second member 36, generally in the form of an inverted U, carries a block of resilient material such as rubber or the like, indicated generally at 37, and is carried by the first member 34 within the legs of the U-shaped member on the support 30. The resilient block 37 is thus confined between the inner surfaces of the member 36 and the upper surface of the member 34.

As best shown in Fig. 6, that portion of the mandrel 26 that lies between the upper and lower support members 13 and 11 is provided with three circumferentially spaced, longitudinally running grooves 38. The upper support member 13 is provided with a longitudinally running groove-forming die element preferably in the form of a hardened steel insert 39. The insert 39 is rigidly carried by the upper support member 13 by means of a plurality of removable cap screws 40. The edge of the insert 39 is rounded and is complementary to the upper groove 38 in the mandrel 26.

The upper support member 13 carries thereon a plurality of means for assisting in locating a tubular member to be received by the mandrel 26. In the present instance there are four such means and each comprises a locating member 41 resiliently mounted on and depending from the upper support member 13. Each member 41 is provided with a pair of longitudinally spaced transverse bores 42. Adjustable screws 43 are passed loosely through the bores 42 and into threaded bores formed in the upper support member 13. Each adjustable screw 43 carries a compression spring 44 interposed between the head of the screw and the proximate side of the locating member 41. The action of the springs 44 is such as to resiliently maintain the positions of the locating members 41 normally as shown in Fig. 6. When a tubular member is mounted on the mandrel 26, the locating members 41 may yield laterally outwardly and the members will rest firmly against the side of such tubular member and will assist in locating the same on the mandrel.

The mandrel 26 includes radially extendible and retractable means for locating the tubular member to be treated on the mandrel. This means is best shown in Fig. 3 and comprises a pair of radially movable plungers 45 mounted in bores formed respectively on radii of the mandrel that intersects the opposite side grooves 38 in the mandrel. The outer end of each bore is concave as at 46 and is coincident with its respective groove 38. A vertical bore 47 formed in the mandrel 26 carries slidably therein a centering plunger 48. A compression spring 49 urges the plunger 48 downwardly in the bore 47 and against the angularly disposed plungers 45. Each of the plungers 45 and 49 has a conical inner end so that functioning of the locating means is accomplished easily and accurately. Each of the plungers 45 is cut out at its upper surface as at 50 and engages a pin 51 firmly in a bore 52 drilled in the mandrel 26 at an angle to the plunger 45. The pins 51, by engagement with the cutouts 50, limit extension and retraction of the locating plungers 45.

An example of a tube fabricated in the die structure just described is shown in Fig. 7. The tube is indicated generally by the numeral 53 and is provided with three longitudinally running circumferentially spaced grooves 54. The formation of the grooves 54 is such that the interior of the tube 53 is formed with a corresponding number of longitudinally running, inwardly directed ribs or rails 55 (only one of which is shown in Fig. 7). The function of the apparatus is such that the ribs 55 serve, in the case of fabrication of launcher tubes, as rails for guiding the rockets to be fired. In the fabrication of the preferred product illustrated, the grooves 54 terminate short of one end of the tube 53. For this purpose the upper portion of the mandrel 26 is provided with a shoulder 56, and a comple-

mentary shoulder 57 is formed on the under surface of the groove-forming insert 39.

Operation

The positions of the parts before the tube 53 is mounted on the mandrel 26 will be as shown in Fig. 5. The support 30, including the resilient mounting 37, will maintain the mandrel in position with the upper and lower portions of its cylindrical surface substantially equally spaced from the arcuate surfaces of the upper and lower support members 13 and 11 (Fig. 6). The curved edge on the groove-forming insert 39 in the upper support member 13 will be correspondingly spaced from the upper groove 38 in the mandrel 26. The spacing between the elements just described is substantially equal to the thickness of the wall section of the tube 53. The tube 53 is then slid endwise on the mandrel 26 and one end thereof abuts against the half-collar 28 on the mandrel. Pressure of the spring 49 in the vertical bore 47 of the mandrel urges the locating plungers 45 radially outwardly against the smooth inner cylindrical surface of the tube. The springs 44 urge the locating members 41 firmly against the smooth outer cylindrical surface of the tube. The upper member 12 is subjected to pressure of a conventional press or the like and the upper support 13 moves downwardly toward the lower support 11. The tube 53 is firmly held on the mandrel 26 between the upper and lower support members and the groove-forming insert 39 embosses or forms inwardly a longitudinal section of the wall of the tube 53, thus forming a longitudinal groove 54 in the tube. The inner portion of the wall section thus embossed conforms to the upper groove 38 of the mandrel 26, thus conforming a longitudinal internal rib 55 on the tube.

After one groove 54 has been formed in the tube 53, pressure on the upper support member is released and the upper member 12 is moved upwardly. The resilient mounting of the mandrel 26 has, during the application of pressure on the upper member 12, permitted the mandrel to float so that it seats properly in the upper and lower support members 13 and 11. When pressure is released from the support members the resilient mounting permits the mandrel 26 to return to its normal position as shown in Fig. 5. Because of the slot and pin connection 25—29, floating of the mandrel 26 will be accomplished in such manner that the mandrel is at all times parallel to the arcuate surfaces 17 and 18 of the lower and upper support members 11 and 13 respectively. The tube 53 is then removed endwise from the mandrel and is rotated 120° (since there are three grooves 54 to be formed). The rib 55 just formed will now engage one of the side grooves 38 in the mandrel as the tube 53 is remounted on the mandrel. As the tube is seated against the collar 28 on the mandrel, the interior rib 55 on the tube will engage the proximate locating plunger 45. Spring pressure behind the centering plunger 48 will cause the locating plunger 45 to contact the rib 55 firmly, which, in conjunction with the action of the locating members 41, serves to locate the tube 53 accurately on the mandrel 26 preparatory to the forming of a second groove 54. The forming of this second groove is accomplished in the manner previously outlined.

After the second groove is formed, the tube 53 is removed from the mandrel and rotated another 120° and remounted on the mandrel. The two interior ribs now formed will be engaged by the locating plungers 45 and the tube will be properly located on the mandrel. The formation of the third groove 54 will occur as previously described.

It will be seen from the foregoing description that a simple and efficient apparatus has been provided for the forming of longitudinal external grooves in a tubular member. The design of the structure is such that the external grooves result in internal ribs that require little, if any, finishing and are suitably adapted for at least the particular purpose intended; that is, as rails in tubes used in rocket launchers. As previously stated, it will be appreciated that the several features of the invention will find application in other instances. It will also be appreciated that the present disclosure pertains to only a preferred embodiment of the invention and that numerous modifications and alterations may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. Die structure for forming longitudinal grooves in a tubular member, comprising a generally flat horizontal base, a support at one end of said base, a longitudinally extending cylindrical mandrel for receiving a tubular member thereon, there being a plurality of circumferentially spaced longitudinal grooves in the cylindrical surface of said mandrel, means including a transverse pivot and a vertical slot connection mounting said mandrel at one end on said support, means including a resilient element connected between said base and said mandrel and mounting said mandrel in position to extend normally above and parallel to said base, a lower support member carried by said base below said mandrel and having an upper concave surface generally concentric with said mandrel, an upper support member disposed above said mandrel and having an under concave surface generally concentric with said mandrel, means mounting said upper support member on said base for vertical movement, and a groove-forming die element rigidly carried by said upper support member longitudinally thereof and in alignment with one of the grooves in said mandrel.

2. Die structure for forming longitudinal grooves in a tubular member, comprising a generally flat horizontal base, a longitudinally extending cylindrical mandrel for receiving a tubular member thereon, there being a plurality of circumferentially spaced longitudinal grooves in the cylindrical surface of said mandrel, means including a resilient element connected between said base and said mandrel and mounting said mandrel in position to extend normally above and parallel to said base, a lower support member carried by said base below said mandrel and having an upper concave surface generally concentric with said mandrel, an upper support member disposed above said mandrel and having an under concave surface generally concentric with said mandrel, means mounting said upper die member on said base for vertical movement, and a groove-forming die element rigidly carried by said upper support member longitudinally thereof and in alignment with one of the grooves in said mandrel.

3. Die structure for forming longitudinal grooves in a tubular member, comprising a generally flat horizontal base, a longitudinally extending cylindrical mandrel for receiving a tubular member thereon, there being a plurality of circumferentially spaced longitudinal grooves in the cylindrical surface of said mandrel, means

including a resilient element connected between said base and said mandrel and mounting said mandrel in position to extend normally above and parallel to said base, a lower support member carried by said base below and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, an upper support member disposed above and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, means mounting said upper die member on said base for vertical movement, and a groove-forming die element rigidly carried by said upper support member longitudinally thereof and in alignment with one of the grooves in said mandrel.

4. Die structure for forming longitudinal grooves in a tubular member, comprising a generally flat horizontal base, a longitudinally extending cylindrical mandrel for receiving a tubular member thereon, there being a plurality of circumferentially spaced longitudinal grooves in the cylindrical surface of said mandrel, means including a resilient element connected between said base and said mandrel and mounting said mandrel in position to extend normally above and parallel to said base, a lower support member carried by said base below and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, an upper support member disposed above and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, means mounting said upper support member on said base for vertical movement, a groove-forming die element rigidly carried by said upper support member longitudinally thereof and in alignment with one of the grooves in said mandrel, and means including a plurality of radially extendible and retractable elements carried by said mandrel for locating and centering the tubular member on said mandrel.

5. Die structure for forming longitudinal grooves in a tubular member, comprising a generally flat horizontal base, a longitudinally extending cylindrical mandrel for receiving a tubular member thereon, there being a plurality of circumferentially spaced longitudinal grooves in the cylindrical surface of said mandrel, means including a resilient element connected between said base and said mandrel and mounting said mandrel in position to extend normally above and parallel to said base, a lower support member carried by said base below and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, an upper support member disposed above and spaced from said mandrel a distance substantially equal to the thickness of the wall section of the tubular member to be carried on said mandrel, means mounting said upper support member on said base for vertical movement, a groove-forming die element rigidly carried by said upper support member longitudinally thereof and in alignment with one of the grooves in said mandrel, means including a plurality of radially extendible and retractable elements carried by said mandrel for locating and centering the tubular member on said mandrel, and means carried by one of said support members

including transversely shiftable resiliently mounted guide elements for assisting in the locating of the tubular member on said mandrel.

6. Die structure comprising a base, a mandrel paralleling said base, means forming a first support on said base, means mounting said mandrel on said first support for floating movement toward and away from said base including a first element on said supporting means and a second element on said mandrel, one of said elements comprising a vertically elongated slot formed in the direction of movement of said mandrel and the other of said elements including a pin passed through said slot between said mandrel and said supporting means, a second support on said base adjacent the end of said mandrel and spaced from said first support, resilient means on said second support connecting said mandrel and said base and normally positioning said mandrel in spaced relation to said base, a die movably carried by said base for cooperation with said mandrel, and a concave support member carried by said base to support said mandrel against the action of said movable die.

7. Die structure comprising a base, a mandrel paralleling said base, means forming a first support on said base, means mounting said mandrel on said first support for floating movement toward and away from said base, a second support on said base adjacent the end of said mandrel carrying resilient means opposing said floating movement, said means connecting said mandrel and said base and normally positioning said mandrel in spaced relation to said base, a die movably carried by said base for cooperation with said mandrel, and a support member carried by said base to support said mandrel against the action of said movable die.

8. Die structure comprising a first work support member, a groove-forming die element rigidly carried by said member, a second support member spaced from said first support member and complementary thereto, a base, means mounting said support members on said base for movement toward and away from each other, a mandrel interposed between said support members and adapted to receive a workpiece to be formed by said die element, and means mounting said mandrel on said base for floating movement within limits in the directions of movement of said support members toward and away from each other, said means including a pin and slot connection and a resilient element between said mandrel and said base.

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