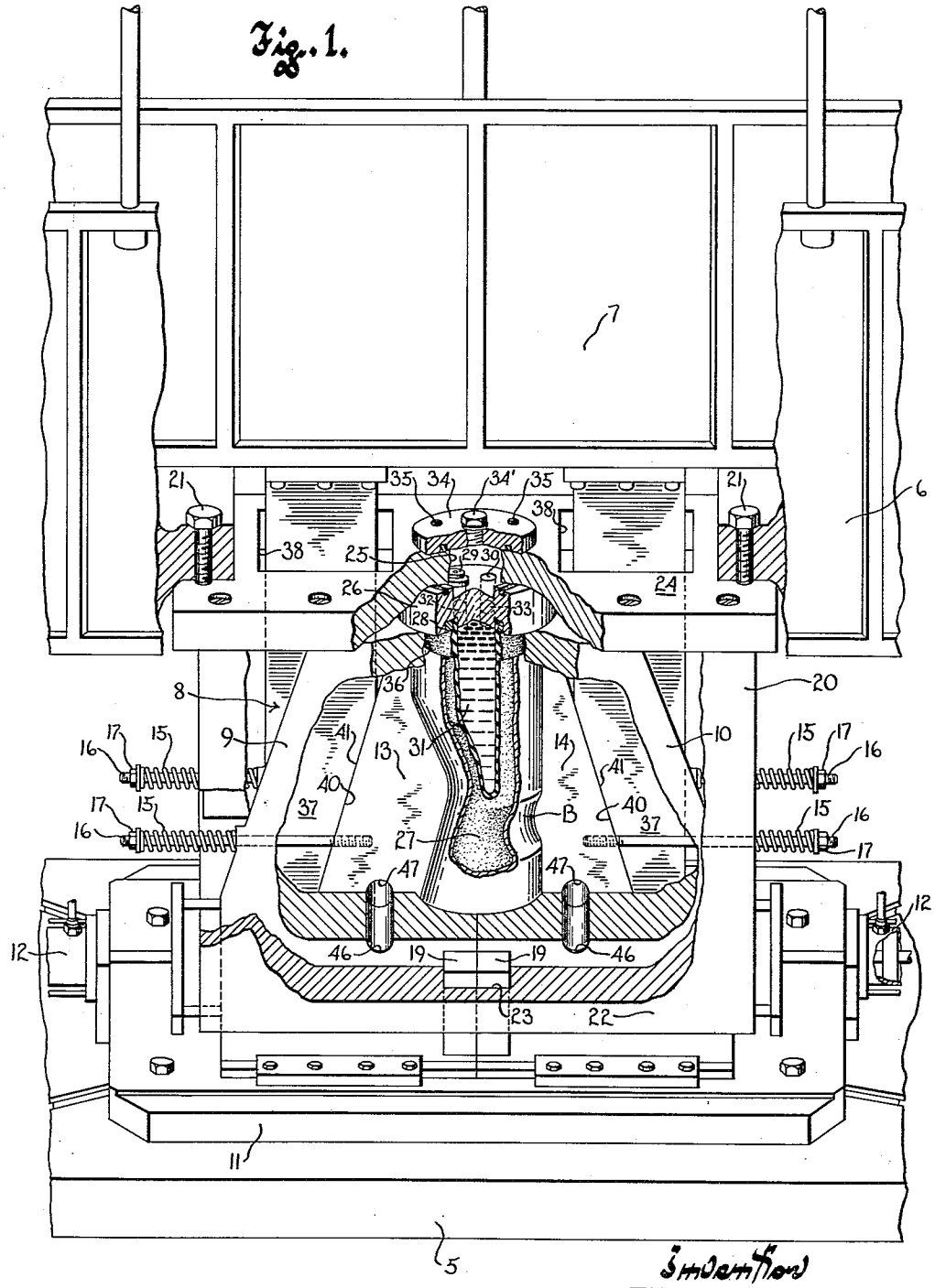
Sept. 4, 1956 H. MÖLLER 2,761,404

HYDRAULIC FORMING ATTACHMENT FOR PRESSES

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Fig. 1.



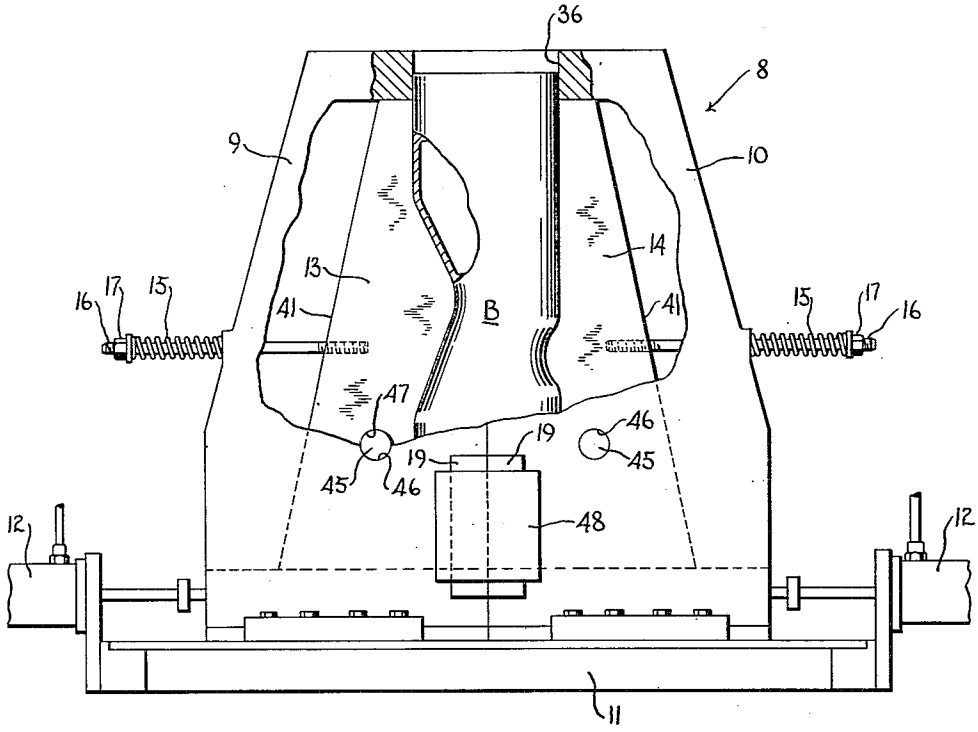
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Sept. 4, 1956 H. MÖLLER 2,761,404

HYDRAULIC FORMING ATTACHMENT FOR PRESSES

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Fig. 2.



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HYDRAULIC FORMING ATTACHMENT FOR PRESSES

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Application December 15, 1954, Serial No. 475,388

Claims priority, application Sweden December 22, 1953

6 Claims. (Cl. 113—44)

This invention relates to the art of metal forming and particularly the forming of tubular parts having irregular and complicated shapes and configurations. Special types of combustion chambers for jet engines are examples of such tubular irregularly shaped parts. Heretofore, as far as known, the manufacture of such parts has entailed the separate production of two or more complementary sections and subsequent joining of these sections either by welding or some other suitable means. Obviously, building up the part in that manner was costly and slow.

It is therefore the primary purpose of this invention to provide a device whereby a previously formed tubular blank may be formed into the desired part in one simple forming operation regardless of the complexity and irregularity of its shape.

Another object of this invention is to provide a device whereby any conventional press may be adapted to the shaping of such preformed tubular blanks into irregularly shaped parts.

Another object of this invention is to provide a device for shaping and forming tubular blanks into parts of irregular shape and configuration through the application of an inwardly directed force applied to the wall of the tubular blank against the opposition of a yielding force provided by a liquid under pressure within an elastic envelope or sack. In this respect, the present invention bears a relationship to the subject matter of the copending application of Hugo Möller, Serial No. 473,926, filed December 8, 1954, now Patent No. 2,761,405.

Another object of this invention is to provide a device whereby a conventional press may be easily and inexpensively adapted to the forming and shaping of a tubular blank by indenting portions of the walls of the blank in a die by closure of the press and which device is so designed and constructed that the die may be locked in its wall deforming condition, removed from the press and mounted in another press equipped with the device of the aforesaid copending application, and by which internal pressure may be applied to the roughly formed tubular blank to accurately conform the same to the die.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel method and construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a perspective view of the device of this invention illustrating the same mounted in a double acting press, and showing the parts in their relative positions at the instant the press is fully closed to complete the shaping operation, parts being broken away and in section to better illustrate structural details; and

Figure 2 is a fragmentary front elevational view of the die and its associated parts removed from the press and illustrating the manner in which the elements of the die may be releasably locked in their closed positions to enable placing the die with the roughly formed part therein, into another press where the final forming operation is performed.

Referring to the accompanying drawing, the numeral 5 designates the table of a conventional double acting press equipped with two press heads 6 and 7, both of which are adapted to move downwardly toward the table 5 either in unison or not. The means for raising and lowering the press heads 6 and 7 has not been illustrated since it forms no part of this invention.

The device of this invention may be considered an adaptor by which any conventional press may be easily and inexpensively adapted to the shaping and forming of tubular blanks into irregular and relatively complicated shapes. One of the main elements of this adaptor is a sectional die indicated generally by the numeral 8. This die comprises a pair of complementary sections 9 and 10 slideably mounted upon a base plate 11. The mounting of the die sections constrain them to translatory motion across the base plate 11, toward and from a closed position in which the sections abut one another and together define an upwardly opening die cavity. Any suitable means such as double acting air cylinders 12, may be provided to slide the die sections to and from their closed positions. The base plate 11 upon which the complementary die sections are slideably mounted, and which carries the air cylinders 12, is securable in any suitable manner to the table 5 of the press.

In addition to its complementary sections 9 and 10, the die 8 includes one or more movable forming blocks. In the present instance, there are two such blocks, one of which designated 13, is mounted in the die section 9, and the other, designated by the numeral 14, is in the die section 10. These forming blocks slide in ways which constrain them to translatory motion toward and from positions projecting into the die cavity. Springs 15 yieldingly maintain the forming blocks in retracted positions. These springs are mounted upon tension rods 16 fixed to the forming blocks and slideably received in holes in the die sections 9 and 10, the springs being confined between appropriate spring seats on the die sections and retainer nuts 17 on the outer ends of the tension rods. Each forming block preferably has two such tension rods and springs spaced apart horizontally.

Attention is directed to the fact that the entire die assembly is carried by the base plate 11 so that it may be quickly mounted on the table 5 of the press or removed therefrom.

Though the die sections 9 and 10 may be held together by their air cylinders, means are also provided to positively secure the sections against separation during the actual forming operation, when the press in which the adaptor is mounted, is closed. For this purpose, the die sections have flanges 19 projecting from the front and rear thereof. In the closed condition of the die, these flanges 19 are contiguous. Hence, by holding the flanges together, the die sections will be secured against separation. To so hold the flanges, the press head 6 has a yoke-like structure 20 secured thereto as by screws 21. This yoke-like structure has parallel spaced-apart front and rear walls 22 provided with keyways 23 to simultaneously receive therein the contiguous flanges 19; such engagement of the flanges 19 in the keyways being effected by bringing the press head 6 down to its position shown in Figure 1.

The yoke-like structure 20 also has a horizontal top wall 24 adapted to overlie the die assembly. This top wall has a bore 25 therethrough, so positioned as to be

coaxial with the die cavity when the adaptor is mounted in the press, and secured to the underside of the wall **24** in line with the bore **25** is a disc **26**. The disc **26** closes the bottom of the bore **25** and has an elastic sack **27** connected thereto as at **28**. The details of the connection **28** form no part of the present invention, being covered in the aforesaid copending application.

The sack **27** is formed of rubber or other elastic material having the characteristics of rubber, and the connection **28** by which its upper edge is secured to the disc **26**, is so designed and constructed as to be fluid tight.

In the normal condition of the sack **27**, its side walls are cylindrical and its bottom may be either flat or rounded, the important consideration being that the disc **26** tightly closes the top of the sack except for two ports **29** and **30** formed in the disc **26**. The elastic sack is thus closed.

The sack **27** is filled with a liquid **31** which can only be displaced therefrom through the port **29**, but the port **29** includes a spring loaded valve **32**. The displacement of liquid from the sack thus entails the application of predetermined pressure upon the liquid. The other port **30** is equipped with a check valve **33** which opens inwardly to permit liquid to flow down into the sack, but will not open during the application of pressure on the sack.

Since the ports **29** and **30** both communicate with the bore **25**, this bore provides an expansion chamber to receive liquid displaced from the sack through the port **29**, and to return the same to the sack when the pressure thereon is removed. The top of this expansion chamber is closed by a cover **34** having a removable filler plug **34'** threaded therein, and preferably this cover and the disc **26** are secured respectively to the upper and undersides of the horizontal wall **24** by screws **35** which extend through the cover and wall **24** and are threaded into the disc **26**. Suitable gaskets provide fluid tight connections between the wall **24** and the disc **26** and cover **34**.

As indicated hereinafter, the parts are so arranged when mounted in a press, that the bore **25** and consequently the eleastic sack **27**, are axially aligned with the die cavity. Accordingly, when the press head **6** is lowered, the sack **27** descends into the die cavity, it being understood that the relative sizes of the cavity and sack permit such entry of the sack into the cavity. Moreover, it is to be understood that the relative sizes of the sack and the cavity are such as to accommodate therebetween the wall of a performed tubular metal blank B inserted into the die cavity through its mouth **36**.

Obviously the placement of the tubular blank into the die cavity requires that the press be open. As the press head **6** is lowered, the disc **26**, is larger in diameter than the mouth **36** of the die cavity, is brought firmly down onto the die sections, and the elastic sack **27** is inserted into the preformed tubular blank B in the die cavity. This insertion, however, does not in anywise operate to shape the blank. It merely readies the device for the forming or shaping operation, which is done by forcing the forming blocks **13** and **14** laterally into the die cavity. Such inward motion is imparted to the forming blocks by a pair of actuators **37**.

The actuators **37** are secured to the press head **7** in position to pass through holes **38** in the wall **24** and bring their lower end portions into cooperative engagement with the forming blocks. By such engagement the downward motion of the actuators **37** is translated into inward lateral movement of the forming blocks, the translation being conveniently effected by having the inner lower edges of the actuators shaped to provide inclined cam surfaces **40**. The faces **41** of the forming blocks which are engaged by the cam surfaces **40**, preferably are also inclined so as to have surface-to-surface engagement with the actuators.

In the operation of the device, and assuming that the parts have been properly mounted in a press; with the press open, the sectional die is first closed to bring its sections **9** and **10** together. The preformed tubular blank B, which may be produced in any suitable way, as by cutting off a length of seamless tubing, is then inserted into the die cavity through its mouth **36**. It is of course, to be understood that at this time the forming blocks **13** and **14** are retracted out of the die cavity.

The press head **6** is then lowered to bring the wall **24** solidly down on top of the die sections **9** and **10** and to engage its keyways **23** over the contiguous flanges **19**. This action also inserts the elastic liquid filled sack **27** into the tubular blank B.

With the parts thus positioned, the press head **7** is lowered to force the forming blocks **13** and **14** toward one another and into the die cavity. This depresses or indents the wall of the tube against the resistance offered by the liquid in the elastic sack and the pressure regulating spring-loaded valve **32** which controls displacement of liquid from the sack. As the liquid is displaced from the sack, it enters the expansion chamber **25**, and when the press is reopened, and the sack **27** is withdrawn from the formed part, its walls return to their normal shape and the liquid flows back into the sack through the port **30**.

After the press is opened the die sections are separated allowing the formed part to be ejected from the die cavity in any suitable fashion.

Since the resistance offered by the liquid in the sack to deformation of the wall of the blank is not positive, there is, of course, no assurance that the formation of the part in the manner described will result in the exact configuration sought. Where such accuracy is necessary, it may be obtained by removing the entire die assembly with the roughly formed part therein, from the press and mounting it in a press equipped with the device of the aforesaid application, where a final accurate forming operation may be carried out. With this in mind, the forming blocks **13** and **14** are securable in their forming positions by pins **45**. These pins may be inserted through holes **46** in the die sections **9** and **10** and into holes **47** in the forming blocks. Also, to hold the die sections together, clips **48** may be engaged over the contiguous flanges **19** after the yoke **20** has been raised and its keyways **23** disengaged from the flanges. The entire die assembly is then removed from the press and mounted upon the table of the other press.

With the die assembly mounted in this second press, the press may be closed to insert its liquid filled sack into the roughly formed part and thereupon, by the exertion of pressure upon the liquid in that sack as described in said copending application, the walls of the roughly formed part will be accurately expanded to the shape and configuration defined by the die cavity. Removal of the accurately formed part of course, entails opening of the press and separation of the die sections.

From the foregoing description taken in connection with the accompanying drawing, it will be seen that this invention provides a simple inexpensive device for quickly and easily shaping a preformed tubular blank into a part having an irregular and complex shape, and that the invention not only enables inexpensive and quick production of such parts, but in addition, adapts any conventional press to this operation.

What I claim as my invention is:

1. A device for indenting the wall of a tubular part comprising: a die having an open-topped cavity to endwise receive a tubular part to be deformed; a movable forming block; means slideably mounting the forming block in the die for translatory movement into and out of the die cavity along a path normal to the axis of the die cavity; means yieldably biasing the forming block to a position retracted from the die cavity; an actuator for the forming block; means mounting and constraining said actuator to translatory movement parallel to the axis of the die cavity; cooperable cam surfaces on the forming

block and said actuator through which movement of the latter in one direction forces the forming block into the die cavity and against the exterior of a tubular part therein to thereby deform the wall of the tubular part; a closed elastic sack of a size to fit freely into a tubular part received in the die cavity before said part is deformed; a liquid filling said closed elastic sack means providing a controlled outlet for the sack including a spring loaded pressure regulating valve adapted to open upon the application of a predetermined pressure upon the liquid in the sack; means defining an expansion chamber adjacent to the sack and into which the controlled outlet from the sack opens so that liquid displaced from the sack enters the expansion chamber; means providing a return duct from the expansion chamber into the sack; a check valve in said return duct arranged to open in response to pressure on liquid in the expansion chamber in excess of the pressure in the sack; and means mounting the elastic sack and the die cavity for relative movement to and from positions at which the elastic sack is disposed within a tubular part in the die cavity, so that the liquid filled elastic sack resists and controls indentation of the wall of a tubular part by the forming block.

2. A device whereby a cylindrical tubular blank may be formed into an irregularly shaped indented part in a conventional press, comprising: a sectional die, the parts of which coact to define a cavity to receive the tubular blank, and including a forming block constrained to move laterally into the die cavity with a translatory motion when the die is closed to inwardly deform the wall of a tubular blank in the cavity; a closed elastic sack of a size to fit freely inside a tubular blank received in the die cavity; a liquid filling the sack; means providing a controlled outlet for the sack including a pressure regulating valve which opens in response to a predetermined pressure on the liquid in the sack; means defining an expansion chamber adjacent to the sack and into which the controlled outlet from the sack opens so that liquid displaced from the sack enters the expansion chamber; means providing a return duct from the expansion chamber into the sack; a check valve in said return duct arranged to open in response to pressure on liquid in the expansion chamber in excess of the pressure in the sack; means for mounting the die and the sack in a press for movement of the sack into and out of the die cavity and a tubular blank received therein, during closure and opening of the press; means operable by closure of the press to move said forming block laterally into the die cavity and thereby inwardly deform the wall of the tubular blank against the resistance offered by the liquid filling the sack, whereby the tubular blank is given a shape approximating its desired configuration; and means for locking the several parts of the sectional die in their closed positions gripping and deforming the wall of the tubular blank, so that upon opening of the press and withdrawal of the elastic sack from the die cavity and the part therein, the entire die assembly may be removed from the press and mounted in another press for completion of the forming operation by pressure exerted upon the inside of the tubular blank.

3. A device for indenting the wall of a tubular part, comprising: a die having a cavity therein to receive a tubular blank to be shaped; a closed elastic sack shaped to pass freely into the die cavity and into a tubular blank to be shaped in the cavity; means mounting the die and said sack for relative movement along a defined path to and from a position in which the sack is inside a tubular blank placed in the die cavity before indentation of the wall of the tubular blank; a liquid filling said sack; means defining a closed expansion chamber adjacent to the sack; means communicating the expansion chamber with the interior of the sack, including a spring-loaded pressure regulating valve adapted to open in response to a predetermined pressure upon the liquid in the sack;

means providing a return duct from the expansion chamber into the sack; a check valve in said return duct arranged to open in response to pressure on liquid in the expansion chamber in excess of the pressure in the sack; a movable forming block; means mounting and constraining the forming block to translating movement into and out of the die cavity in directions normal to said path to thereby effect indentation of the wall of a tubular blank in the cavity against the resistance of the liquid in the sack encircled by the tubular blank as a consequence of inward motion of the forming block; and means for forcing the forming block into the die cavity and against the exterior of a tubular blank therein.

4. A device for indenting the wall of a tubular blank, comprising: a die having a cavity therein to receive a tubular blank to be indented; a movable forming block; means mounting the forming block on the die and constraining it to move back and forth with a translating motion along a defined path from a retracted position at which a tubular blank to be indented is freely inserted into the die cavity, toward an advanced position at which the forming block engages the exterior of a tubular blank in the cavity and effects indentation of the wall of the blank; a closed liquid filled sack of a shape to pass freely into a tubular blank in the die cavity to a position at which wall portions of a tubular blank in the cavity lie between the sack and the retracted forming block; means providing a controlled outlet for the sack including a spring loaded pressure regulating valve adapted to open upon the application of a predetermined pressure upon the liquid in the sack; means defining an expansion chamber adjacent to the sack and into which the controlled outlet from the sack opens so that liquid displaced from the sack enters the expansion chamber; means providing a return duct from the expansion chamber into the sack; a check valve in said return duct arranged to open in response to pressure on liquid in the expansion chamber in excess of the pressure in the sack; means for moving the sack relative to the die to and from said position within a tubular blank in the die cavity; and means for moving the forming block to said advanced position in the die cavity to thus effect indentation of the wall of a tubular blank in the cavity against the resistance of the liquid in the sack encircled by the blank.

5. A device for imparting an indented irregular shape to a tubular part made of deformable metal, comprising: a closed elastic sack of a size to fit freely inside the tubular part; a liquid filling the sack; means providing a controlled outlet for the sack including a spring loaded pressure regulating valve adapted to open upon the application of a predetermined pressure upon the liquid in the sack; means defining an expansion chamber adjacent to the sack and into which the controlled outlet from the sack opens so that liquid displaced from the sack enters the expansion chamber; means providing a return duct from the expansion chamber into the sack; a check valve in said return duct arranged to open in response to pressure on liquid in the expansion chamber in excess of the pressure in the sack; a sectional die having a cavity to receive the tubular part to be shaped and including a forming block movable laterally with a translating motion, into the die cavity to indent the wall of a tubular part in the cavity against the resistance offered by the liquid in the sack; means for moving said sack relative to the die to and from a position within a tubular part in place in the die cavity; and means for moving said forming block into the die cavity.

6. In a device for indenting a tubular blank, means for controlling the indentation of the blank, comprising: a sectional die having a cavity to receive the tubular blank and including a forming block movable laterally with a translating motion into the die cavity to indent the wall of a tubular blank in the cavity; a mounting member comprising a substantially horizontal wall overlying said die cavity; means on said wall defining a chamber open-

ing to the underside of said wall; a closure member fixed to the underside of said wall and sealing the mouth of said chamber; a liquid filled elastic sack carried by said closure member and depending therefrom, said sack being freely insertable into a tubular blank in the die cavity so that the fluid in the sack resists and controls inward deformation of the blank by force applied to its exterior; means for moving said mounting member up and down relative to the die to carry the sack to and from a position within a tubular blank in the die cavity; means in said closure member providing a controlled outlet for said sack leading into said chamber, said last named means including a spring loaded pressure regulating valve adapted to open upon the application of a predetermined

pressure upon the liquid in the sack; means in said closure member providing a return duct leading from said chamber into the sack; and a check valve in said return duct arranged to open in response to pressure on liquid in said chamber in excess of the pressure in the sack.

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