Sept. 20, 1955 R. K. SEDGWICK 2,718,048

METHOD AND MEANS FOR DEFORMING HOLLOW MEMBERS

Filed Jan. 25, 1949 2 Sheets-Sheet 1

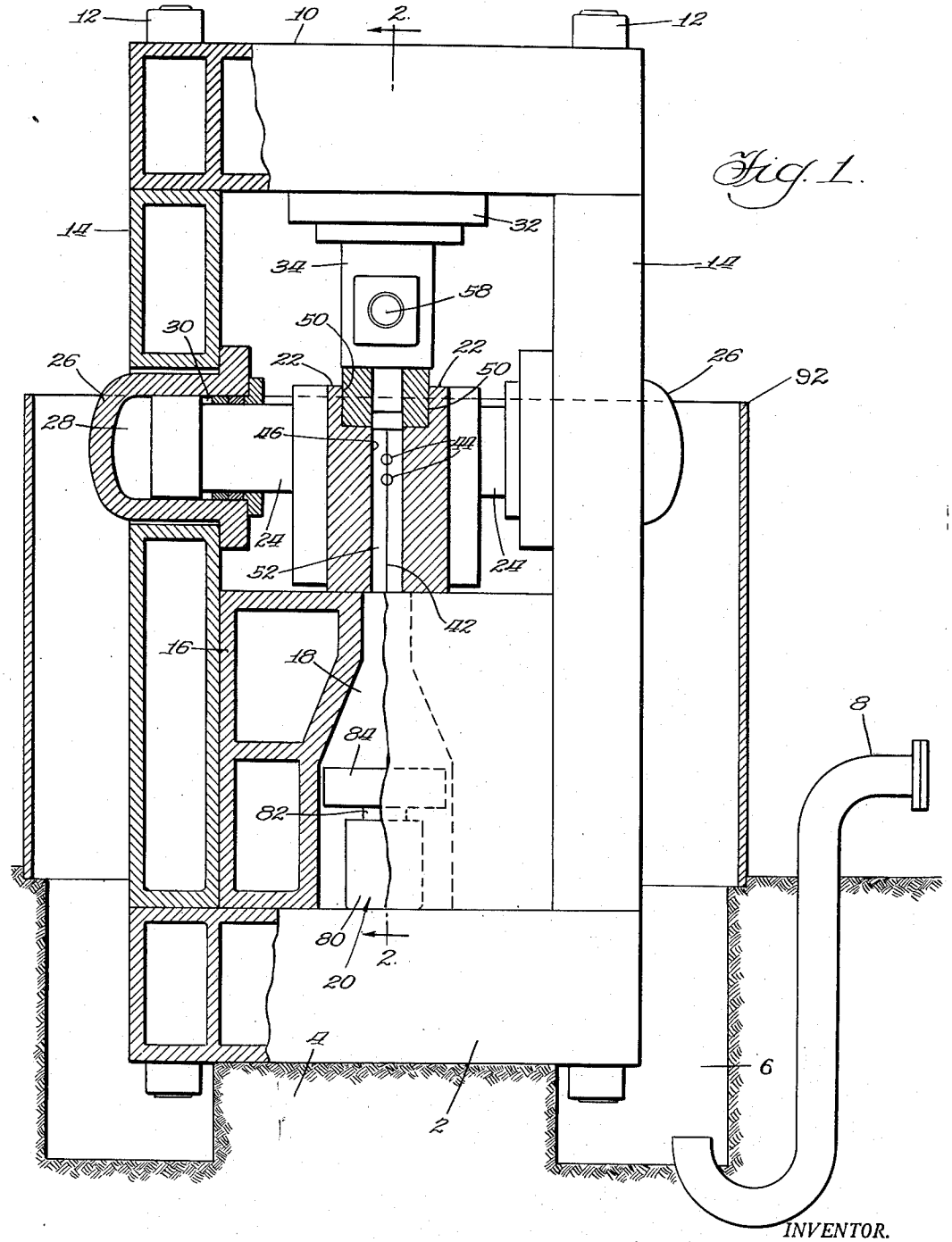


Fig. 1.

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Fig. 5.

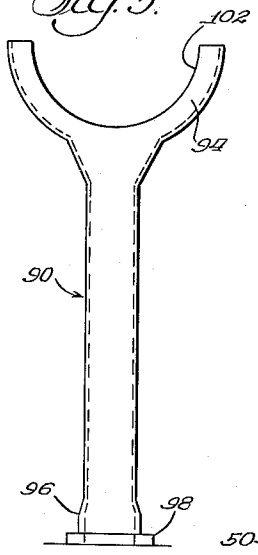


Fig. 2.

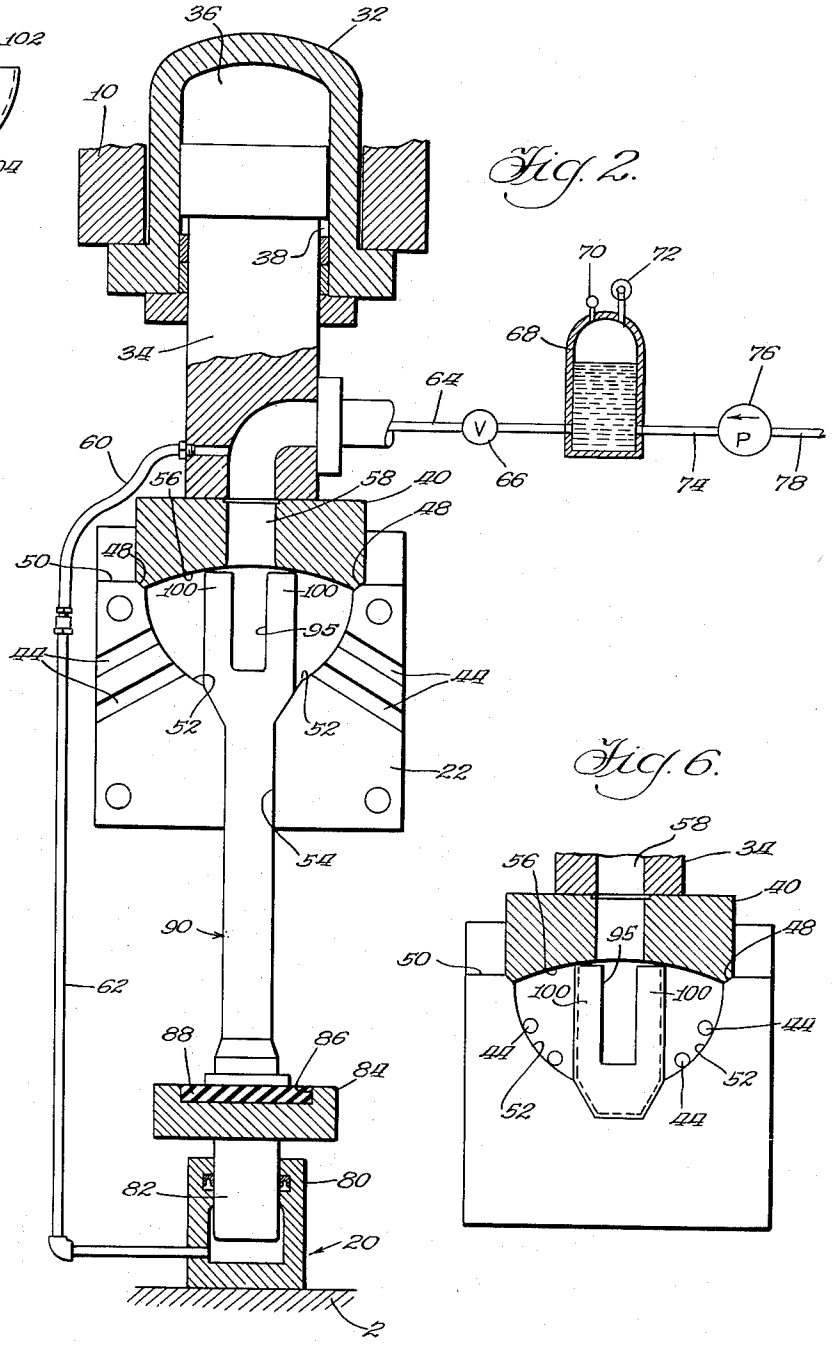


Fig. 3.

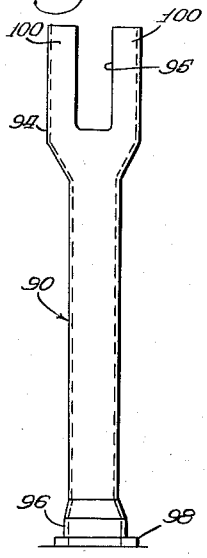


Fig. 6.

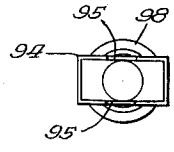


Fig. 4.

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METHOD AND MEANS FOR DEFORMING HOLLOW MEMBERS

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Application January 25, 1949, Serial No. 72,687

9 Claims. (Cl. 29—463)

This invention relates to a novel method and means for deforming a hollow deformable member by developing hydraulic pressure therein.

A primary object of the invention is to device a method and means for developing adequate hydraulic pressure within the member to be deformed without the necessity of affording a sealed hydraulic connection thereto thereby facilitating practice of the invention with respect to members of varying dimensions.

A corollary object of the invention is to prevent fluid pressure from equalizing against the internal and external areas of the section to be flared by disposing that section within a chamber having ports externally of the member and by directing hydraulic pressure fluid into the member at a rate substantially greater than the rate at which the fluid passes between the member and the adjacent margins of the chamber to the ports.

A more specific object of the invention is to devise a method and means for flaring the end of a deformable tube.

Another object of the invention is to seal one end of the tube while developing a charge of hydraulic fluid in the other end thereof within a die chamber to flare the other end of the tube to conformity with the die.

Still another object of the invention is to devise a method and means for automatically sealing one end of the tube after air has been expelled therefrom by hydraulic fluid admitted to the end of the tube within the die chamber.

A further object of the invention is to device a method for fabricating an axle housing component by flattening and notching one end of the tube and then flaring the notched end by sealing the opposite end and admitting hydraulic pressure fluid to the notched end of the tube within a die chamber at a pressure sufficient to flare the notched end to conformity with related die surfaces without bursting the tube.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and the accompanying drawings, wherein:

Figure 1 is a side elevational view, partly in central vertical section, of an hydraulic press embodying the novel apparatus utilized in the practice of the invention;

Figure 2 is a fragmentary sectional view on the line 2—2 of Figure 1, in combination with a novel hydraulic system for automatically sealing one end of the tube and then flaring the other end thereof;

Figures 3 and 4 are, respectively, a side elevational view and a top plan view of a tube which has been flattened and notched preparatory to the flaring operation performed by the apparatus of Figures 1 and 2;

Figure 5 is a side elevational view of the tube after completion of the flaring process; and

Figure 6 is a fragmentary sectional view corresponding to that of Figure 2 but showing a modified die structure.

Describing the invention in detail and referring first to Figures 1 and 2, the novel hydraulic press comprises

a bed 2 supported by a foundation 4 containing an annular well or pit 6 surrounding the bed and provided with a fluid outlet pipe 8 adapted for connection to the suction side of conventional pump means (not shown). The bed 2 is connected in conventional manner to an upper support member 10 by tension members 12 extending through complementary openings (not shown) in side panels 14. The bed 2 supports a hollow guide casting 16 comprising an internal chamber 18 which contains an hydraulic piston and cylinder device 20 supported by the bed 2.

It may be noted that the bed 2 and the members 10 and 14 together with the casting 16 constitute a frame supported by the foundation 4 and may be fabricated in any desired manner, the embodiment shown being merely for the purpose of illustration.

The casting 16 provides slidable support for a pair of die members 22 operated, respectively, by rams 24 reciprocal within conventional cylinders 26 to define advance and return chambers 28 and 30 therein. The member 10 similarly supports a cylinder 32 containing a ram 34 defining advance and return chambers 36 and 38 therein and the ram 34 at its lower end supports another die segment 40.

It will be understood that the rams 24 and 34 are advanced and retracted within their respective cylinders by means of a conventional hydraulic circuit which is not shown in order to clarify the illustration, inasmuch as the circuit constitutes no part of the invention. Furthermore, if desired, the die segments 22 and 40 may be operated by any conventional motors, the hydraulic motors shown being preferred.

In the closed position of the die segments 22 and 40, the segments 22 are seated in substantially fluid-tight engagement at 42 (Figure 1) and are formed with complementary recesses defining outlet ports 44 communicating with a pressure chamber 46 formed by the segments 22 and by the segment 40 which in closed position is seated against the segments 22 along complementary diagonal surfaces at 48 (Figure 2) and is snugly fitted within recesses 50 in the segments 22, to substantially prevent flow of hydraulic fluid from the chamber 46 between the mating surfaces of the segments 22 and 40.

The die segments 22 are provided with flaring arcuate die surfaces 52 merging at their remote ends with the diagonal surfaces 48, the flared surfaces 52 being spaced at their adjacent ends by a fluid outlet passage 54. The inner side of the segment 40 is formed with an arcuate closure surface 56, serving a purpose hereinafter described in detail in connection with the operation of the device, and the surface 56 is interrupted by a fluid inlet passage 58 which continues through the ram 34 and is connected to a flexible pipe 60 coupled to an inlet pipe 62 connected to the cylinder of the device 20 for a purpose hereinafter described.

Hydraulic fluid is delivered to the passage 58 by an inlet line 64 having a conventional quick opening valve 66. The line 64 is connected to an accumulator 68 illustrated in Figure 2 as an air ballasted accumulator containing a charge of compressed air at its upper end maintaining pressure in the line 64 within a predetermined range of pressure values. The accumulator 68 comprises an air valve 70 and a pressure gauge 72 and is connected by a pressure line 74 to the discharge side of a conventional pump 76, the suction side of which is connected by a line 78 to a source (not shown) of hydraulic fluid, such as oil or water.

The device 20, as best seen in Figure 2, comprises a cylinder 80 and a piston 82 which supports a plate or block 84 having a recess 86 containing a resilient pad 88 adapted to seal the lower end of a tube, generally designated 90.

The entire apparatus is preferably closed within a wall or partition **92** having one or more doors (not shown) affording access to the apparatus for loading and unloading the tubes.

The above-described apparatus is utilized in flaring a tube **90**, as hereinafter described. The tube **90** is flattened as at **94** and the flattened section is notched at each side thereof as at **95**. The tube is also upset as at **96** and flanged as at **98** in a hot forging operation.

The lower or upset end of the tube **90** is then seated on the resilient pad **88** whereupon the side rams **24** are actuated to close the die sections **22** thereby lifting the tube **90** slightly above the pad **88** as the flared upper end of the die passage **54** engages complementary surfaces of the tube, as best seen on Figure 2. The top ram **34** is then advanced to move the die section **40** to the closed position shown in Figure 2.

It will be understood that under these conditions the chamber **46** is substantially closed at the sides thereof which conform to and snugly contain the notched sides of the tube and at the top of the chamber which is defined by the before-mentioned surface **56**, said surface being accurate in form to conform to the path of the tube sections which are flared against the surfaces **52**, as hereinafter described.

Under these conditions the quick opening valve **66** is opened admitting hydraulic fluid under pressure of the order of one thousand pounds per square inch to the passage **58** which delivers the fluid to the upper end of the tube **90** thereby expelling air from the lower end of the tube. After substantially all the air has been expelled from the tube, pressure rises within the passage **58** sufficiently to actuate the device **20** urging the piston **82** upwardly thereby engaging the pad **88** with the lower end of the tube to seal the same. It may be noted that the cross-sectional area of the piston **82** is greater than that of the intermediate portion of the tube **90** and is smaller than that of the flattened section **94** of the tube whereby the pressure within the line **62** and the cylinder **80** is effective to maintain the pad **88** in sealed engagement with the lower end of the tube without pushing the tube upwardly from its normal position shown in Figure 2. If the lower end of the tube is closed, the device **20** may be eliminated.

Under these conditions fluid delivered to the flattened section **94** of the tube may pass to the ends of the chamber **46** bounded by the flattened die surfaces **52** only through the restricted areas at the top and sides of the chamber which, as above noted, conform to and are closely spaced from the top and notched sides of the tube section **94**. Thus pressure builds up rapidly within the section **94** and two legs **100** thereof, as seen in the side elevational views of Figures 2 and 3, are first spaced out in a V shape and are then deformed to conformity with the flared surfaces **52**. During deformation of the tube, the hydraulic fluid which passes along the top and sides of the chamber **46** to the ends thereof passes from the ports **44** and is directed against the wall **92** from which the fluid falls into the chamber **6** and is piped therefrom by the outlet pipe **8**.

It will be understood by those skilled in the art that the pressure required to flare the flattened and notched section of the tube **90** to conformity with the die surfaces **52** is considerably less than that which would burst the intermediate portion of the tube **90** and the range of operating pressure values is determined by the material of which the tube is formed and the thickness of the tube wall.

After completion of the flaring operation, the valve **66** may be closed and the die sections **22** and **40** may be opened to accommodate removal of the finished product from the device. The finished product is shown in Figure 5 wherein it will be seen that the flattened section **94** of the tube has been flared to form a semi-cylindrical housing **102**, two of which may be welded together to form an axle housing for a conventional automotive vehicle.

A modification of the invention is shown in Figure 6 which is a fragmentary view coresponding to Figure 2 wherein parts corresponding to those of Figure 2 are identified by corresponding numerals.

In Figure 6 the passage **54** is eliminated, and the hollow member to be flared is preferably closed at its lower end but otherwise corresponds exactly in configuration to the flattened section **94** of the tube **90** shown in Figures 3 and 4. Also the ports **44** in Figure 6 are formed through the sides rather than the ends of the die sections **22** but are connected to the flared die surfaces **52** to accommodate escape of hydraulic fluid from between these surfaces and the legs **100** of the member **94** as it is flared against the surfaces **52**, as above described in connection with the embodiment of Figures 1 and 2.

It may be noted that a primary feature of the invention is to avoid the necessity of connecting the source of high pressure hydraulic fluid to the deformable member by a sealed connection and this feature of the invention may be utilized with a pressure chamber of any desired configuration provided that the pressure fluid is delivered to the interior of the hollow member to be deformed and is restricted against flow therefrom to a rate substantially less than that at which the fluid is delivered to the member. In order to prevent equalization of pressure against the interior and exterior surfaces of the member to be deformed, the fluid flowing from the interior thereof is permitted to flow freely from the pressure chamber, externally of the member.

I claim:

1. In an apparatus for flaring a flattened and bifurcated end section of a hollow member; the combination of relatively movable die segments adapted in closed position to define a pressure chamber and adapted in open position to accommodate insertion of said section, said chamber having substantially flat side walls complementary to the sides of said section and having end die surfaces against which said section is to be flared, and said chamber having another surface extending between the side walls and extending arcuately between the die surfaces, said other surface being adapted to conform to the path of movement of said section as it is flared against said die surfaces, fluid outlet means connected to the ends of the chamber for discharging hydraulic fluid trapped between said surfaces and the flared portions of said section, a high pressure, hydraulic fluid inlet passage interrupting said other surface and connected to said chamber, the space between said section and side walls combined with the space between said section and said other surface having less flow capacity than said inlet passage and having less flow capacity than said outlet means, said passage being disposed between the die surfaces and being adapted to deliver hydraulic pressure fluid to said section to develop hydraulic pressure therein and flare the section against the die surfaces.

2. Apparatus, according to claim 1, wherein the pressure chamber is provided with a passage approximately diametrically opposed to the inlet passage and adapted to receive an intermediate portion of the hollow member having a cross-sectional area substantially less than that of the flattened section thereof, and means are provided for sealing the end of the hollow member remote from the flattened section thereof, said sealing means comprising a cylinder member and a piston member therein having greater cross-sectional area than the intermediate portion of the hollow member and a smaller cross-sectional area than the flattened section of the hollow member, one of the piston and cylinder members carrying a seal, and an hydraulic connection is provided between the inlet passage and the cylinder member of said device, the flow capacity of the space initially existing between the seal and the hollow member being less than the supply rate of the

inlet passage as reduced by flow of fluid from the outlet means.

3. In apparatus for flaring a notched end of a tube, the combination of a plurality of die segments movable to closed position defining a die having a chamber adapted to receive said end, said segments in closed position defining a passage adapted to receive an intermediate portion of the tube, said die having spaced surfaces in said chamber against which said tube is to be flared, another passage through said die substantially aligned with the first-mentioned passage, a plurality of exhaust ports through said die connected to said surfaces, means for sealing the other end of said tube comprising a sealing member, an hydraulic piston and cylinder device operatively connected to said member for actuation thereof to seal said tube, means for connecting a source of hydraulic pressure fluid to the second-mentioned passage, and an hydraulic connection between the second-mentioned passage and said device, the flow capacity of the space initially existing between the tube and the sealing member being less than the flow capacity of the second-mentioned passage as reduced by flow of fluid from the exhaust ports, whereby, upon connection of said source to said second-mentioned passage, hydraulic fluid flowing therefrom into said tube expels air therefrom, whereupon pressure builds up in the second-mentioned passage to automatically actuate said device and then flare the notched end of said tube against said surfaces.

4. In an apparatus for flaring a bifurcated end section of a hollow member; the combination of a pressure chamber having side walls and having die surfaces at opposite ends respectively of said chamber against which surfaces the bifurcations of said section are to be flared, said chamber having a closure surface extending between said side walls and extending arcuately between the die surfaces, said closure surface being adapted to conform to the path of movement of the bifurcations of said section as they are flared against said die surfaces, said chamber having ports accommodating flow of hydraulic fluid from between said die surfaces and the flared bifurcations of said sections, a high pressure hydraulic fluid inlet passage connected to said chamber at a point between said die surfaces to deliver high pressure hydraulic fluid between the bifurcations of said section, the space between said side walls and the bifurcations of said section combined with the space between said closure surface and the bifurcations of said section having less flow capacity than that of said inlet passage and having less flow capacity than that of said ports, whereby high pressure fluid from said inlet passage develops hydraulic pressure between the bifurcations of said section to flare the bifurcations against respective die surfaces.

5. Apparatus according to claim 4, wherein the inlet passage interrupts said closure surface.

6. Apparatus according to claim 4, wherein the ports extend through at least one side wall.

7. Apparatus according to claim 4, wherein the ports extend through the die surfaces.

8. Apparatus of the class described comprising a plurality of relatively movable die segments adapted in closed position to define a pressure chamber for reception of a tube and having internal surfaces against which associated tube sections are to be flared, said chamber having exhaust ports connected to said surfaces, opposed passages connected to said chamber between said surfaces, one passage being adapted to deliver hydraulic pressure fluid to the chamber and the other passage being adapted to contain a portion of the tube, said one passage being aligned with one end of said tube in said chamber and being open at all times to communication with said ports by flow of said fluid from said end of said tube through said chamber to said ports, the flow capacity of said one passage to said end of said tube being greater than the flow capacity of the chamber from said end of said tube to said ports, an hydraulic piston and cylinder device externally of the chamber for sealing the end of the tube remote therefrom, said last mentioned end of said tube being spaced from said device until air has been expelled from the tube by hydraulic fluid from said one passage, and an hydraulic connection between the cylinder and inlet passage, the flow capacity of the space initially existing between said device and said tube being less than the flow capacity of said one passage as reduced by flow of fluid from said exhaust ports.

9. A method of flaring a deformable tube comprising the steps of notching one end thereof, then inserting said end into a die chamber having outlets externally of the tube, then directing hydraulic fluid under pressure to said end of the tube until substantially all air has been expelled from the other end of the tube, and then sealing said other end of the tube and developing hydraulic pressure in the notched end of the tube sufficient to flare said notched end to conformity with related surfaces in the die chamber.

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