Oct. 19, 1971 MASANOBU NAKAMURA 3,613,423

BULGING APPARATUS

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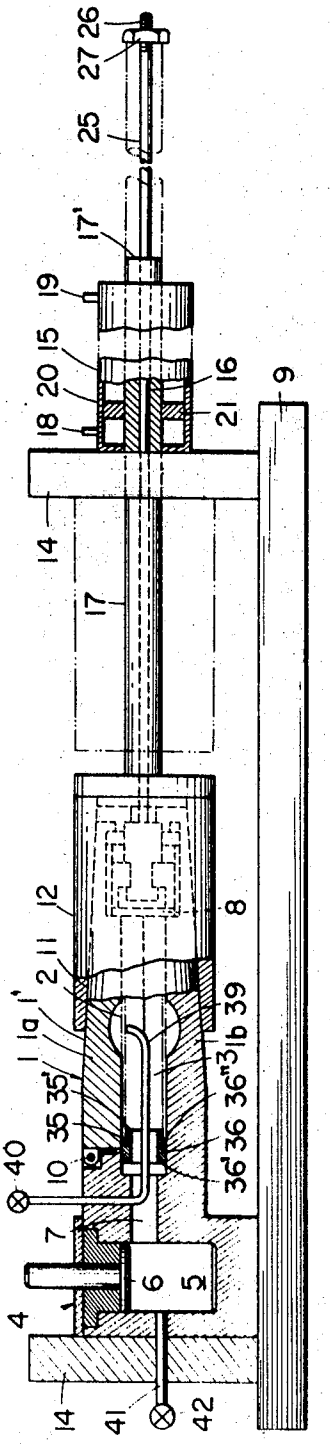

FIG. 1

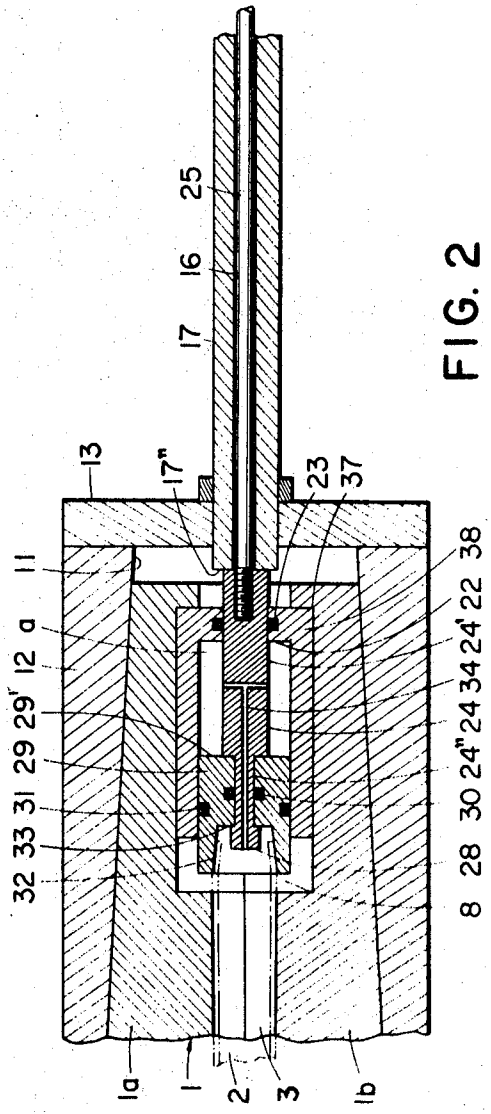

FIG. 2

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BULGING APPARATUS

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ABSTRACT OF THE DISCLOSURE

A fluid pressure bulging apparatus comprised of a die cavity in which a tube to be bulged is enclosed. A chuck automatically grips the front end of the tube to permit accurate bulging without off-center working.

This invention relates to a bulging apparatus in which, when pressure fluid is introduced into a length of tube to be bulged which is enclosed in a die cavity, a chuck automatically grips the front end of the tube firmly to permit accurate bulging without off-center working and other undesirable possibilities and, after the bulging, the chuck fitted tightly to the front end of the tube is released safely, smoothly and easily.

The present invention will be more particularly described below with reference to the accompanying drawings, in which:

FIG. 1 is a front elevational view, partly in section, of an embodiment of the invention; and

FIG. 2 is a vertical sectional view, on an enlarged scale, of a part of the embodiment shown in FIG. 1.

A split die is generally indicated at **1**, as comprised of an upper die **1***a* and a lower die **1***b*, which have matching recesses on the opposing surfaces jointly to form a die cavity **3** to receive a length of the tube **2** as a blank. The inlet port of the cavity **3** (at the left end of FIG. 1) is communicated through a passage **7** to a hydraulic pressure generating chamber **5** of a pressure generator **4** which is equipped with a piston **6** and mounted altogether on a bed **9**. At the front end (at the right end of FIG. 1) the die cavity is connected to a larger-diameter chamber **8**.

The split die **1** is so constructed that the lower die **1***b* is fixed at the rear end to the lower part of a side of the hydraulic pressure generator **4**, while the upper die **1***a* is pivotally connected at the rear end to the upper part of the same side of the generator **4** with a horizontal pivot or pin **10** so that the upper die **1***a* can turn up or down about the pin **10** thereby to open or close the dies. The die body **1** is tapered frontwards over a suitable length from the front end, and an end cap or sleeve **12** having a cylindrical hollow **11** with a matching taper is fitted thereon securely to fasten the upper die **1***a* and the lower die **1***b* together.

Through the end plate **13** of the die sleeve **12** is secured at one end of a tubular slide bar **17** which is horizontally supported by a holder **14** on the bed **9** and is adapted to be urged back and forth by a suitable hydraulic device **15**. By the sliding movement of this bar **17**, the sleeve **12** is caused to advance or retract axially over the die body **1** into or out of sliding engagement therewith.

In the eembodiment shown, numerals **18** and **19** designate the fluid inlet and outlet, respectively, of a cylinder **20** of the hydraulic device **15**. On the slide bar **17** is securely mounted a piston **21**, and the cylinder **20** is fixed at one end to the holder **14**.

Through the front end wall **22** of the expanded chamber **8** of the die body **1**, a plunger **24** is inserted slidably while a liquidtight seal is maintained by an O-ring **23**. To the outer end (at the right end as viewed in the drawing) of the plunger **24** is connected to the inner end (at the left end) of a rod **25** which is inserted through the entire length of the tubular slide bar **17**.

The outer end of this rod **25** extends beyond the slide bar **17**, and an externally threaded part **26** of the front end portion thereof engaged with a stopper nut **27**. The nut is so designed that, when the sleeve **12** once fitted on the die body **1** to clamp the die members together is brought back out of contact with the die body **1**, the outer end **17'** of the bar is abutted against and stopped by the nut.

The plunger **24** provided through the end wall **22** of the expanded chamber **8** of the die body **1** is formed of a large-diameter portion **24'** and a small-diameter portion **24''** of a suitable length formed close to the inner end, the diameter of the latter portion being considerably smaller than the inside diameter of the tube **2** to be bulged. At the inner extremity of the plunger **24** there is formed a flange **28** which is smaller in diameter than the tube **2** but is slightly thicker than the small-diameter portion **24''**.

Around the small-diameter portion **24''** of the plunger **24**, a cylindrical chuck **29** which combines a drawing die member is fitted, with an O-ring **30** that establishes a liquidtight seal therebetween. The combined drawing die-chuck **29** in turn is slidably held in the expanded chamber **8** while maintaining a liquidtight seal against the surrounding wall of said chamber with the aid of an O-ring **31**. Between the outer end surface **29'** of the chuck **29** and the inner end wall surface **22** of the expanded chamber there is defined an enclosed chamber *a*.

The inner end wall of the combined drawing die-chuck **29** is formed with an expanding mouth **32** to take a good bite at the front end of the tube **2**, so that when the chuck actually grips the front end of the workpiece the mouth **32** receives it to the inner bottom **33** thereof.

The plunger **24** is formed with a through hole **34** which extends from the inner end surface thereof to the surface of the large-diameter portion **24'**, or into the enclosed chamber *a*.

On the other hand, in the inlet of the die cavity **3** through which hydraulic fluid flows in, there is inserted a stepped cylindrical presser **36** having a protrusion **35** of a sufficiently reduced diameter to receive the rear end (left end as shown) of the tube **2** into the annular space defined between said reduced-diameter portion and the surrounding wall of the die cavity.

The area of the inner end surface of this presser **36**, or of the stepped end surface **36''**, is smaller than the area of the outer end surface **36'** on the side where the hydraulic fluid flows in.

Therefore, when hydraulic fluid is forced into the tube **2**, the presser **36** is automatically urged deep into the die cavity **3** by dint of the pressure difference due to the dissimilarity of the pressure-receiving areas on both ends of the presser **36**. Consequently, the protrusion is fitted in the rear end portion of the tube **2** and the stepped end face **36''** of the presser **36** pushes the rear edge of the tube and holds the rear end portion securely.

In a hollow space **37** of an increased diameter formed in the front end portion of the die body **1**, a hollow cylinder **38** having a closure wall **22** is inserted. The interior of the cylinder **38** thus provided serves as the expanded chamber **8** above described.

In the embodiment shown in FIG. 1, a vent pipe **39** is held in the die cavity **3** and is open at a suitable upper point inside the tube **2** for the escape of air therefrom upon filling of the tube with hydraulic fluid. The vent pipe **39** is equipped with a valve **40**, and a line **41** for the supply of hydraulic fluid to the chamber **5** of the hydraulic pressure generator **4** is also provided with a valve **42**. The two valves **40**, **42** are so arranged that they can suitably and automatically close when the air inside

the tube 2 has been completely discharged therefrom through the vent pipe 39 due to the inflow of the pressure fluid, or when the fluid has begun overflowing out of the exterior end of the vent pipe 39.

With the construction so far described, the bulging apparatus according to the present invention is operated in the following way.

First, the sleeve 12 is removed from the split die 1, the upper die 1*a* is turned upward about the pin 10, and a length of tube 2 to be bulged is placed on the recess of the lower die 1*b* or the lower half of the die cavity 3. At this time, the front end (right end) of the tube 2 is inserted into the mouth 32 of the chuck 29, while the rear end (left end) of the tube is held by the presser 36.

Next, the upper die 1*a* is turned down to close the dies, and the slide bar 17 is urged toward the die body 1 by the hydraulic means 20, so that the sleeve 12 is moved forward to cover the tapered frontal portion 1' of the die body 1, thus fastening the upper die 1*a* and the lower die 1*b* together.

The valves 40, 42 of the hydraulic pressure generator 4 then open, and hydraulic fluid is pumped into the chamber 5, passage 7 and tube 2. When all of the spaces have been uniformly filled with the fluid, the valves 40, 42 close.

The piston 6 of the hydraulic pressure generator 4 is urged downward suitably as by a press to exert pressure on the fluid in the cylindrical chamber 6. The pressure is conducted to the fluid inside the tube 2 to force the tube wall outward to conform with the surrounding die cavity 3 as desired.

According to the invention, part of the pressure fluid forced into the tube for the purpose of bulging is introduced, through the hole 34 in the plunger 24 which extends through the end wall of the expanded chamber 8, into the enclosed chamber *a* defined between the outer end face 29' of the combined drawing die-chuck 29 and the closure wall 22, thereby exerting pressure on the outer end face 29' of the chuck 29.

Since the plunger 24 of the combined drawing die-chuck 29 is inserted slidably into the closure wall 22 of the expanded chamber, the chuck 29 is urged toward the tube 2, with the result that the tapered mouth 32 takes a better bite on the tube end and draws and grips the end portion of the tube, the front end of the tube being held at the inner bottom 33 of the mouth.

In this way accurate bulging of the tube 2 is accomplished without the danger of a deviation of the tube position out of the axial center, or any other irregularity during the bulging operation.

The formed tube 2 is then taken out of the die body 1 after the discharge of pressure fluid from the interiors of the tube 2 and the passage 7, in the following manner.

By the reverse operation of the hydraulic device 20 the slide bar 17 is caused to recede (rightward as shown) until the clamping sleeve 12 is completely pulled off from the die body 1. The upper die 1*a* is now able to turn upward about the pin 10 so as to open the dies, but the tube 2 is still unable to be taken out because its front end is in the grip of the chuck 29.

As the slide bar 17 further retracts and the outer end 17' hits a nut 27, the rod 25 is pulled out together with the slide bar 17, and the plunger 24 at the inner end of the rod 25 moves in the direction where it is shifted in position outwardly of the wall 22 of the expanded chamber 8. By this movement the chuck 29 is moved integrally with the plunger toward the end wall 22 of the expanded chamber 8, so that the chuck 29 is urged out of engagement with the front end of the tube 2.

It is then possible to disconnect the other end of the tube 2 from the presser 36 and take out the tube 2 simply from the lower die 1*b*.

For the bulging of another length of tube, the workpiece is forced into the die body, and the slide bar 17 is caused to advance by the hydraulic device 20 and the sleeve 12 is moved onto the die body 1 to clamp the same. The arrangements are of course so set that, in this case, when the sleeve 12 has moved forward to a predetermined point of the sleeve 12, the inner end face 17'' of the slide bar 17 pushes the outer end face of the plunger 24 pulled outside of the end wall 22 of the expanded chamber 8 and brings the plunger 24 back to the original position, so that the enclosed chamber *a* is exactly defined in the expanded chamber 8.

I claim:

1. A bulging apparatus having a chuck which tightly grips the front end of a tube and can be readily removed after bulging of the tube, comprising a horizontal split die body consisting of an upper die and a lower die, with a die cavity formed axially therethrough and provided with a larger-diameter or expanded chamber at the front end, is tapered as a whole toward the front end and is connected at the rear end to one side of a hydraulic pressure generator, the rear end of the die cavity is communicated to a chamber which serves as a cylinder for the piston of the hydraulic pressure generator, a closure plate at the rear end of a cylindrical die-clamping sleeve having an inwardly tapered hollow for the engagement purpose is attached to the inner end of a tubular slide bar which is horizontally supported by a suitable holder and is adapted to be moved back and forth parallel with the axis of the horizontal die body by means of a hydraulic device, so that the sleeve can be urged into and out of engagement with the horizontal die body by the forward and backward movements of the slide bar, a rod is loosely fitted in the tubular hollow of the slide bar, a plunger provided at the inner end of the rod is liquid tight and slides in an extended direction through the end wall of the expanded chamber, a cylindrical chuck which combines a drawing die having a mouth to take a grip at the front end of tubing to be worked and which is adapted to slide liquid-tight through the enlarged chamber, is mounted on the plunger, an enclosed chamber is defined between the outer end face of this chuck and the end wall of the expanded chamber, the plunger is formed with a through hole from the inner end face of the chuck mouth to the enclosed chamber, the outer end of the rod inserted in the slide bar is extended from the outer end of the slide bar, beyond the distance of travel required by the die-clamping sleeve for engagement with and disengagement from the die body, and a stopper is provided at the outer end of the rod so that, when the slide bar has receded to bring the sleeve out of engagement with the die body, the outer end of the slide bar can be abutted against the stopper for no more backward movement.

References Cited

UNITED STATES PATENTS

2,748,455	6/1956	Draper et al.	72—61
3,494,160	2/1970	Tominaga et al.	72—60
3,535,901	10/1970	Tominaga	72—60

FOREIGN PATENTS

24,746	10/1969	Japan	72—61

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