April 3, 1956 W. L. VEATCH 2,740,455

APPARATUS FOR MAKING SHORT RADIUS ELBOWS

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FIG. 1.

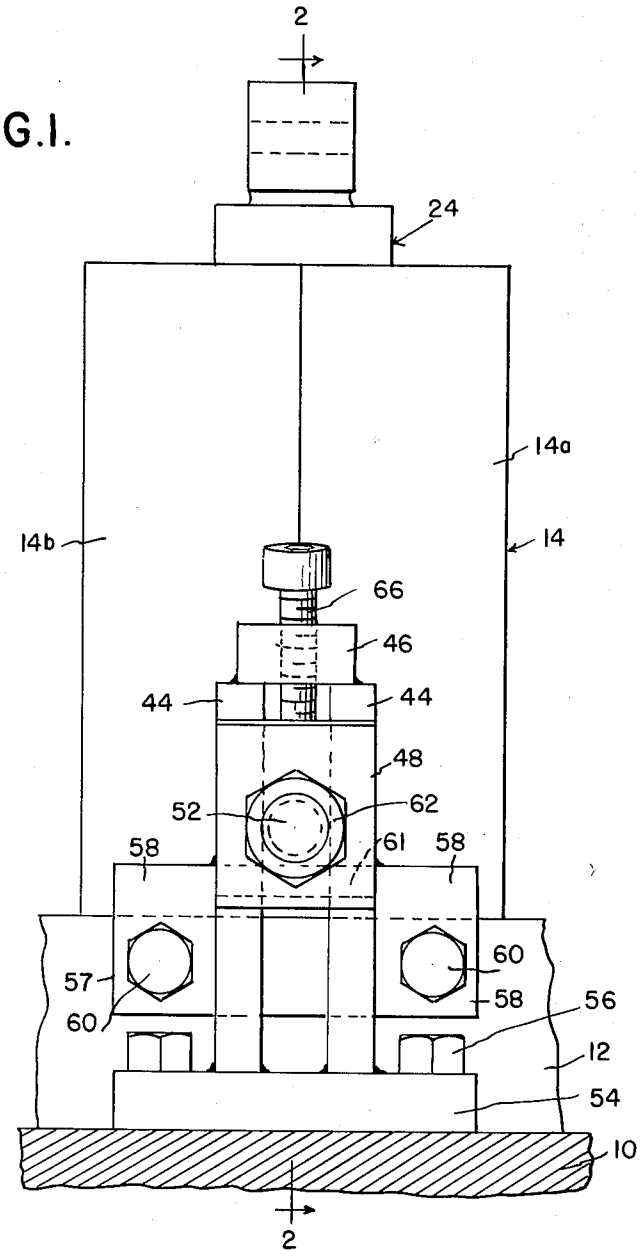

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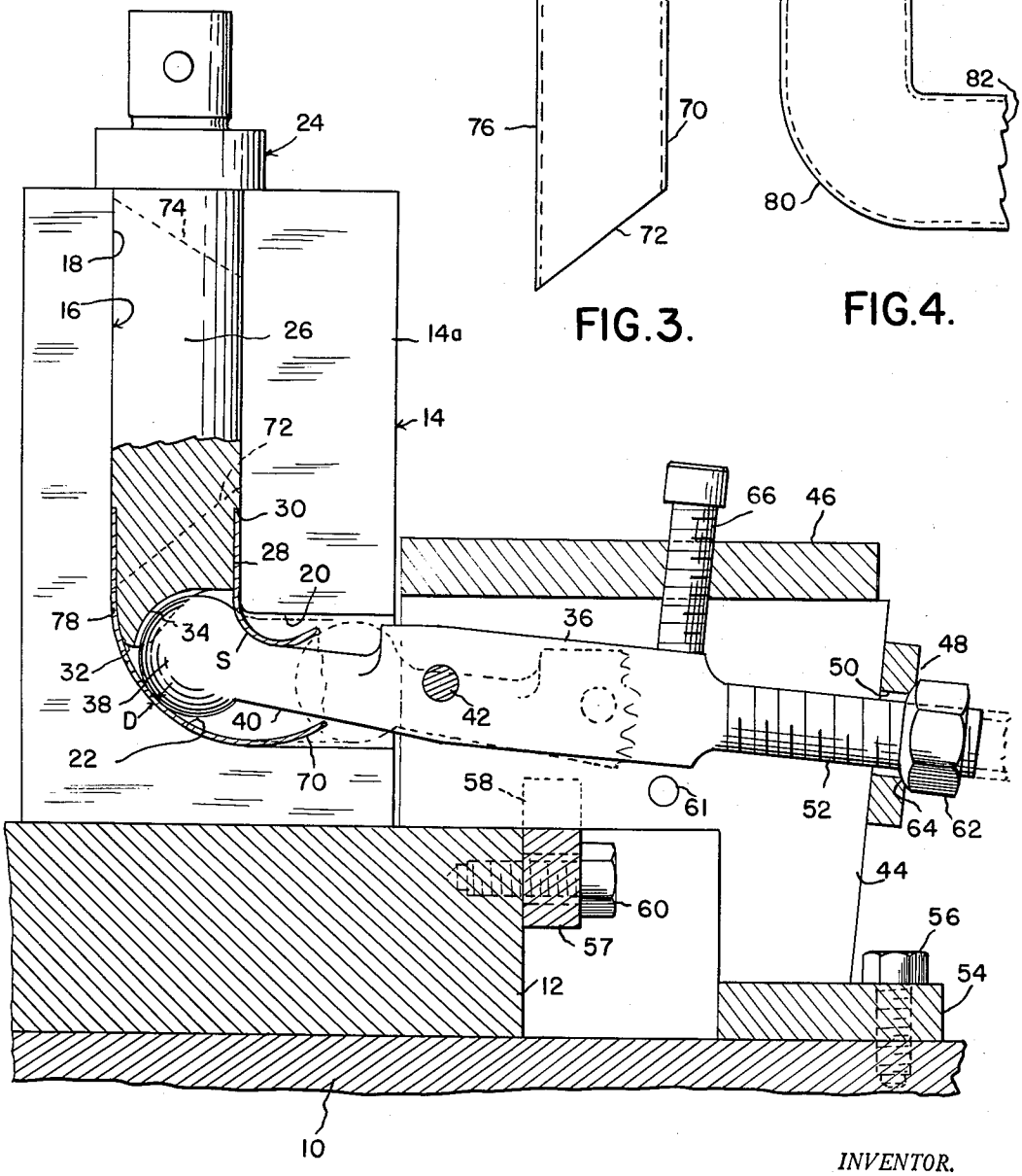
FIG.2.



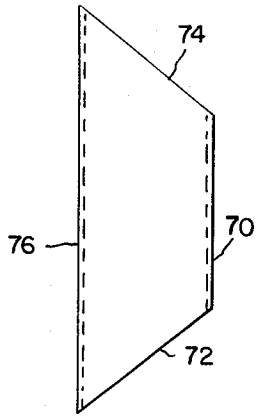


FIG.3.

FIG.4.

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APPARATUS FOR MAKING SHORT RADIUS ELBOWS

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8 Claims. (Cl. 153—48)

The present invention relates to a method and apparatus for making short radius elbows from tubular stock.

It is an object of the present invention to provide a method and apparatus for forming tubular stock into elbows having short radii and characterized by a minimum change in wall thickness of the elbow as compared with the wall thickness of the tubular stock.

More particularly, it is an object of the present invention to provide apparatus for producing elbows from tubular stock which comprises a die having a passage extending therethrough corresponding to the shape of the elbow to be produced, in conjunction with a headed mandrel, the head having cylindrically shaped portions, means for disposing the head of the mandrel at the bend of the passage in the die, means for pressing tubular stock partly around the bend in the die and partly past the head of the mandrel, and means for thereafter withdrawing the head of the mandrel from the die to shape the leg of the elbow which has been pressed past the bend of the die.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is an elevational view of the apparatus for producing elbows.

Figure 2 is a sectional view on the line 2—2, Figure 1.

Figure 3 is an elevational view of a tubular element to be shaped to elbow form.

Figure 4 is an elevational view of the tubular element after it has been shaped to tubular form.

The apparatus comprises a bed **10** of a hydraulic press carrying a vise base **12** on which is located die structure **14**. The die structure **14** is composed of two separable parts **14***a* and **14***b*, each of which is provided with a recess **16** including a vertically extending cylindrical portion **18**, a horizontally extending cylindrical portion **20**, and an arcuate portion **22** intermediate and connecting the straight portions **18** and **20**. As will be readily understood, the two halves of the die are assembled together with the recesses **16** in registration so as to produce an opening through the assembled die which is of uniform circular cross-section and which has open ends at the top and side of the die assembly as illustrated.

Associated with the die structure **14** is a punch or plunger indicated generally at **24** which includes a cylindrical portion **26** shaped to fit closely within the cylindrical portion **18** of the die passage. At its lower end the plunger **24** is reduced as indicated at **28** and is provided with a circular shoulder **30** perpendicular to

the length of the plunger **24**. The lower end of the plunger is provided with a projecting portion **32** and is spherically concave as indicated at **34** for a purpose presently to be described.

Associated with the die **14** and plunger **24** is a mandrel **36** having a spherically shaped head **38** and a reduced neck portion **40**. In the illustrated simplified embodiment of the invention the mandrel is supported in the full line position by a pin **42** extending through a transverse opening in the mandrel and into openings in side plates **44**, the plates being interconnected by a top plate **46**. Spanning the side plates **44** and slidable vertically thereon is a transverse plate **48** having an opening **50** therethrough for receiving the threaded end **52** of the mandrel **36**. The die supporting structure also includes a plate **54** connected to the lower end of the side plates **44** and bolted to the bed **10** by bolts **56**. A yoke member **57** is provided having ears **58** bolted to the vise base **12** by the bolts **60** and which engage the sides of the plates **44**, thereby completing the assembly of the mandrel supporting structure on the bed **10** of the hydraulic press. Pin **61** spans plates **44** and supports the mandrel **36** when pin **42** is withdrawn.

Connected by the threaded portion **52** of the mandrel is a nut **62** having spherical surfaces **64** seated in correspondingly shaped spherical surfaces formed at the outer end of the opening **50**. It will be observed from the foregoing that the mandrel **36** is mounted for rocking movement about the axis of the pin **42**, when the pin is inserted to retain the mandrel in the full line position illustrated. To provide for adjustment of the exact location of the headed end **38** of the mandrel, an abutment screw **66** is provided which extends through a threaded opening in the plate **46**. By suitable adjustment of the abutment screw **66**, the head **38** may be located with desired clearance with reference to the inner surfaces of the die passage. In actual practice the spherical portion of the ball head **38** of the mandrel is dimensioned with reference to the circular cross-sectional dimensions of the passage through the die so as to provide an annular space surrounding the ball head at the curved portion of the die passage, this space having a transverse dimension equal to the nominal wall thickness of the tubular blank plus the required clearance factor which in the case of thin walled tube may be about .002"–.004".

The surface of the mandrel at the zone S which interconnects the neck **40** and the ball head **38**, is concavely curved, as best illustrated in Figure 2, to serve as a guiding surface for the portion of the tube located at the inner side of the elbow.

In operation the tubular blank is illustrated at **70** and has bevelled ends **72** and **74** dimensioned to provide the necessary stock to preserve substantially the same wall thickness in the completed elbow as in the completed stock. The long side **76** of the stock of course corresponds to the outside radius of the elbow and provides the necessary excess stock to prevent excessive thinning of the wall section of the elbow.

The spherical concave end surface **34** of the plunger is shaped to receive and partly envelop the ball head **38** of the mandrel, and the projecting portion **32** of the plunger is to extend the annular space **78** intermediate the reduced portion **28** of the plunger and the adjacent surface of the die passage into proximity to the zone

indicated by the letter D so as to provide a maximum guiding action for the material of the tube as it is pressed around the curved intermediate section of the die passage. In practice, the projecting portion 32 of the plunger may be extended into close proximity to the zone indicated by the letter D.

In operation the mandrel 36 is located in the full line position and is retained in such position by the pin 42 which is inserted to extend through aligned openings in the mandrel and the side plates 44. The exact location of the ball head 38 of the mandrel is determined by adjustment of the abutment screw 66. As previously indicated the bed 10 is the bed of a hydraulic press and the plunger or punch 24 is associated with the hydraulically actuated movable press head so as to press the tubular element 70 from the position indicated in dotted lines in Figure 2 to the full line position illustrated therein. It will be observed that movement of the plunger 24 forces one end portion of the tubular element around the curved intermediate portion of the die passage and through the annular space defined between the ball head 38 and the adjacent surfaces of the die passage. The portion of the tubular blank which is thus forced through the annular passage is somewhat distorted and will assume a shape somewhat as illustrated in Figure 2. To complete the elbow the pin 42 is removed and the mandrel is moved to the right by suitable means. In the simplified illustrative form of the invention disclosed herein movement of the mandrel may be accomplished by rotation of the nut 62 so as to move the ball head 38 outwardly through the distorted end of the elbow. Thereafter, the two halves 14*a* and 14*b* of the die structure may be separated and the completed elbow removed. At this time the elbow will have the shape as illustrated at 80 in Figure 4 and to complete it will require only trimming of the irregular end 82.

It will be observed that the upper portion of the tubular element 70 is confined in the space between the reduced portion 28 of the plunger and the adjacent surface of the die passage, and that accordingly the wall thickness of the tubular element at its upper end cannot be substantially increased. Moreover, the elbow is formed without serious thinning of the wall of the elbow at the outside of the radius due to the excess stock provided by the long side 76 of the tubular element.

The guide surface S intermediate the head 38 and the reduced neck 40 of the mandrel serves to shape and guide the portion of the elbow at the inside of its radius to the shape illustrated in Figure 2, and withdrawal of the head of the mandrel further shapes this surface to the abruptly curved radius illustrated in Figures 2 and 4.

The operation results in forming the outer radius of the elbow in compression by forcing the stock between the die recess and head 38. This tends to thicken the wall of the elbow where it would normally become thin. At the same time the small inside radius is substantially formed in tension by withdrawal of the mandrel.

It will be appreciated that the illustration of the present invention is simplified for clarity and that in actual operation automatic means may be provided for locating and moving the mandrel in order to speed up production. However, the operating principles are illustrated by the simplified structure disclosed herein and the changes necessary to make the operation more fully automatic are within the scope of the present invention.

While the invention has been described in conjunction with forming cylindrical tubing, it will be apparent that it is applicable to other tubular stock, such as square, oval, etc.

The drawings and the foregoing specification constitute a description of the improved method and apparatus for making short radius elbows in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. Apparatus for forming elbows from tubular open ended elements comprising a die having an elongated passage extending therethrough, said passage consisting of two angularly related straight end portions and a curved intermediate portion connecting said end portions, a plunger movable into one straight end portion of said passage and having a reduced end portion dimensioned to fit within a tubular element which in turn fits within said passage, the reduced end portion being dimensioned to extend at least partly into the curved intermediate portion of said passage, and having a concavity at its end, said plunger having a shoulder engageable with the end of such tubular element, a mandrel having a partly spherical head adapted to be located within the curved intermediate portion of said passage and to define therewith an annular space, means for forcing said plunger into one end of said passage, means for supporting said mandrel for movement into the other end of said passage and for movement laterally thereof to provide for movement of said head into the curved intermediate portion of said passage and partly into said concavity, means for holding said head in said curved intermediate portion during movement of said plunger into the said one end of said passage and for withdrawing said mandrel to cause its head to smooth out the portion of said tubular element which was forced around the curved intermediate portion of said passage.

2. Apparatus as defined in claim 1 in which said passage is of substantially uniform circular cross-section.

3. Apparatus as defined in claim 2 in which said mandrel includes a neck of reduced diameter.

4. Apparatus as defined in claim 3 in which the side of said neck at the inside of the curved portion of said passage is shaped to provide a concave curve of a radius substantially in excess of the inside radius of the curved portion of said passage.

5. Apparatus as defined in claim 1 in which the means for supporting said mandrel comprises a pivot support therefor, and an adjustable abutment engageable with said mandrel to provide for adjustment of said head transversely of said passage.

6. Apparatus as defined in claim 5, said pivot means comprising a removable pivot element engageable with said mandrel to hold said mandrel in position during inward movement of said plunger, said pivot element being removable to provide for withdrawal of said mandrel from said passage.

7. Apparatus as defined in claim 1 in which said head has transverse dimensions smaller than the corresponding transverse dimensions of said passage by an amount slightly in excess of twice the nominal wall thickness of the tubular elements to be shaped.

8. Apparatus for forming elbows from tubular stock comprising a two-piece die having an elongated passage extending therethrough, said passage comprising two angularly related straight end portions and a curved intermediate portion connecting said end portions, a plunger movable in a working stroke into one straight end portion of said passage and having a reduced end dimensioned to fit within a tubular element which in turn fits within said passage, a shoulder at the inner end of the reduced portion of said plunger, said plunger being dimensioned to cause the end of its reduced end portion to extend partly within the curved intermediate portion of said passage at the end of its working stroke, a mandrel having a partly spherical head movable through the other straight portion of said passage to a fixed position partly within the curved intermediate portion of said passage, the end of the reduced end portion of said plunger having a recess adapted to receive a portion of said head, means for supporting said head rigidly in said fixed position in said passage, means for moving said plunger in its working stroke to force a tubular element partly around the intermediate curved portion of said passage

to a position in which said head is partly received in said recess, and means for withdrawing said mandrel to cause its head to smooth out the portion of said tubular element which was forced around the curved intermediate portion of said passage.

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