Oct. 3, 1967 F. SASSAK 3,344,639

TUBE BENDING MACHINE AND MANDRIL ASSEMBLY

Filed Dec. 15, 1964 3 Sheets-Sheet 1

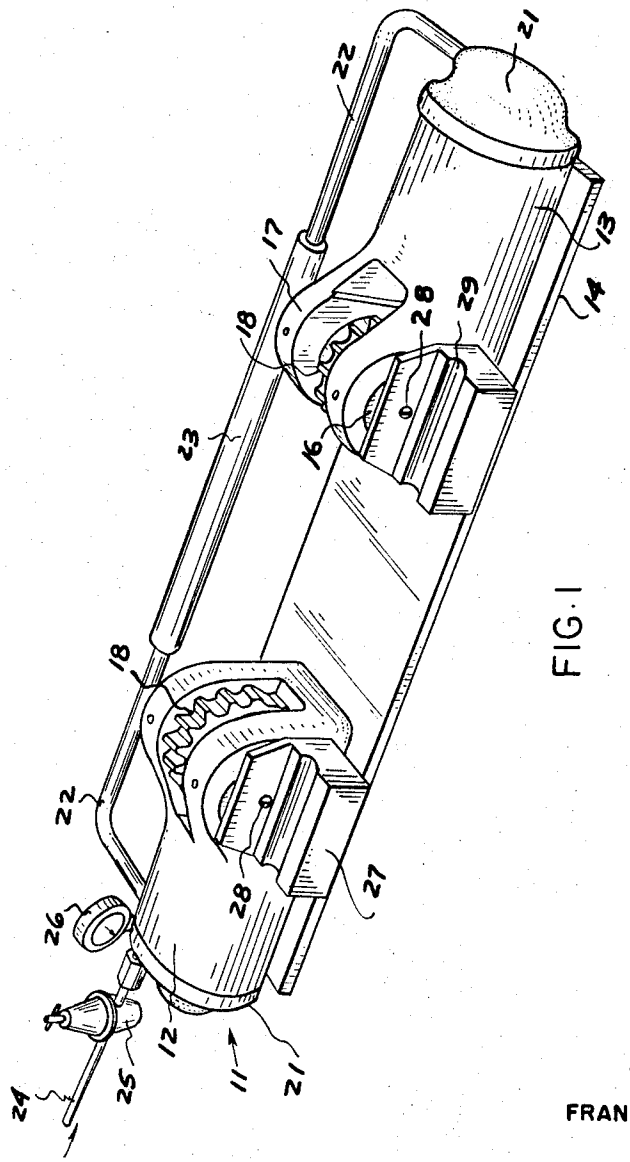


FIG. 1

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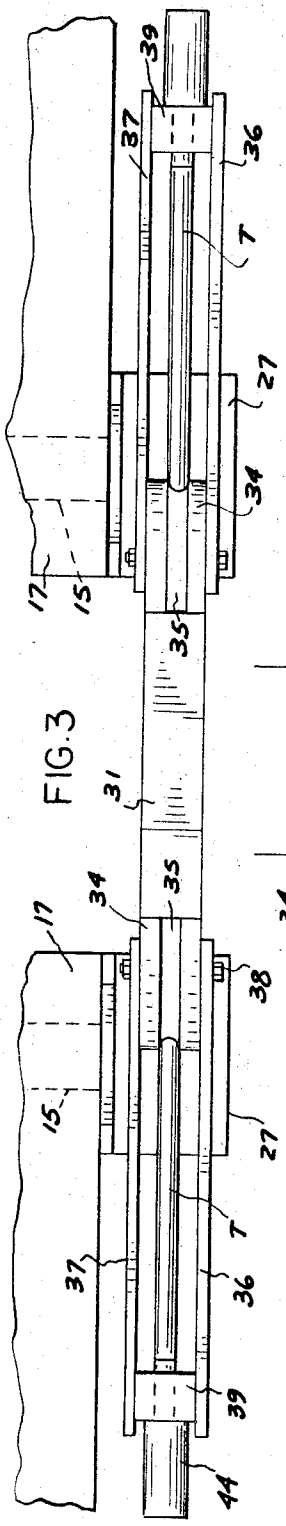


FIG. 3

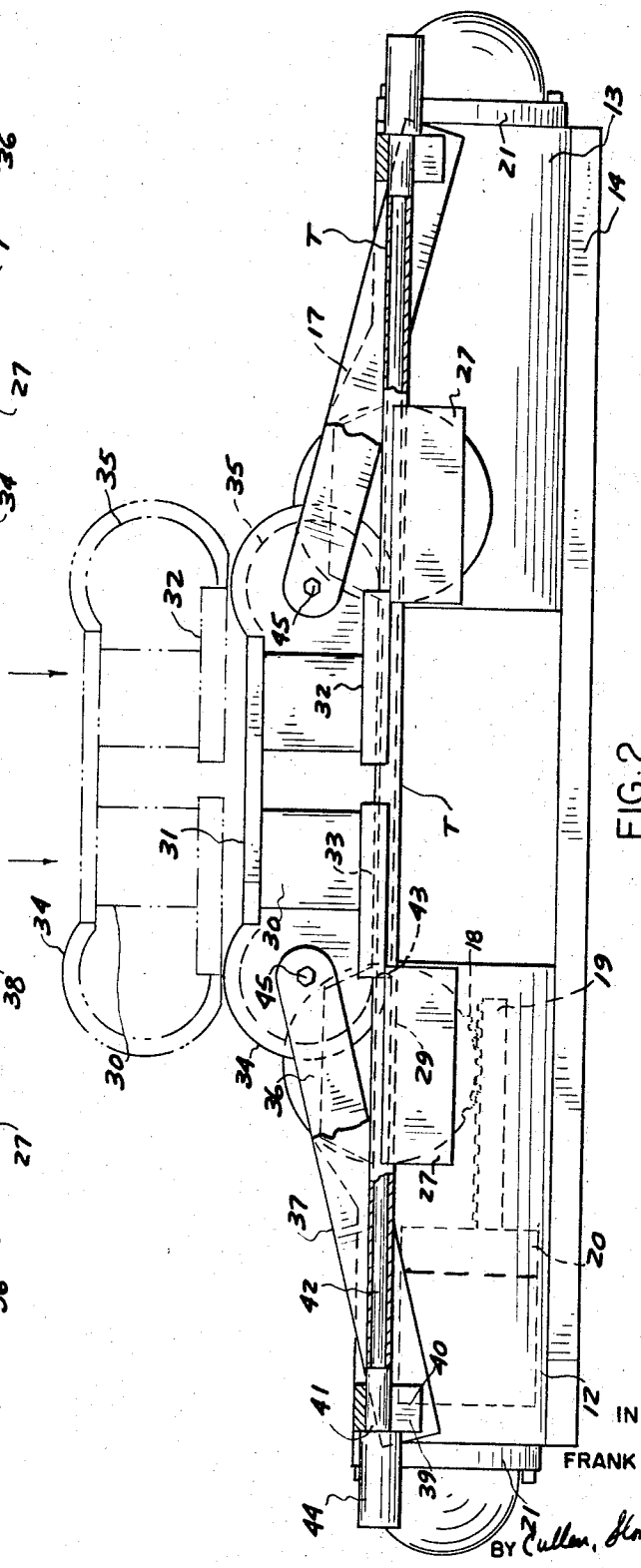


FIG. 2

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TUBE BENDING MACHINE AND MANDRIL ASSEMBLY

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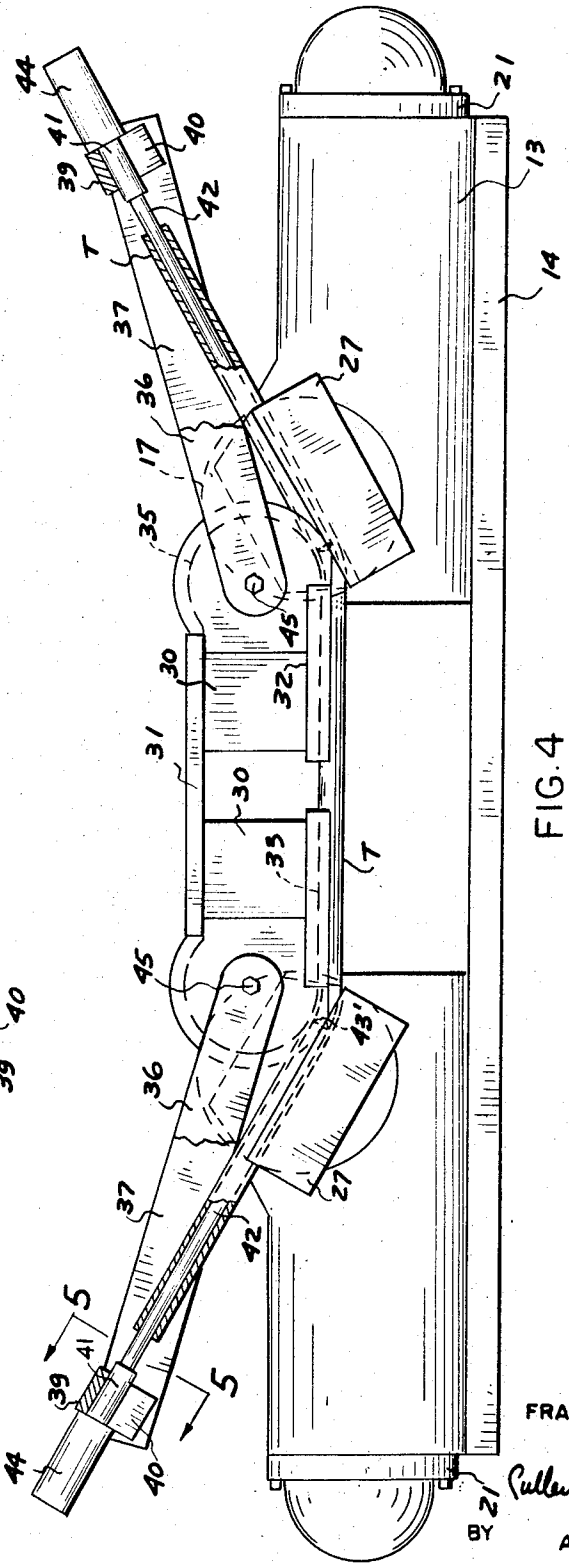


FIG. 4

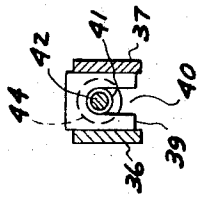


FIG. 5

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TUBE BENDING MACHINE AND MANDRIL ASSEMBLY

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Filed Dec. 15, 1964, Ser. No. 418,399
1 Claim. (Cl. 72—150)

ABSTRACT OF THE DISCLOSURE

A tube bending machine is provided with an upper die-mounted linkage for automatically withdrawing a mandril at a controlled rate from the tube as it is bent to permit the mandril to maintain position adjacent the shifting point of tangency between the tube and the upper die as the tube wraps around the die.

The present invention relates to tube bending machines of the type disclosed in my co-pending patent application, Ser. No. 350,355, filed Mar. 9, 1964, now U.S. Patent No. 3,306,093, issued Feb. 28, 1967.

Heretofore, in the bending of tubes and pipes various mechanisms have been employed to prevent buckling of the tube and for maintaining a constant internal and exterior diameter. Devices of this type have been ineffective, cumbersome or too costly.

It is an object of the present invention to provide an improved tube bending machine together with a mandril assembly projected down into the tube ends to prevent buckling during bending and with means for effecting outward movement of the mandril during bending so that the inner end portion of each mandril is always outwardly of and tangent to the curved portion of the tube being bent.

It is an object of the invention to provide in a tube bending machine a novel mandril assembly together with means for controlling the location of the mandril during bending.

These and other objects will be seen from the following specification and claim in conjunction with the appended drawings in which:

FIG. 1 is a front perspective view of a portion of the present tube bending machine with the die blocks in normal inoperative tube support position before the bending operation.

FIG. 2 is a front elevational view thereof with the associated forming die on the movable platen of a press.

FIG. 3 is a fragmentary plan view thereof.

FIG. 4 is similar to FIG. 2, but with the movable die moved downwardly in the tube bending operation.

FIG. 5 is a section taken on line 5—5 of FIG. 4.

It will be understood that the above drawings illustrate merely a preferred embodiment of the invention, and that other embodiments are contemplated within the scope of the claims hereafter set forth.

Referring to the drawings, FIGS. 1 and 3, a pair of spaced aligned support housings **12** and **13** form a part of the tube bending machine **11**, and are adjustably secured upon the bed **14** of a press.

Housings **12** and **13** include at their inner ends the upright spaced supports **17**. Shafts **15** at their ends are journaled within bearings **16** nested and retained within their respective upright supports **17**, all as fully set forth in detail in co-pending application No. 350,355.

Mounted upon each of the shafts **15** and between the supports **17** are the pinions **18**, FIGS. 1 and 2. Each pinion is in mesh with a longitudinally reciprocal rack gear **19** slidably mounted upon the interior of housings **12** and **13**. Said gears at their inner ends are connected to a piston

20 movably sealed within a cylinder bore upon the interior of housings **12** and **13**.

Housings **12** and **13** include cylinder heads **21** at their outer ends with suitable passages which communicate with the interior of said cylinder bores outwardly of the respective piston therein. The closed conduits **22** join the respective cylinder heads **21** and also join each other by the flexible tubing **23**, FIG. 1, which is provided since housings **12** and **13** are longitudinally adjustable with respect to each other upon support platen **14** and fixedly secured thereon, such as shown in copending application No. 350,355.

A source of air under pressure is delivered through pipe **24** through regulator **25** and pressure gauge **26**, which communicates with tubes **22** for providing an initial constant air pressure upon the interior of cylinder housings **12** outwardly of pistons **20** normally resisting outward movement of said pistons and providing a reactive pressure during bending.

Spaced aligned horizontally disposed rotatable die blocks **27** are journaled upon the exterior of housings **12** and **13** adjacent supports **17** being fixedly secured as at **28** to shafts **15**. Said die blocks are longitudinally grooved at **29** to support a tube T to be bent, FIG. 2. The radius of said grooves is substantially the same as the outside radius of tube T to provide support for said tube prior to and during the bending operation.

In the normal bending operation there is provided a pair of interconnected vertically reciprocal longitudinally spaced forming dies **32–34**. These are vertically aligned with die blocks **27** and are mountable upon vertically reciprocal platen **31** which forms a part of a conventional press. The die assembly includes supports **30**, FIG. 2, to which are secured the pairs of movable die elements **32, 34**.

A die of this type is provided wherein the tube to be bent will have a central straight portion and outwardly thereof the respective ends of the tube will be bent upwardly at a pre-determined angle. For this purpose the movable die elements include the spaced opposed aligned horizontally extending die portions **32** which terminate at their outer ends in the circular die portions **34**.

Die elements **32** have longitudinal grooves **33** in their undersurfaces adapted to cooperatively register with the straight portion of tube T, **33**. Said grooves correspond to the outside radius of said tube. The circular die elements **34** also have corresponding grooves **35** which merge with groove **33**, being of the same radius, for cooperative engagement with the tube during the bending operation, FIG. 4.

The center distance **45—45** between the circular die elements **34** is less than the center distance **28—28** between the rotatable die blocks **27**, FIG. 1.

In the normal operation of the tube bending machine as the movable dies **32–34** move downwardly from the retracted dotted line position, FIG. 2, to the solid line position and thence to the position shown in FIG. 4, the respective die blocks **27** will rotate to the angular position shown. This causes rotation of pinions **18** respectively on supports **17**. This also causes retraction of the rack gears **19** and connected pistons within the support cylinder housings **12** and **13**. These retracting movements are resisted by the compressed air upon the interior of said housings, as fully set forth in co-pending application No. 350,355.

In the present tube bending machine there are incorporated a pair of straight mandril rods **42** which adjacent their outer ends have sleeves **41** of increased diameter and terminate in handles **44** of still greater diameter. The individual mandril rods **42** are adapted to be snugly and slidably projected into opposite ends of tube T prior to

the bending operation, FIG. 2; and sleeves **41** operatively engage end portions of the tube limiting inward movement of the mandrils.

For a particular bending operation the inner ends **43**, FIG. 2, of the respective mandrils are in substantial vertical registry with the center of curvature of the circular dies **34** corresponding to the beginning of that portion of the tube which is to achieve a curvature during the bending operation.

The principle of operation is that as the tube end portions are bent upwardly towards the positions shown in FIG. 4, central portions of the tube T adjacent the straight portion shown in FIG. 2 and FIG. 4 will be curved upwardly corresponding to the radius of the circular dies **34–35**. This means that as the tube curves around the circular dies, the straight mandril **42** must be retracted so as to remain at all times tangent to the circular forming dies **34–35**, and to thus prevent buckling of the tube during bending.

For this purpose there are provided a pair of linkages. Each linkage includes a pair of parallel spaced elongated links **36–37**, FIGS. 2 and 3 which have secured therebetween at their outer ends the control block **39**. Said control block has a vertical slot **40** to cooperatively receive sleeve **41**, FIGS. 2 and 5. The slot **40**, however, is of a width less than the diameter of handle **44** so that block **39** is adapted to operatively engage the handle for effecting outward movement of the mandril rods as required and during the forming operation. The respective spaced inner ends of links **36–37** are pivotally mounted at **45** to the center of curvature of the vertically movable dies **34**.

Accordingly, upon downward movement of platen **31** and die assembly **32–34** there will be an upward bending movement of the free ends of tube **T** such as to the position shown in FIG. 4.

Thus, as the central inner portions of the tube are being bent the respective blocks **39** are effective to operatively engage the respective mandril handles **44** for retracting the same so that the inner end portion **43**, in FIG. 2, within the tube has now become retracted as at **43'**, FIG. 4, so as to remain within the straight portion of the tube T.

This position is at all times tangent to the forming die **34** and to the curved portion of the tube as it is formed. As the tube bends, its straight portion is shortened. Block **39** through links **36–37** stays at a constant distance from center **45**.

Thus, during the downward forming movement of dies **32–34** and the upward formation of the tube ends, mandrils **42** are automatically retracted.

The length of linkage **36–37** remains constant. Thus,

upward bending movement of the tube ends pivots the linkages **36–37** upward and causes a retracting movement of the mandril rods **42** continuously during the process of bending.

Having described my invention, reference should now be had to the following claim.

I claim:

In a tube bending machine characterized by an upper vertically reciprocable arcuate die and a straight lower die block rotatably and adjustably secured to the bed of the machine, beneath the upper die on an axis of rotation offset from the path of the center of curvature of the upper die, the improved means for preventing cross-sectional distortion in the bend zone of a tube being bent which comprises:

a mandrel having an inner end adapted to be inserted into a tube to be bent and an outer end;

a mandrel-positioning link pivotally mounted at one end to the upper arcuate die at the center of curvature thereof, the opposite end of said link being removably secured to said outer end of said mandrel;

the point at which said link is secured to said mandrel being so positioned along the length of said mandrel that, when said mandrel is inserted in a tube lying on the lower die block, said mandrel inner end lies substantially at the point of tangency of the tube and the upper arcuate die;

whereby when the upper arcuate die is driven downwardly into engagement with the tube, causing the lower die to pivot and the tube to bend, the swinging of the free end of the tube and said mandrel causes said link also to pivot, the pivoting of said link effecting a controlled withdrawal of said mandrel from the zone of the bend, such that said mandrel inner end remains at said tangency point as said tangency point shifts during the bending of the tube.

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