

[54] TUBE BENDING APPARATUS

[72] Inventor: Ernest C. Sindelar, Sugar Grove, Ill.
[73] Assignee: Pines Engineering Co., Inc.
[22] Filed: Oct. 10, 1969
[21] Appl. No.: 865,287

[52] U.S. Cl. 72/150, 72/310
[51] Int. Cl. B21d 9/05, B21d 5/04
[58] Field of Search 72/150, 310, 319, 387

[56] References Cited

UNITED STATES PATENTS			
588,223	8/1897	Fowler.....	72/150
2,777,500	1/1957	Ekholm	72/310
812,258	2/1906	Brinkman.....	72/150
2,740,454	4/1956	Fuchs	72/150

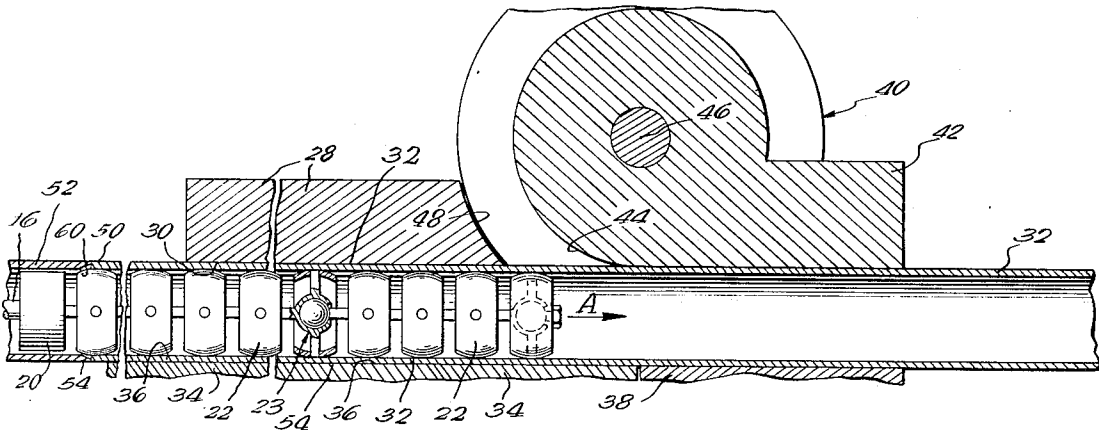
3,118,488 1/1964 Barnhill 72/319
3,456,482 7/1969 Maier 72/150

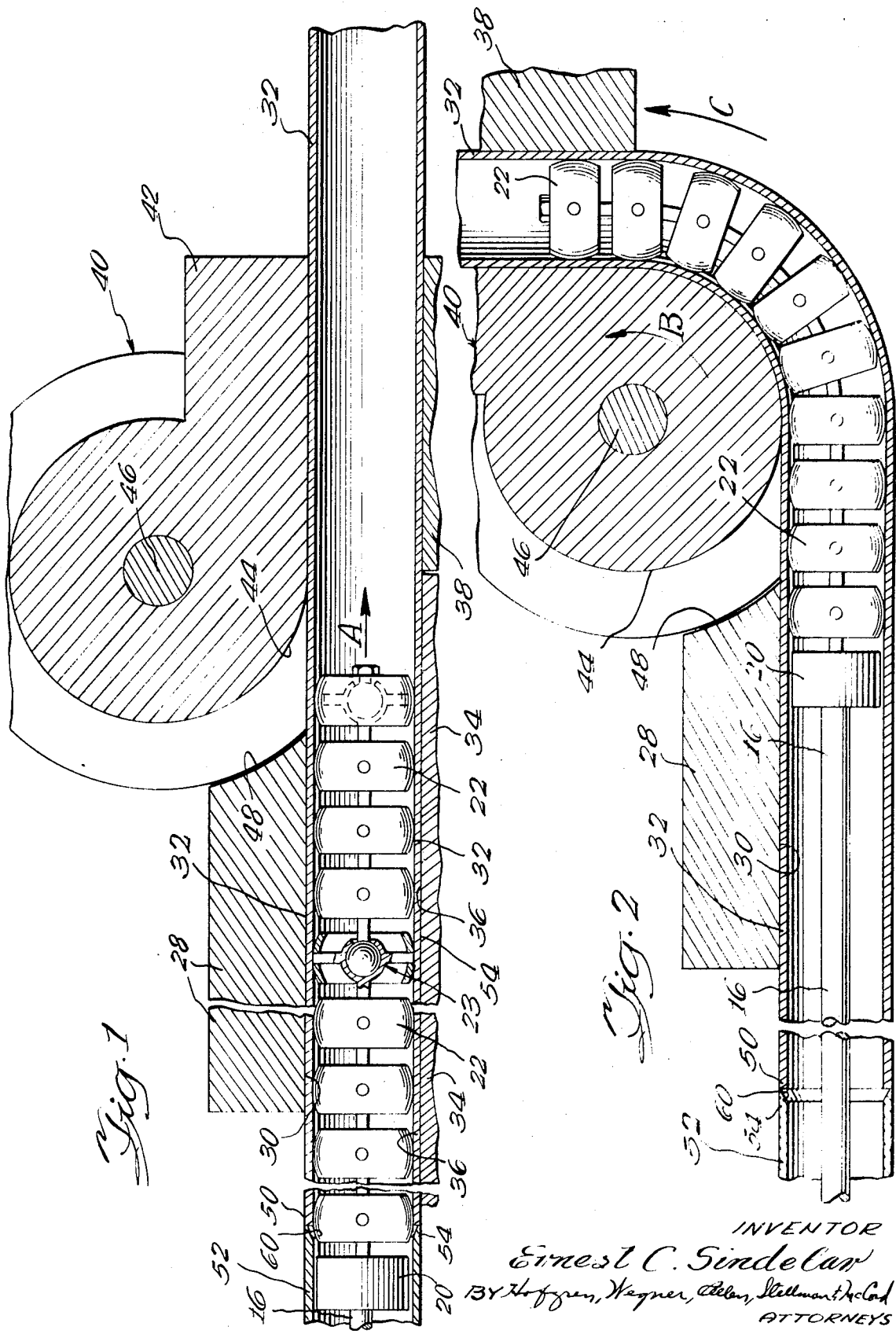
Primary Examiner—Charles W. Lanham
Assistant Examiner—R. M. Rogers
Attorney—Hofgren, Wegner, Allen, Stelman & McCord

[57] ABSTRACT

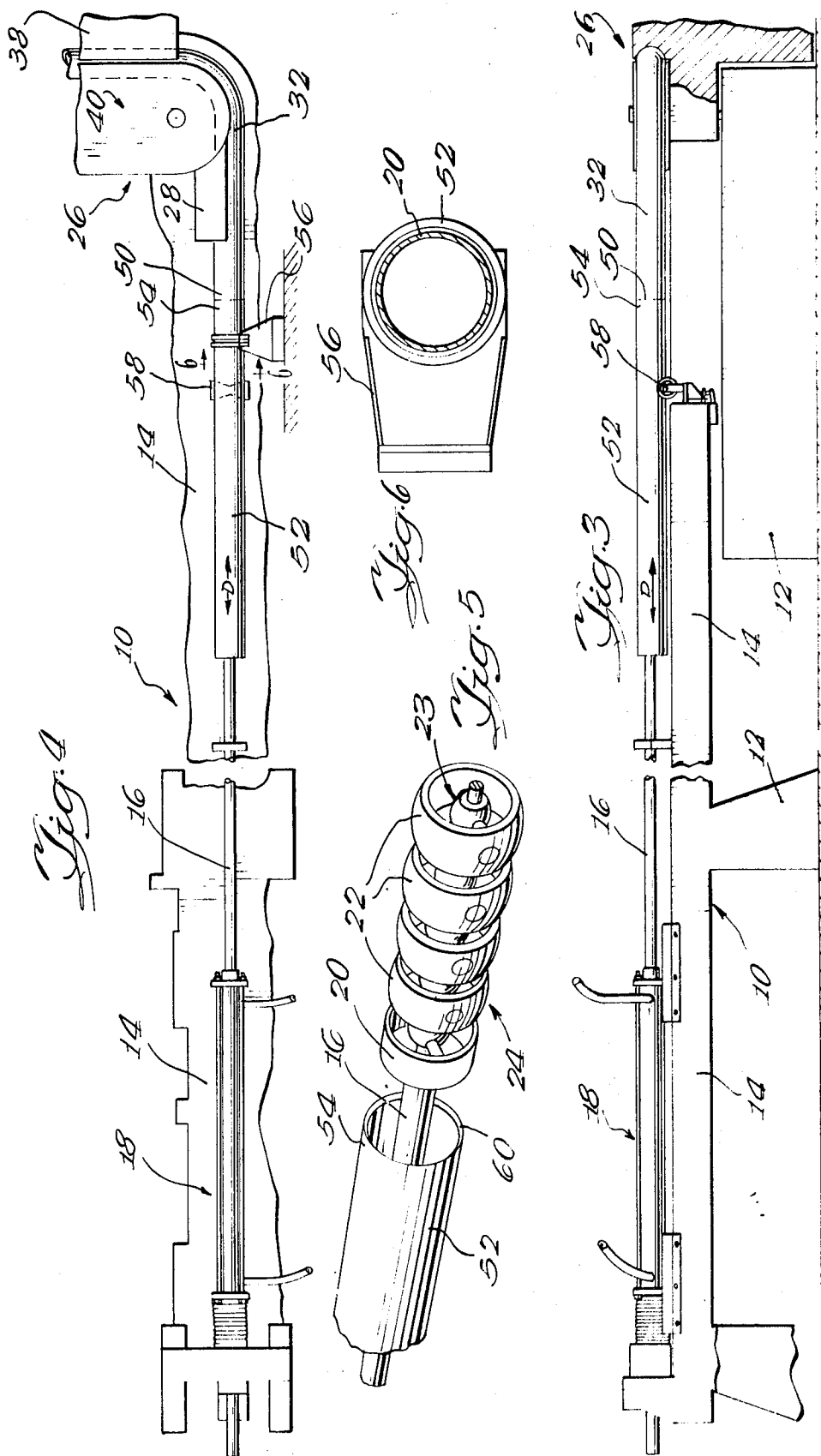
In an apparatus for producing bends in tubing, including a flexible mandrel movable axially into and out of one end of tubing disposed in position on the apparatus for bending. The mandrel has a plurality of mandrel balls universally mounted in a chain whereby the mandrel balls are unsupported against gravity on the end of the mandrel. A cylindrical reload member is disposed adjacent the one end of the positioned tubing for receiving the mandrel and orienting the mandrel balls when outside of the positioned tubing to align the mandrel balls for insertion into the tubing.

10 Claims, 6 Drawing Figures





INVENTOR
Ernest C. Sindelar
BY Hoffman, Wagner, DeLong, Stillman & Co.
ATTORNEYS



TUBE BENDING APPARATUS

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to the art of manufacturing tubing, and more particularly with the bending of hollow tubing.

It has long been recognized that the bending of tubing is a difficult operation. Solid rods can be bent with relative ease, but when hollow tubes are bent, there is a definite tendency for a circular cross section to become oval in the curve or bent part of the tube. More specifically, the inner radius of the bent portion of the tubing will wrinkle or the outer radius will form less than a true circular arc. Both of these conditions are undesirable because they reduce the cross sectional area of the tube through the bend and they weaken the tubing less than the strength that is afforded by a circular cross section.

To solve these problems of bending hollow tubing, external bending dies have been employed to bend the tubing, with an internal flexible mandrel positioned within the tubing at least at the bent portion thereof. Such flexible mandrels generally consist of a number of interconnected balls which counteract the ovaling of the tubing. The balls are universally mounted in a chain on the end of the mandrel which is inserted into one end of the tubing positioned in the bending dies and, therefore, the mandrel balls are unsupported against gravity and normally hang downwardly from the end of the mandrel when outside of the tubing. With relatively small diameter tubing, relatively small mandrel balls are employed and are easily hand manipulated for insertion into the one end of tubing disposed in position for bending. However, with large diameter tubing, such as large diameter titanium tubes which are used in the airline industry, large, heavy mandrel balls are required to prevent ovaling of the large diameter tubing, and the repositioning or reloading of the flexible mandrel into one end of the positioned tubing is quite different and cumbersome. In fact, a single mandrel ball for a 7-inch diameter tube, for instance, might weigh as much as 20 lbs. In some instances, a mandrel may employ as many as 10-15 mandrel balls. Thus, in order to reposition or reload the flexible mandrel into the open end of the positioned tubing, a number of workers must lift and orient the balls generally coaxially with the positioned tubing and guide the balls into the tubing as a reciprocating ram or piston and cylinder device moves the flexible mandrel fully into the positioned tubing. Not only is this procedure difficult, but it is dangerous to the workers and, if not performed properly, could cause damage to the open end of the positioned tubing.

The principal object, therefore, of the present invention is to provide an improvement in an apparatus for producing bends in tubing to eliminate the problems and difficulties inherent in handling heavy flexible mandrels.

Another object of the invention is to provide in an apparatus for producing bends in tubing, a reload means disposed adjacent one end of tubing positioned on the apparatus for bending for orienting the flexible mandrel when outside of the positioned tubing to align the flexible mandrel for insertion into the tubing.

A further object of the invention is to provide a reload means as set forth in the preceding paragraph which automatically aligns the flexible mandrel for reinsertion into positioned tubing as a result of the withdrawal of the flexible mandrel from previously bent tubing.

Still another object of the invention is to provide a reload means for flexible mandrels of the type having at least one member universally mounted on the outer end of the mandrel whereby the member is unsupported against gravity, the reload means comprising support means adjacent the open end of the positioned tubing to support the member against gravity when outside of the tubing and align the member with the adjacent end of the positioned tubing.

In the embodiment of the invention illustrated herein, the flexible mandrel is of the type which includes a plurality of mandrel balls universally mounted on the outer end of the mandrel for insertion into one end of positioned tubing, and

the support means comprises a cylindrical member through which the mandrel reciprocates into and out of the positioned tubing, the cylindrical member having an open end adjacent the inserting end of the positioned tubing and adapted to receive the mandrel and mandrel balls when retracted from the positioned tubing after bending. The cylindrical member is disposed generally coaxially with the axis of the positioned tubing and the interior of the cylindrical member is of the same size as the interior of the tubing. Preferably, the open end of the cylindrical member adjacent the tubing is chamfered to provide a cam means to facilitate guiding the mandrel balls into the cylindrical member on retraction from the bent tubing.

Other objects, features and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 is a horizontal sectional view through a length of tubing and the dies of a bending apparatus before bending of the tubing;

FIG. 2 is a view similar to FIG. 1 with the parts moved to effect a right angle bend of the tubing;

FIG. 3 is an elevational view, partially cut away and on a reduced scale, of an apparatus for producing bends in tubing, incorporating the reload means of the present invention;

FIG. 4 is a top plan view, partially cut away, of the apparatus shown in FIG. 3;

FIG. 5 is a perspective view of a flexible mandrel having mandrel balls and positioned outside of one end of the reload cylindrical member of the present invention; and

FIG. 6 is a sectional view, on an enlarged scale, taken generally along the line 6—6 of FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

Referring now in greater particularity to the drawings, and first to FIGS. 3 and 4 for a general understanding of the machine, there will be seen a base, generally designated 10, which comprises pedestal means 12 (FIG. 3) and a bed 14. A mandrel shaft or rod 16 extends substantially from end to end of the bed and is spaced thereabove. A hydraulic operating system, generally designated 18, including a cylinder and piston is connected to one end of the mandrel rod 16 for effecting controlled reciprocating movement thereof. Control can be effected by manual manipulation of valves, but preferably is effected by automatic sequence controls within the base, in conventional manner. Any detailed consideration thereof is believed to be superfluous.

The end of the mandrel rod 16 opposite the hydraulic operating system 18 is provided with an enlarged cylindrical plug 20, as best may be seen in FIGS. 1, 2 and 5. A plurality of members 22 generally referred to as mandrel balls are universally connected to one another in conventional manner, as at 23 in FIGS. 1 and 5 in a chain and to the plug 20, the balls and plug forming a flexible mandrel, generally designated 24 in FIG. 5, which is flexible at least in part.

At the end of the bed 14 opposite the hydraulic operating system 18 is mounted a bending mechanism, generally designated 26. The bending mechanism is of conventional structure and comprises a wiper die 28 (FIGS. 1 and 2) having a semicircular groove 30 for clamping a tube 32. The bending mechanism also includes a clamp die 34 mounted generally opposite the wiper die and is provided with a semicircular longitudinally extending groove 36 for engaging the tube 32. A pressure die 38 is mounted adjacent the clamp die 34. Opposite the pressure die 38 and adjacent the wiper die 28 there is provided a bending form, generally designated 40. This bending form is generally circular in configuration with a tangent clamping portion or bending die 42. As is known in the art, a circumferential groove 44 extends around the bending form 40 and also along the bending die 42. The bending die is arranged in alignment with the pressure die 38 so that the tube

32 can be clamped therebetween. The bending form 40 is mounted for pivoting movement about an axis or pivot shaft 46. The wiper die 28 has an arcuate edge 48 for cooperating with the bending form 40.

Before going into the details of the reload means of this invention, specific reference now will be made to the bending operation. First, a tube 32 is placed between the wiper die 28, clamp die 34, pressure die 38, and bending die 42 and the dies are brought to the position shown in FIG. 1 to clamp and hold the tube 32 therebetween. The flexible mandrel 24 is then inserted into the end 50 of the tube 32 in the direction of arrow A (FIG. 1). The bending form 40 (with bending die 42) and pressure die 38 are then rotated in the direction of arrows B and C, respectively, (FIG. 2) so as to effect a bend in the tube, a right angle bend being shown in FIG. 2. The mandrel balls 22 prevent ovaling of the tube, as set forth above.

The reload means of the present invention comprises a cylindrical member 52 through which extends the mandrel rod 16, as shown best in FIGS. 3 and 4. The cylindrical member is open ended and has an open end 54 (FIGS. 1 and 2) adjacent the end 50 of the positioned tube 32 and is adapted to receive the flexible mandrel 24 when retracted from the tubing, opposite the direction of arrow A (FIG. 1), after the tubing has been bent as shown in FIG. 2. The cylindrical member is releasably clamped in position by a clamp means 56 (FIGS. 3, 4, and 6) and is supported on a roller 58. The cylindrical member is disposed generally coaxially with the end 50 of the positioned tubing 32 and preferably has an interior size or diameter the same as the size of the tubing to be bent. The open end 54 of the cylindrical member 52 is chamfered as at 60 in FIGS. 1 and 2 to provide a cam means to facilitate guiding or reloading the mandrel balls 22 thereinto on retraction from the tubing.

The reload tube or cylindrical member 52 is adjustable, by releasing clamp 56, for axial movement back and forth in the direction of arrows D (FIGS. 1 and 2). This adjustment is necessary to maintain the open end 54 of the cylindrical member closely adjacent the end 50 of positioned tubing due to the fact that various lengths of tubing may be bent at various positions along their lengths. In addition, the end 50 of any particular length of tubing may be disposed at various axial positions relative to the cylindrical member 52 because the bend itself may be formed at various axial positions along the length of tubing.

Flexible mandrels of the type referred to herein actually are flexible only in directions transverse to the mandrel rod 16. When the mandrel balls are aligned coaxially with rod 16 as shown in FIG. 1, the flexible mandrel may be pushed or pulled by the reciprocating mandrel rod just as if the mandrel was an extension of the rod. Thus, once the flexible mandrel is initially loaded into the cylindrical member 52, and as long as the mandrel is maintained positioned within the cylindrical member when not inserted into positioned tubing, the mandrel will always be aligned for reinsertion into the next length of positioned tubing. With the open end 54 of the cylindrical member maintained closely adjacent the end 50 of the tubing, the mandrel balls will be aligned automatically on retraction of the mandrel from the tubing after it has been bent, and thus reloaded for the next length of tubing to be bent.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom as some modifications will be obvious to those skilled in the art.

I claim:

1. In an apparatus for producing bends in tubing, including a flexible mandrel mounted on shaft means for axial reciprocating

movement into and out of one end of tubing disposed in position on said apparatus for bending, the improvement comprising reload means for said flexible mandrel, said reload means being disposed adjacent said one end of said positioned tubing for orienting said flexible mandrel when outside of the positioned tubing to align the flexible mandrel for insertion into the tubing.

2. The apparatus of claim 1 wherein said reload means automatically aligns the flexible mandrel as a result of retracting the mandrel from said one end of the tubing.

3. The apparatus of claim 1 wherein said flexible mandrel is of the type having at least one member hingedly mounted on the end of the mandrel opposite said shaft means whereby said member is unsupported against gravity, and said reload means comprises support means adjacent said one end of the positioned tubing to support said member against gravity when outside said tubing and align the member with said one end of the positioned tubing.

4. The apparatus of claim 3 wherein said support means has means defining a support surface for supporting said member against gravity when outside said tubing, said surface being disposed generally at the same level as the lower interior wall of the positioned tubing.

5. The apparatus of claim 3 wherein said member is mounted on said one end of the mandrel for universal movement thereabout, and said support means has means defining an upwardly facing arcuate surface for supporting said member against gravity when outside said tubing, said arcuate surface having a radius of curvature substantially the same as the interior of said tubing and being disposed generally in line with a projection of the lower interior arcuate wall of the positioned tubing.

6. The apparatus of claim 3 wherein said member comprises a mandrel ball mounted for universal movement on said one end of said mandrel, and said support means comprises a cylindrical member through which said shaft means extends, said cylindrical member having an open end adjacent said one end of the positioned tubing and adapted to receive said mandrel and said member when outside of the positioned tubing.

7. The apparatus of claim 6 wherein said cylindrical member is disposed generally coaxially with said one end of the positioned tubing.

8. The apparatus of claim 7 wherein the interior of said cylindrical member is of the same size as the interior of said tubing.

9. The apparatus of claim 6 wherein said cylindrical member at said open end is chamfered to provide a cam means to facilitate reloading the mandrel ball thereinto on retraction from the tubing.

10. Tube bending apparatus comprising: means defining a fixed die adapted to receive a portion of a length of tubing; means defining a movable die adjacent said fixed die for receiving another portion of the length of tubing whereby movement of said movable die relative to said fixed die will bend said another portion of the length of tubing; means defining a flexible mandrel adapted to be received in said another portion of the length of tubing; means for moving said flexible mandrel along a path defined by a length of tubing received in said dies, and operable to move said flexible mandrel between a first position wholly withdrawn from a length of tubing received by said dies and a second position within said another portion of the length of tubing; and means for guiding and supporting said flexible mandrel during movement of the same to and from said first position up to a point of entry or exit from a length of tubing.

* * * * *