Dec. 26, 1967 J. K. FAULL 3,359,776

BENDING APPARATUS

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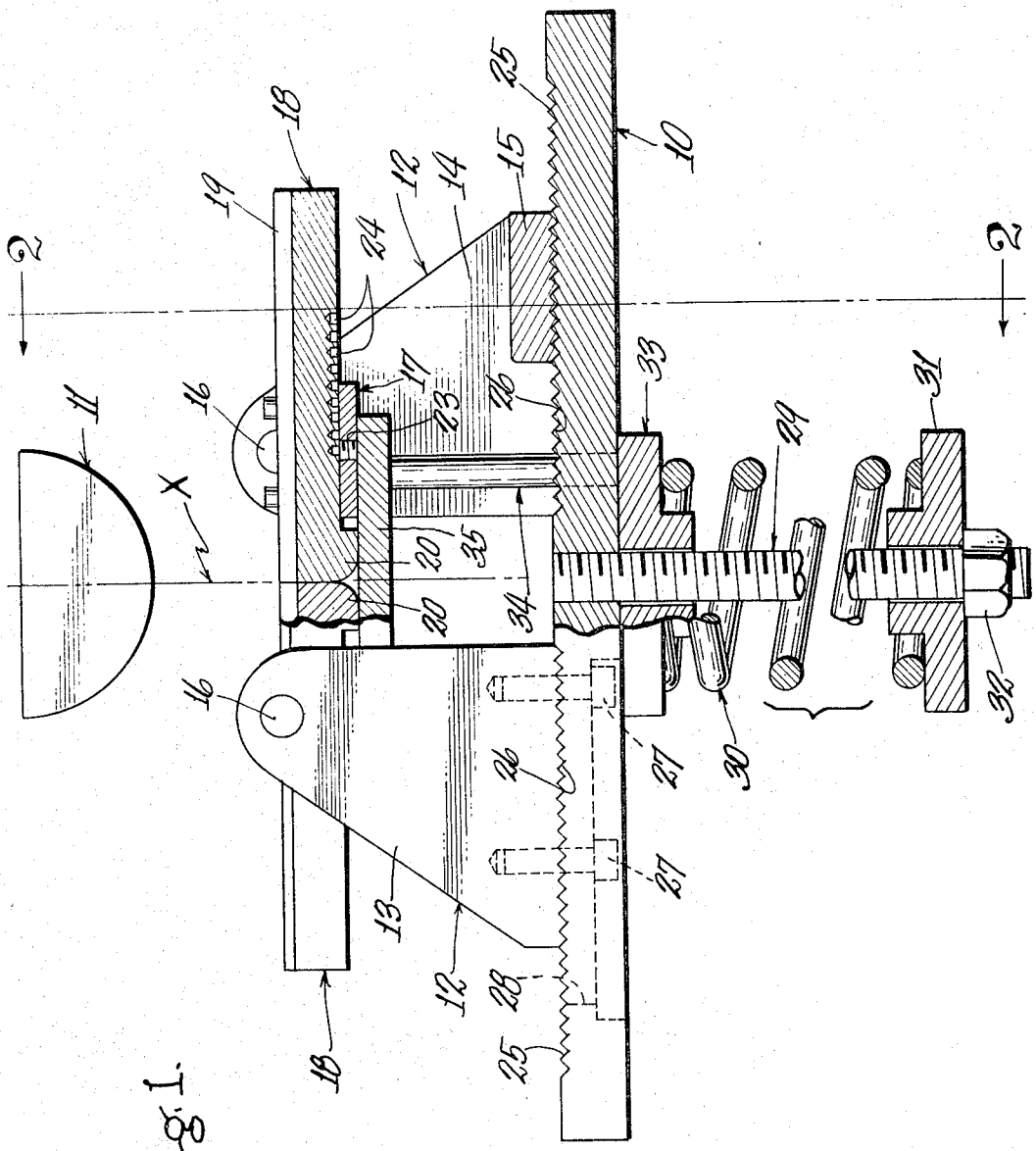


Fig. 1.

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Fig. 2.

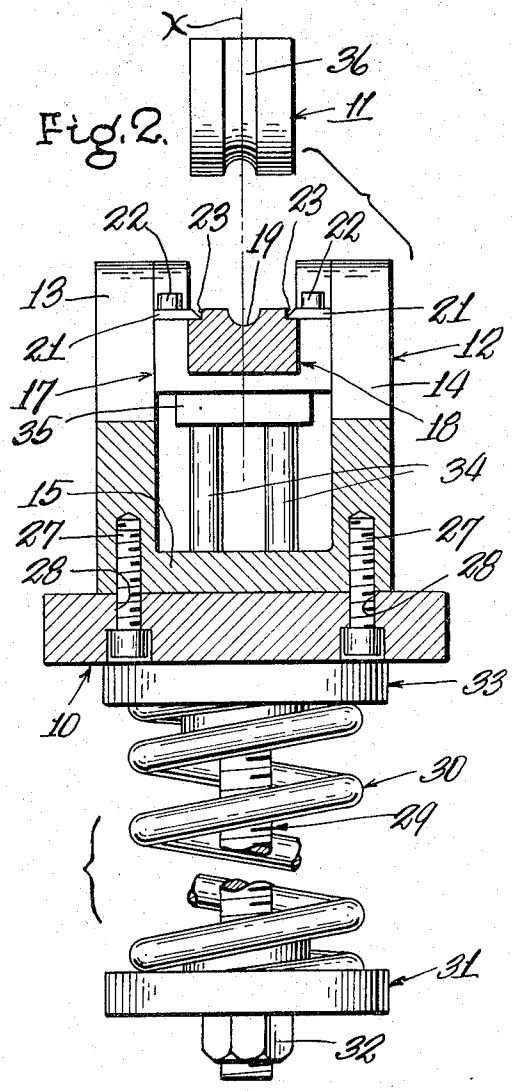


Fig. 3.

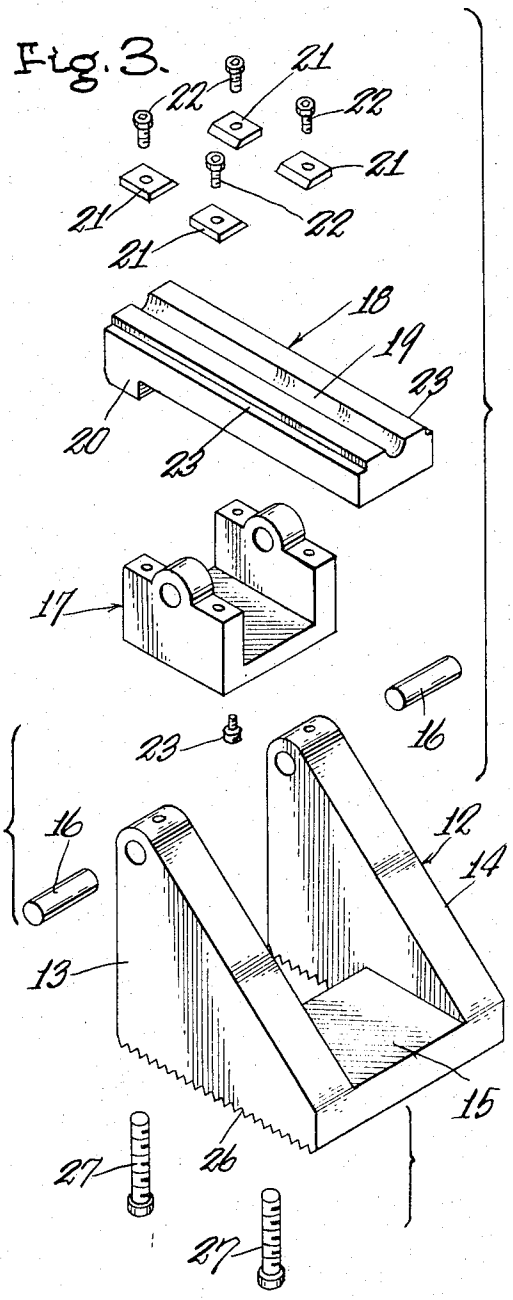
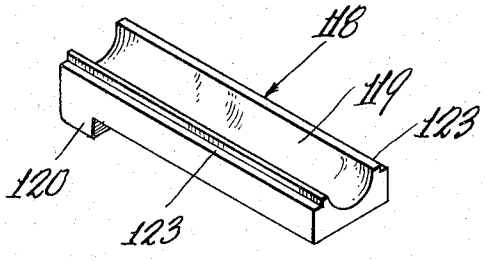


Fig. 7.



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Fig. 4.

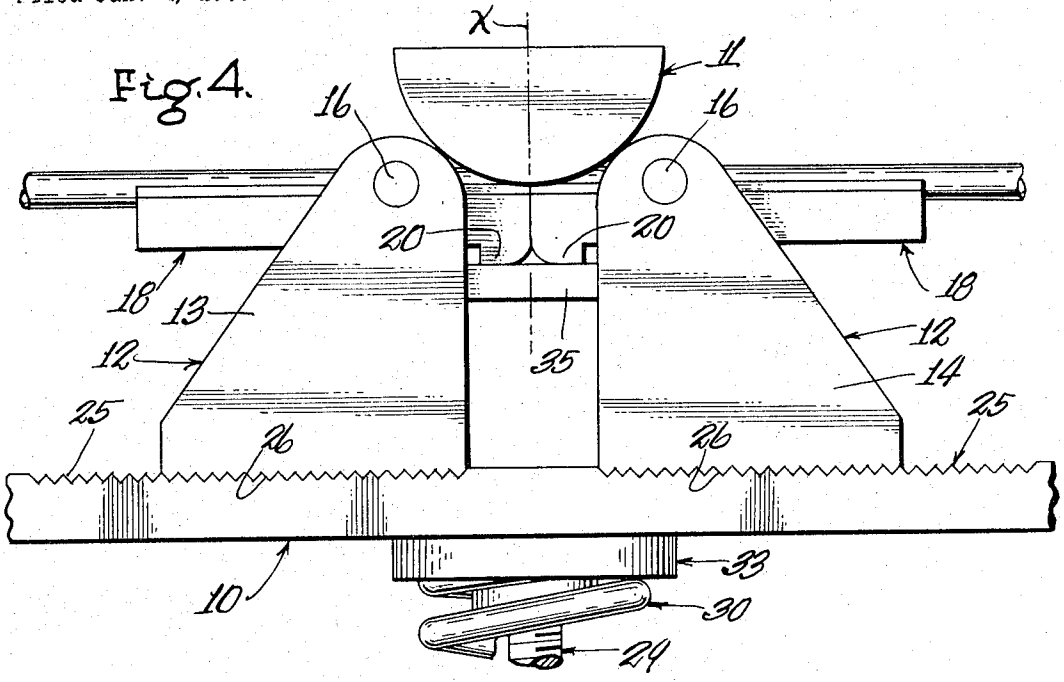
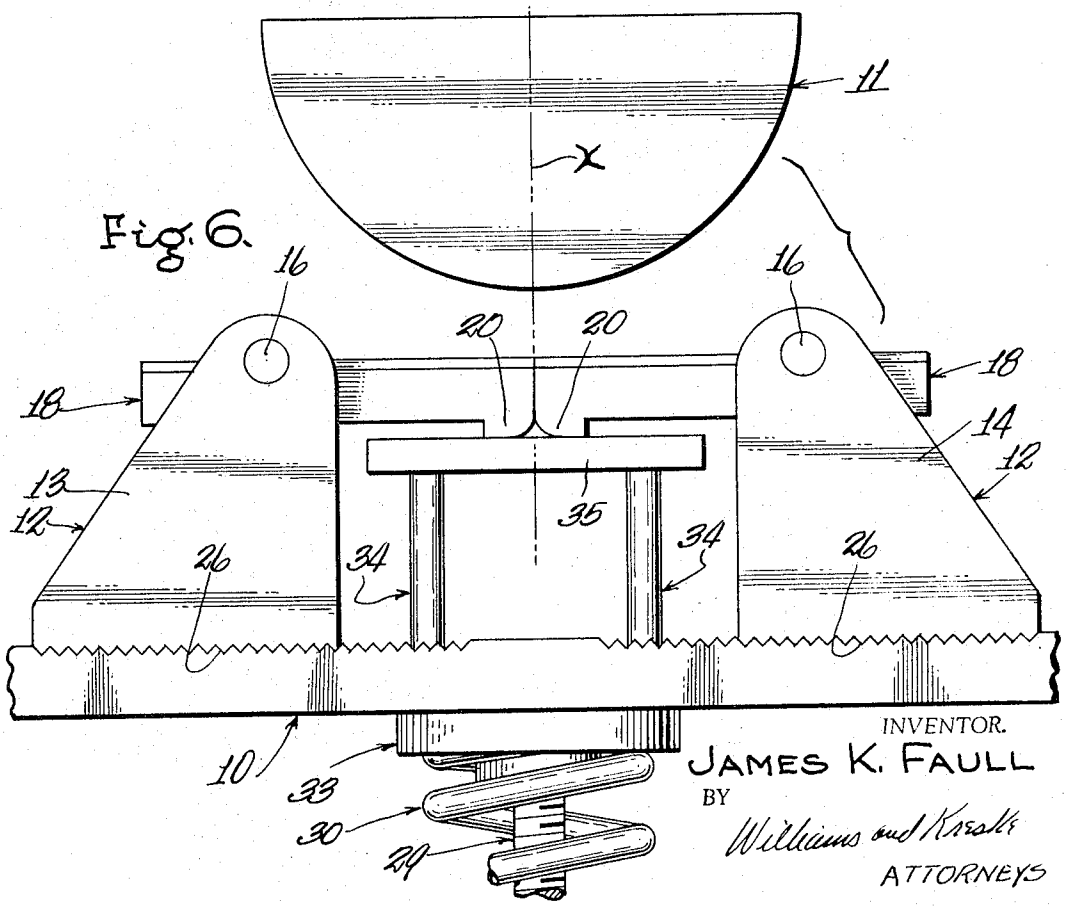


Fig. 6.



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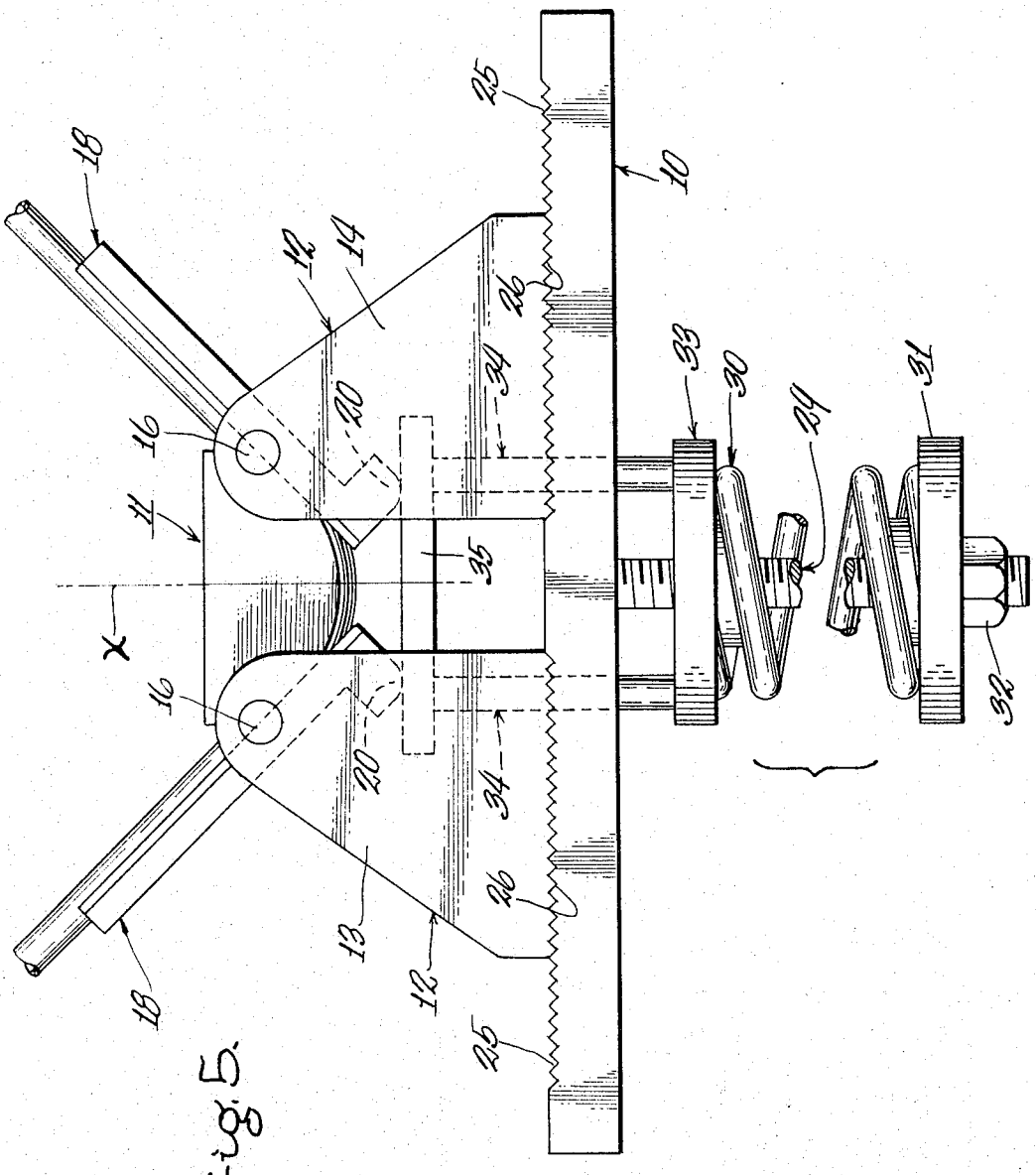


Fig. 5.

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BENDING APPARATUS

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13 Claims. (Cl. 72—389)

ABSTRACT OF THE DISCLOSURE

Tube bending apparatus in which the tube to be bent is gripped between a bending head and a pair of bending arms normally disposed in end-to-end abutting relation. The bending arms are respectively pivoted about axes spaced apart an amount equal to twice the radius to which the tube is to be bent and the spacing between the arm pivots is adjustable to accommodate various bend radii while maintaining the normal, end-to-end abutting relationship of the bending arms.

The present invention relates to bending apparatus, more particularly to tube bending apparatus, and the principal object of the invention is to provide new and improved apparatus of the character described.

While apparatus for production bending of tubing has been available heretofore, such apparatus, even though it functioned properly, has been less than completely satisfactory since it has been expensive due to its complexity and quite limited in its ability to bend tubing of various diameters to various bend radii. In many cases, a change of tubing diameter and/or change of bend radius required either separate apparatus or the time-consuming replacement of expensive parts in the basic apparatus.

In contrast, the present invention provides highly efficient bending apparatus which can readily bend various sizes of tubing to various bend radii by means of simple adjustments and by substitution of simple, low-cost parts. These and other advantages will readily become apparent from a study of the following description and from the drawings appended hereto.

In the drawings accompanying this specification and forming a part of this application there is shown for purpose of illustration, an embodiment which the invention may assume, and in these drawings:

FIGURE 1 is a broken, side elevational view of a preferred embodiment of the invention, parts on the near side being broken away to illustrate the underlying structure,

FIGURE 2 is a broken, sectional view generally corresponding to the line 2—2 of FIGURE 1.

FIGURE 3 is an exploded perspective view of certain details,

FIGURE 4 is a view similar to FIGURE 1 but showing the present device during a stage of a bending operation,

FIGURE 5 is a view similar to FIGURE 4 but showing the device during another state of a bending operation,

FIGURE 6 is a view similar to FIGURE 1 but showing the device as adjusted to bend to a larger radius, and

FIGURE 7 is a perspective view of a detail seen in FIGURE 3 but proportioned to accommodate a larger diameter tube to be bent.

With reference first to FIGURES 1 and 2, the present device comprises a base plate **10** which is adapted to be secured by any suitable means to the bed of a conventional press (not shown) and a bending head **11** adapted to be secured to the ram of such press for rectilinear movement along the axis or path of travel X toward and away from the base plate **10**.

Removably secured to the base plate **10** in upstanding relation on opposite sides of the path of travel of the head **11** are bifurcated stands **12**, each having spaced side

walls **13**, **14** joined together by a lower, transverse wall **15** which terminates short of the adjoining ends of the stands **12** to provide operating clearance for means to be disclosed. The upper portions of the side walls **13**, **14** of the stands **12**, see also FIGURE 3, provide aligned apertures for receiving stubs shafts **16** which pivotally secure cradles **17** to respective stands **12** between their side walls.

Mounted in each cradle **17** is a tube nest **18** each having an upwardly directed longitudinally extending rectilinear groove **19** for closely receiving the tube to be bent. Adjoining ends of the tube nests **18** have depending, rounded portions **20** for a purpose to appear. As best seen in FIGURES 2 and 3, the means presently provided for securing each tube nest to its cradle comprises flat, apertured clamp members **21** secured to respective cradles by screws **22** and having bevelled, overhanging end portions seated in respective, longitudinally extending rabbets **23** formed in opposite, upper sides of each tube nest. Means are provided for accurately locating each tube nest **18** within its cradle and with respect to the path of travel of the head **11**, and as shown in FIGURE 1, a dog point set screw **23** is threaded into the floor of each cradle and projects upwardly thereof for closely fitting within any one of a series of depressions **24** formed in the underside of each tube nest **18**.

Means are also provided for accurately and predeterminedly locating each stand **12** with respect to the path of travel of the bending head **11** and as best seen in FIGURES 1 and 3, the upper surface of the base plate **10** and the lower surfaces of the stands **12** have cooperable serrations **25**, **26** respectively, formed therein. Capscrews **27** project upwardly through the base plate **10** and are threaded into the stands **12** to secure the latter to the base plate, such screws passing through elongated slots **28** in the baseplate to provide the adjustment aforesaid of the stands.

Threaded into the base plate **10** and projecting downwardly therefrom is a threaded stud **29** encircled by a helical compression spring **30**. The lower end of spring **30** is seated against a washer **31** which is slidable along the stud **29** and a nut **32** is threaded on the stud and provides an adjustable abutment for the washer **31** for a purpose to be seen. The upper end of spring **30** bears against a disk **33** which is slidable along the stud **29** and, projecting upwardly of the disk and slidably extending through the plate **10**, are guide pins **34** to whose upper ends is secured a pressure pad **35**. In the position of parts seen in FIGURE 1, spring **30** yieldably maintains the disk **33** against the underside of base plate **10** to maintain the pressure pad **35** as shown wherein the tube nests **18** are supported with their grooves **19** in aligned relation. Nut **32**, of course, provides for adjustment of the spring pressure thus supporting the tube nests against rotation about their respective pivots.

With the parts positioned as seen in FIGURES 1 and 2, and noting that bending head **11** has an arcuate groove **36** aligned with the tube nest grooves **19** and also proportioned to closely receive the tube to be bent, such tube will be positioned within the tube nest grooves **19**. It should be noted at this time that the arcuate bending head has been chosen to provide the desired bend radius and that both the head and the tube nests have been chosen to provide the proper grooves required for the diameter of the tube being bent.

The stands **12** are shown positioned in opposed relation, each with its cradle pivot axis spaced from the axis of travel X of the bending head an amount equal to the radius to which the tube is to be bent. The tube nests **18** are shown adjusted on their cradles **17** so that they abut at the aforesaid axis of travel X of the head. It should be mentioned that in FIGURES 1 and 2, the apparatus is shown arranged to bend a relatively small diameter tube

to the smallest radius of bend within the range of the illustrated apparatus.

With the tube T (FIGURE 4) resting upon the tube nests **18** as previously described, the press ram (not shown) on which the bending head **11** is mounted will be activated to move such head downwardly. As the bending head reaches the position seen in FIGURE 4, its downward movement will tend to be arrested by the spring **30** holding up on the pressure pad **35**. The ram, however, will have sufficient power to overcome the resistance of spring **30** and thus will move the parts to the position seen in FIGURE 5 wherein the tube T has been bent approximately 90 degrees. In the event a lesser degree of bend is required, downward movement of the bending head will be arrested before the FIGURE 5 position is reached. Note that tilting movement of the tube nests **18** from the positions seen in FIGURE 4 to the positions seen in FIGURE 5 will be resisted by spring **30** whose exerted force for proper bending will be adjusted by the nut **32**.

Following bending of the tube **7** as above-described, the bending head **11** will be elevated to the position seen in FIGURE 1, spring **30** will return tube nests **18** and all the associated parts to the position seen therein, and the now bent tube will be removed and replaced by the next tube to be bent.

In the event a larger diameter tube is to be bent to the same radius as thus far disclosed, the tube nests **18** will each be removed from their cradles **17** and replaced by tube nests **118** (FIGURE 7) each having an appropriately sized larger groove **119** for closely receiving the larger diameter tube to be bent. Also, the bending head **11** will be replaced by one having an arcuate groove corresponding to groove **36** (FIGURE 2) but large enough to closely receive such larger diameter tube.

When a tube of the size shown in FIGURES 4 and 5 is to be bent to a larger radius, for example, the largest radius of bend within the range of the illustrated apparatus, the bending head **11** will be replaced with a bending head **211** having the desired larger bend radius. The stands **12** will be moved away from each other so that the cradle pivot axis of each is spaced from the axis of travel X of the head an amount equal to the desired bend radius. The tube nests **18** will need not be replaced so long as there is no change of tube size but they will be adjusted in their cradles so that their adjoining ends abut as shown on the aforesaid axis of travel X of the head.

Obviously, in the event a bend radius intermediate those shown in FIGURES 1 and 6 is required, the appropriately sized bending head will be employed along with an appropriate adjustment of the stands **12** and the tube nests **18**.

It is to be noted that the size of the serrations **25** of the base plate **10** is preferably such that the stands **12** will latch into place at more or less standard bend radii positions. For example, as herein shown, the spaces between adjoining serrations may be ⅛ inch so that bend radii may be established at every ⅛ inch within the range of adjustment. Similarly, since with every adjustment of the stands **12** along the base there must be a corresponding but opposite adjustment of the tube nests **18** within their cradles **17**, adjoining screw-receiving depressions **24** in the tube nests will likewise be spaced the same as the serrations **25** or, in the present instance, ⅛ inch apart. As will be apparent, the provision of precise detent positions to which the stands and the tube nests may be positioned greatly facilitates adjustment of the apparatus to bend tubing to various radii and insures satisfactory operation and accurate, predictable results.

While the presently disclosed apparatus is shown and described as being designed to bend round in cross-section tubing, it will be apparent that tubing of other cross-sectional shapes may be bent by providing appropriately shaped grooves in the tube nests and the bending head.

Moreover, the apparatus can also be used to bend elongated stock other than tubing; for example, bar stock of various cross-sectional shapes. Accordingly, the use of the word tubing in the present specification and the claims is to be considered as an example rather than as a limitation.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiment herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described; hence it will be appreciated that the herein disclosed embodiment is illustrative only, and that my invention is not limited thereto.

I claim:

1. Tube bending apparatus comprising a base, a pair of pivot stands shiftably secured to said base in spaced-apart relation, a pair of bending arms normally disposed in end-to-end abutting relation for receiving the tube to be bent, a pivot carried by each of said stands and mounting respective arms aforesaid thereon, said pivots being spaced apart an amount equal to twice the radius to which the tube is to be bent, an arcuate bending head mounted for movement transversely of and toward said arms and along a path substantially bisecting the arm pivots to grip the tube between said head and said arms, means urging said arms about their pivots to end-to-end relation aforesaid and yieldably opposing movement of said arms about their pivots from such relation, and interengageable means in part carried by said base and in part carried by said stands providing for disposition of said stands at various preselected positions relative to the path of movement of said head to provide for bending of the tube to various preselected bend radii.

2. The construction of claim **1** wherein said stands each pivotally support a cradle, wherein said arms are secured to respective cradles, and wherein interengageable means are in part carried by respective cradles and in part carried by respective arms to provide for disposition of said arms relative to said cradles at various preselected positions correlated with the radius to which the tube is being bent.

3. The construction of claim **2** wherein identical spacing between adjoining, preselected positions is provided by said first-mentioned and said second-mentioned interengageable means.

4. Tube bending apparatus comprising

a pair of bending arms normally disposed in predetermined, end-to-end relation for receiving a tube to be bent,

pivots for respective arms spaced-apart an amount equal to twice the radius to which the tube is to be bent,

an arcuate bending head mounted for movement transversely of and toward said arms and along a path bisecting said arm pivots to grip the tube between said head and said arms,

and means urging said arms about their pivots to end-to-end relation aforesaid and yieldably opposing movement of said arms about their pivots from such relation.

5. The construction of claim **4** wherein said arm pivots are adjustable toward and away from the path of movement of said head to accommodate variations in the bend radius,

and wherein said arms are adjustable relative to and independently of respective arm pivots to maintain the predetermined, end-to-end arm relation aforesaid to properly support the tube during bending thereof.

6. The construction of claim **5** wherein said bending arms are in abutment in their normal relation aforesaid.

7. Tube bending apparatus comprising

a pair of bending arms normally disposed in predeter-

mined, end-to-end relation for receiving a tube to be bent,

pivots for repsective arms and spaced-apart from each other,

an arcuate bending head mounted for movement transversely of and toward said arms and along a path bisecting said arm pivots to grip the tube between said head and said arms,

and means urging said arms about their pivots to end-to-end relation aforesaid and yieldably opposing movement of said arms about their pivots from such relation,

said arm pivots being adjustable toward and away from the path of movement of said head to accommodate variations in the bend radius,

and said arms being adjustable relative to and independently of respective arm pivots to maintain the predetremined, end-to-end arm relation aforesaid to properly support the tube during bending thereof.

8. Tube bending apparatus comprising

a base,

a pair of pivot stands secured to said base in spaced-apart relation,

a pair of bending arms pivotally carried by respective stands, said arms normally being disposed in end-to-end relation for receiving the tube to be bent and said arms each having a groove for closely receiving such tube,

an arcuate bending head mounted for movement transversely of and toward said arms and along a path substantially bisecting the arm pivots to grip the tube between said head and said arms and said head having an arcuate groove for closely receiving the bent tube,

means urging said arms about their pivots to end-to-end relation aforesaid and yieldably opposing movement of said arms about their pivots from such relation,

first interengageable means in part carried by said base and in part carried by said stands providing for disposition of the latter at various preselceted positions relative to the pah of movement of said head to provide for bending of the tube to various preselected radii,

and second interengageable means in part carried by respective arms to provide for disposition of the latter relative to said stands at various preseleced positions correlated with the radius to which the tube is being bent.

9. The construction of claim **8** wherein said pivot stands are so disposed that respective pivots carried thereby are spaced from each other an amount equal to twice the radius to which the tube is to be bent,

and wherein said bending arms are so disposed in their normal positions that their adjoining ends are in abutting relatioin.

10. The construction of claim **8** wherein identical spacing between adjoining, preselected positions is provided by said first and said second interengageable means.

11. The construction of claim **10** wherein said means urging said arms about their pivots comprises a member engaged with those arm ends adjacent each other, wherein a spring urges said member to arm engagement, and wherein means are provided to adjust the effective force of said spring to vary arm movement resistance aforesaid.

12. The construction of claim **11** wherein said member has sliding connection with said base and sliding engagement with those arm ends adjacent each other.

13. The construction of claim **12** wherein a threaded rod is secured to said base, wherein said stands, arms, head and member are disposed on one side of said base and said rod is disposed on the other side thereof, wherein said spring is a helical compression spring and encircles said rod, wherein one end of said spring bears against a collar adjacent said base on said other side thereof and which likewise encircles said rod, wherein guide pins slidably extend through said base and connect said collar to said member for unitary movement, and wherein nut means is threaded on said rod and provides an adjustable abutment for the other end of said spring so that compression on the latter can be varied thus varying the force which resists movement of said arms away from their end-to-end relation aforesaid.

References Cited

UNITED STATES PATENTS

3,306,093	2/1967	Sassak	72—389
2,451,302	10/1948	Peters	72—389
2,525,403	10/1950	De Witt	72—309
3,021,886	2/1962	Ferris	72—389
3,196,661	7/1965	Lance	72—389

FOREIGN PATENTS

681,293	10/1952	Great Britain.
887,160	1/1962	Great Britain.

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