

Nov. 30, 1943.

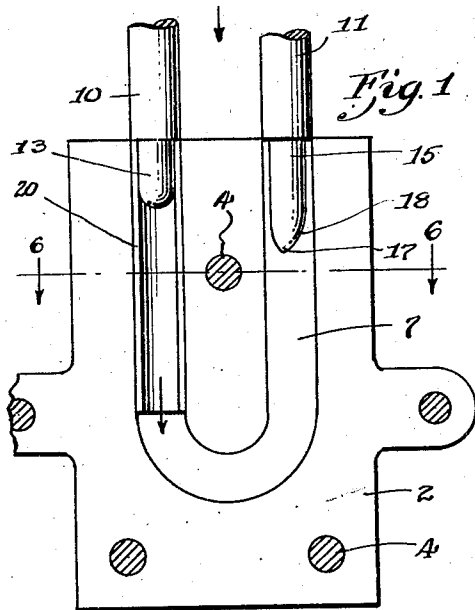
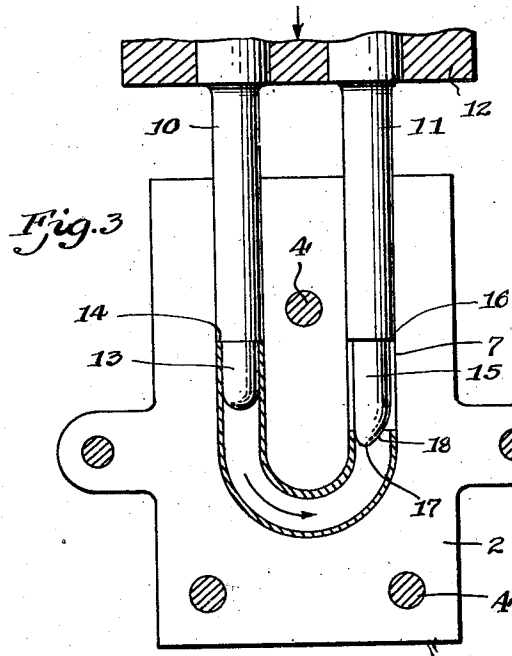
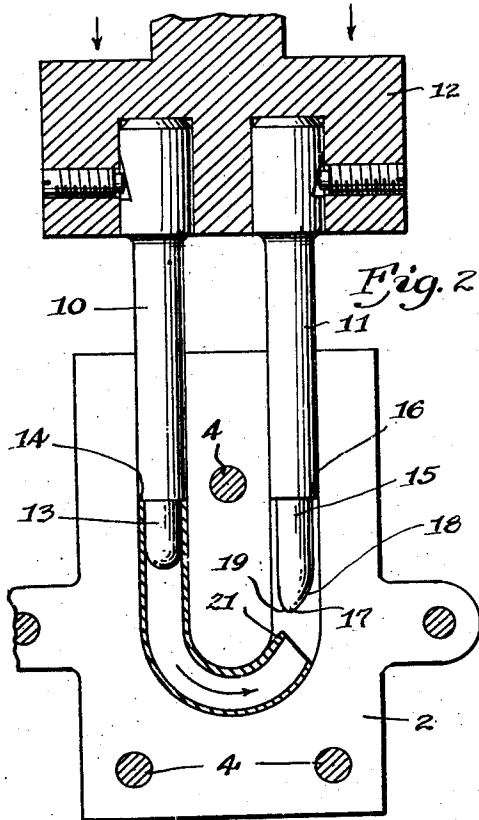
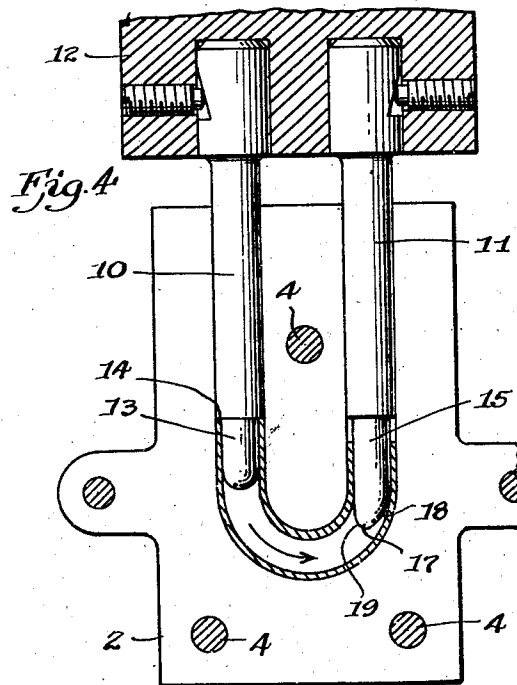
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2,335,342

APPARATUS FOR TUBE BENDING

Filed April 28, 1941

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

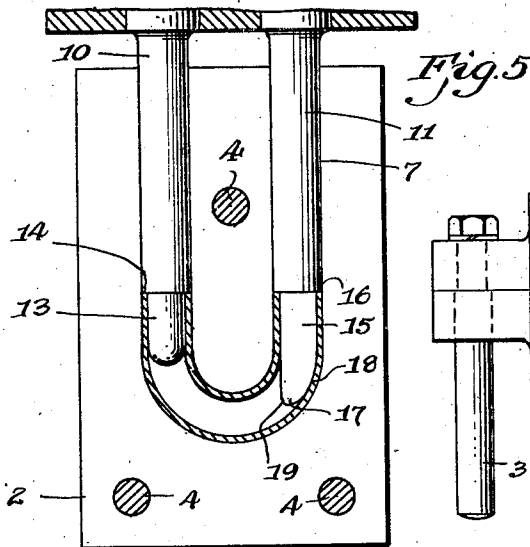
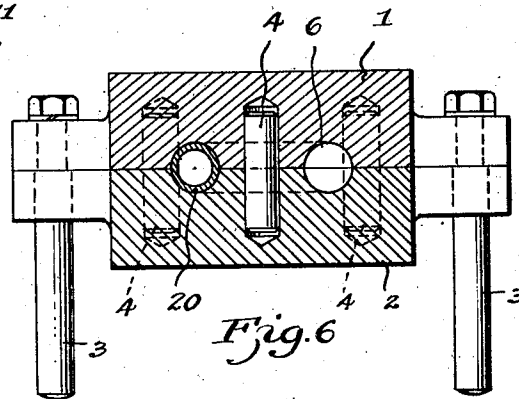
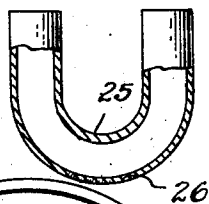
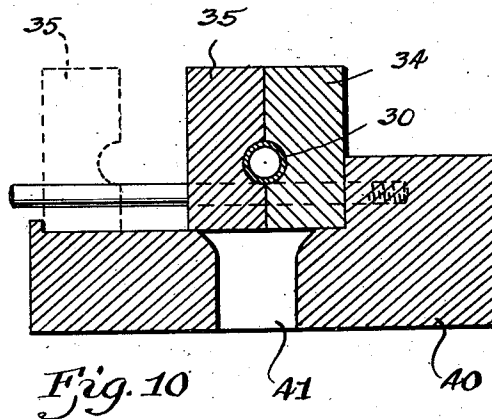
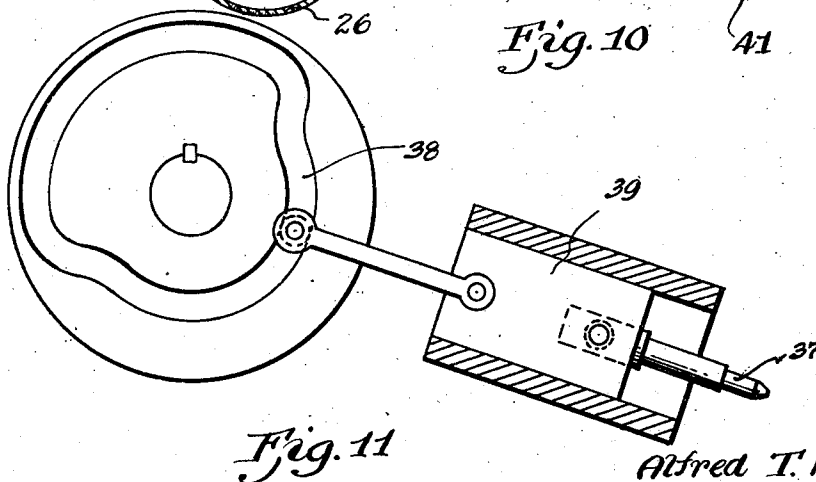


Fig. 7



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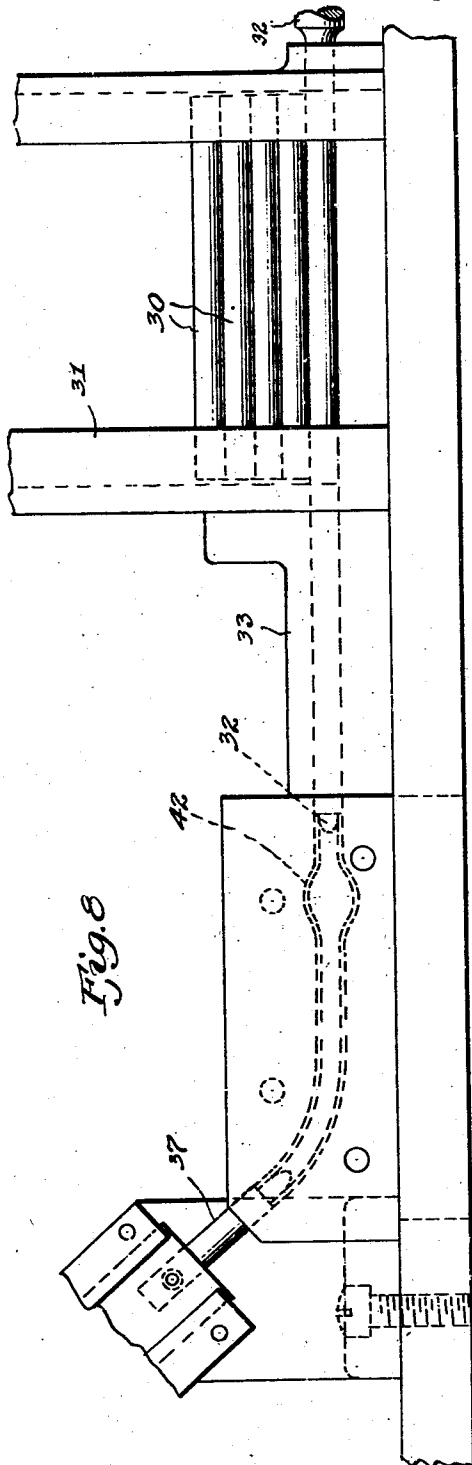
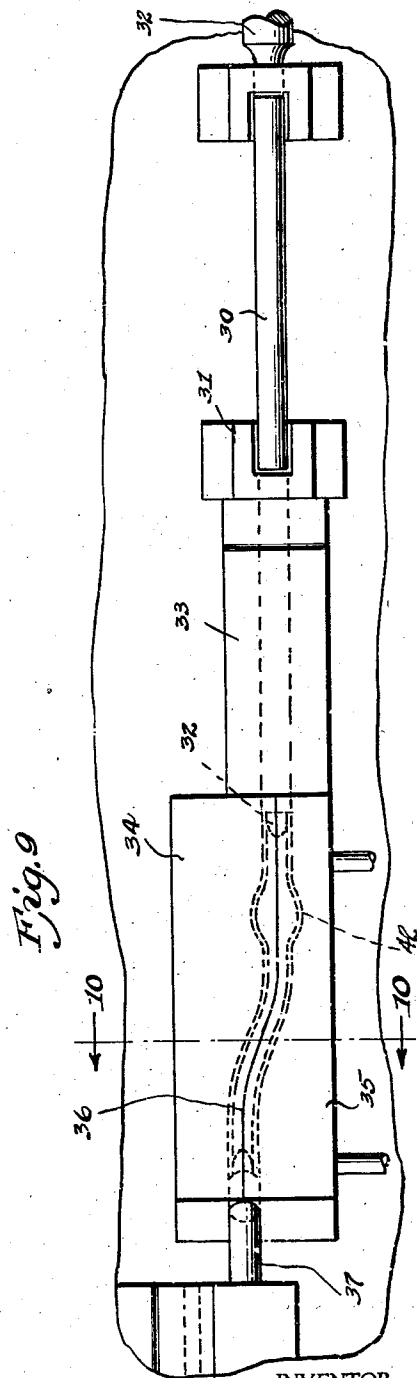
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APPARATUS FOR TUBE BENDING

Filed April 28, 1941

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,335,342

APPARATUS FOR TUBE BENDING

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Application April 28, 1941, Serial No. 390,694

1 Claim. (Cl. 153—32)

This invention relates to tube bending, and particularly to apparatus for bending tube.

When a straight length of tube is bent on a radius, it is obvious that there must be some displacement of metal, since the portion of the tube wall on the outside of the bend, and therefore on a greater radius, is relatively long while the portion of the tube wall on the inside of the bend is relatively short. Heretofore, this displacement of metal has resulted in a thinning of the metal on the greater radius, thus weakening the wall structure. Furthermore, if the bend is on a relatively short radius, the wall on the outer portion of the bend is liable to be collapsed or partially collapsed, thus restricting the tube.

The present invention aims to provide improvements in tube bending wherein the outer wall is not, at least to any appreciable extent, thinned or stretched, nor collapsed or partially collapsed. The invention aims furthermore to provide improvements in tube bending whereby tubing may be fashioned or bent on radii relatively short as compared to the tube diameter. Still further, the invention aims to provide improvements wherein tube may be given various shapes and fashioned into bends with relatively small radii without the use of an internal supporting arbor. The invention provides for bending a length of tube into a complicated shape having compound bends, so to speak, or in other words, bends in different directions without employing an internal supporting arbor and wherein the fashioned tube may be easily and quickly released from the bending apparatus. The invention also provides an arrangement by means of which the tube wall can be expanded so as to form an enlargement in an intermediate portion of a length of tube, and this without the employment of an internal arbor or expanding device.

The invention is exemplified in the accompanying drawings wherein two different forms of devices are shown for bending or fashioning tube. In these drawings

Fig. 1 is a view showing a die block with a straight length of tube therein ready to be bent.

Fig. 2 is a view similar to Fig. 1 showing the tube partially bent.

Fig. 3 is a view similar to Figs. 1 and 2 showing a further advanced step in the bending of the tube.

Fig. 4 is a view similar to Figs. 2 and 3 showing a still further advanced step in the bending of the tube.

Fig. 5 is a view similar to Figs. 1 and 4 showing the final step in the bending of the tube.

Fig. 6 is a cross sectional view taken substantially on line 6—6 of Fig. 1 showing the die.

Fig. 7 is a view largely in cross section illustrating the wall structure of the tube at the bend.

Fig. 8 is a side elevational view of a modified form of bending apparatus.

Fig. 9 is a plan view of the modified form of bending apparatus.

Fig. 10 is a cross sectional view taken substantially on line 10—10 of Fig. 9 showing the die.

Fig. 11 is a view illustrating means for operating a sizing punch.

The die illustrated in Figs. 1 to 6, inclusive, as illustrated in Fig. 6, may comprise two die blocks, one of which is shown at 1 and the other at 2 arranged so that they can be separated. To this end the block 1 may be fixedly mounted on the ends of rods 3 while the die block 2 may slide thereon, so that the die may be opened and closed by any suitable means. The die blocks may be guided together and accurately positioned by dowel pins 4. The die blocks have grooves therein arranged to be matched to thus provide a channel or guideway which substantially fits the tube. The die block 1, in the form shown in Figs. 1 to 6 inclusive, has a groove 6 which is generally of U formation while the block 2 has a groove 7, and when the die blocks are placed together the grooves form a closed U-shaped channel.

There are two punches or plungers respectively illustrated at 10 and 11, and they may be carried by a single supporting head 12. One of the plungers, such as the plunger 10, is arranged to force or push a length of tube along the die channel, and to this end it may have a reduced end portion 13 so that its shoulder 14 may engage the end of the tube with the reduced portion 13 extending into the tube. The punch or plunger 11 performs a shaping and sizing operation, and it has a reduced end 15 terminating at a shoulder 16. The end 15 is preferably longer than the reduced end 13, and its tip 17 is off center as regards the center of the plunger 11 for purposes which will presently appear, while its surface at 18 is of curved formation corresponding substantially to the curvature of the bend in the die block.

The operation of this apparatus and the method are as follows: A length of tube, as illustrated at 20, is pushed into the channel of the die, and suitable means may be provided for advancing the holder 12 relative to the die blocks. As the plungers advance, the tube is forced to follow the channel formation in the die blocks

and thus is caused to take the shape of the channel. This happens to be a U-shape in the structure shown in Figs. 1 to 6. As the leading end of the tube passes through the curved formation, its end is slightly deformed. For example, the inner wall at the bend may project away from the wall of the channel as illustrated at 21, while the opening at the leading end may not be in the form of a true circle or symmetrical. The point 17 is positioned to enter the end of the advancing tube, to which end the point 17 is properly positioned, and the surface 19 adjacent the end connects the shape of the portion 21 as illustrated in Fig. 3. Continued movement causes the reduced end 15 to enter the leading end of the tube until the Fig. 5 position is reached, at which time the shoulders 14 and 16 abut ends of the tube and may subject the tube structure to compressive forces. These compressive forces are not for the purpose of upsetting the metal, but may be sufficient to give the tube its final set and shape. In this final position, as shown in Fig. 5, the curved surface 18 substantially parallels for a distance the outer surface of the U-shaped channel so that this leading section of the tube is ironed out against the walls of the channel.

By this arrangement a length of tube can be fashioned or bent on a very short radius as regards the diameter of the tube. For example, a tube fashioned from strip steel stock having an outside diameter of about .375 of an inch and a wall thickness of about .028 of an inch can very readily be bent through 180° on a radius of ½ an inch. In other words, the distance across the diameter of the bend measured from center to center is 1 inch. Yet the bending of the tube on such a short radius does not collapse the tube wall nor reduce the thickness of the wall section on the outside of the bend to any appreciable extent. To the contrary, the wall at the inside of the bend is thickened by the flow of metal. This is illustrated in several of the views where it will be observed that the wall 25 on the inside of the bend is relatively thick while the wall 26 on the outside of the bend has substantially the same thickness as that of the original tube.

In Fig. 8 a plurality of tubes 30 may repose in a magazine 31 and the tubes are pushed, one at a time, by a plunger 32, through a guide block 33 and into the die. This die also is in the form of two die blocks 34 and 35, having a line of separation as illustrated at 36 on the center line of the tube. These die blocks are arranged to give the tube a multiple or compound bend. As shown in Fig. 8 the leading end is bent upwardly as Fig. 8 is viewed, while in Fig. 9 the tube is bent laterally.

A sizing punch 37 is arranged to enter the leading end of the tube, and to this end it may have a reciprocatory movement given to it by suitable means such as a closed cam 38, the die being mounted on a slidable head 39. The two die blocks may be mounted upon a base 40, and one of the blocks may be arranged for lateral movement to open the die. To this end the block 35 (Fig. 10) may be shifted to a position as indicated by the dotted line position so that when the die blocks open the fashioned tube may fall through an opening 41 in the base.

The operation is substantially the same as the operation of the form above described, in that the plunger 32 forces the tube through the forming channel portion of the die and at the end of the movement the sizing punch 38 enters the tube and the ends of the tube may be engaged by the shoulders and the plunger and sizing die to apply compressive forces thereto. Then the sizing punch 37 retracts and the die blocks are opened for the discharge of the fashioned tube.

The wall of the tube may, if desired, be expanded to form any suitable enlargement or bulb formation. This is accomplished by forming the die blocks with a suitable enlarged portion as illustrated at 42. The compressive forces which are applied to the tube at the end of the bending operation forces the wall of the tube outwardly against the walls of the enlarged portion to thus expand the same.

I claim:

An apparatus for making a U bend in a length of tube which comprises, an openable die block having an unobstructed U-shaped die passage therein with the ends of the legs of the passage opening through one side of the die block, a plunger for pushing a length of tube lengthwise in one leg of the U-shaped passage to cause the leading end of the tube and successive sections following the same to advance through the bight portion of the passage to bend the same and then to advance into the other leg of the U-shaped passage to substantially straighten the same whereby the tube is fashioned into U shape, another plunger having an end portion for entering the leading end of the tube to expand the tube end against the wall of the die passage to reshape and correct distortions therein caused by its passage through the bight portion of the die passage, and shoulders on the two plungers of a size as to pass into the die passage for engaging both the trailing and leading ends of the tube to apply compressive forces thereto after the same have been shaped.

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