May 7, 1946. T. SATO 2,399,892

BENDER FOR ROLLED-UP METAL STRIP

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Fig. 1

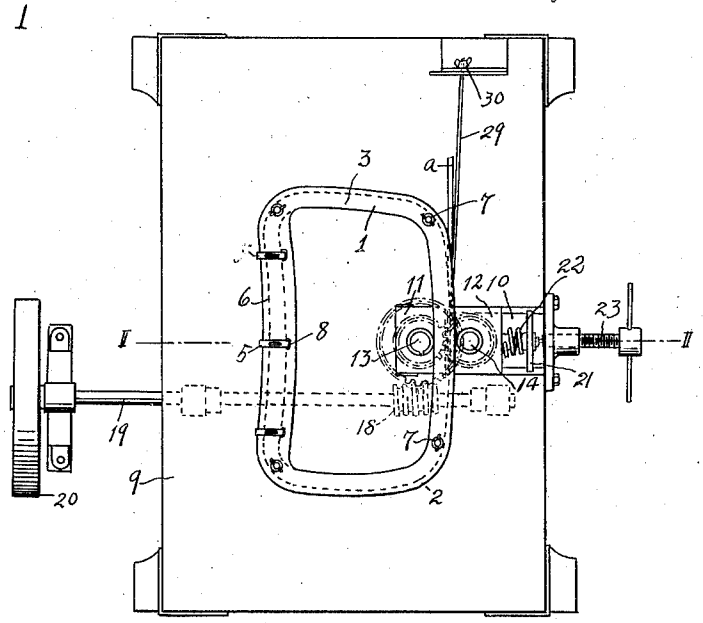


Fig. 4

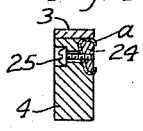


Fig. 3

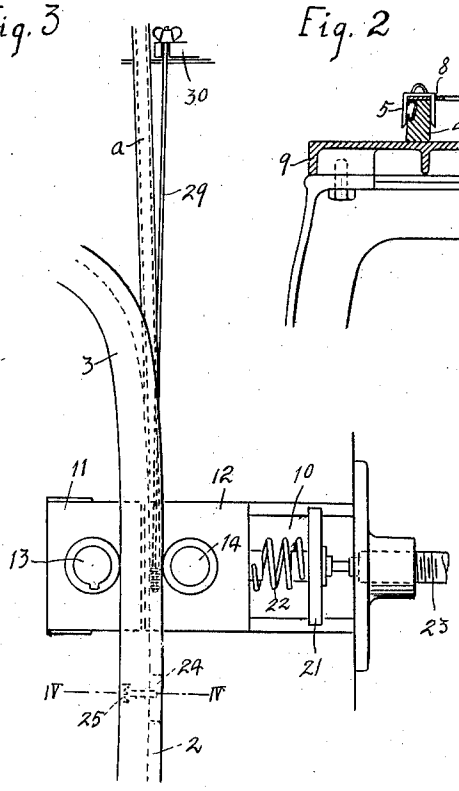


Fig. 2

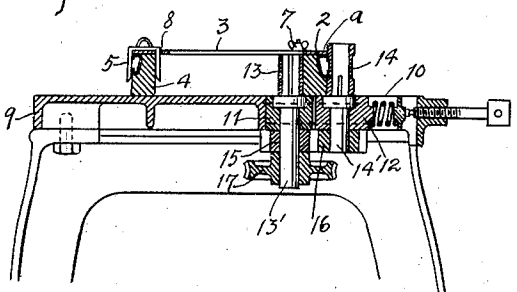
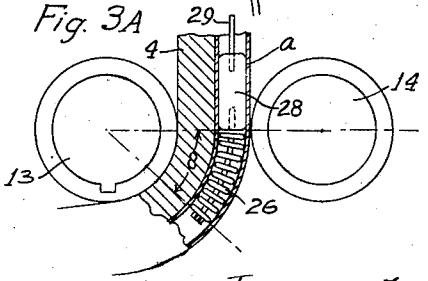


Fig. 3A



Inventor

Jakes Sato

By Connolly Bro

Attys

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Fig. 5

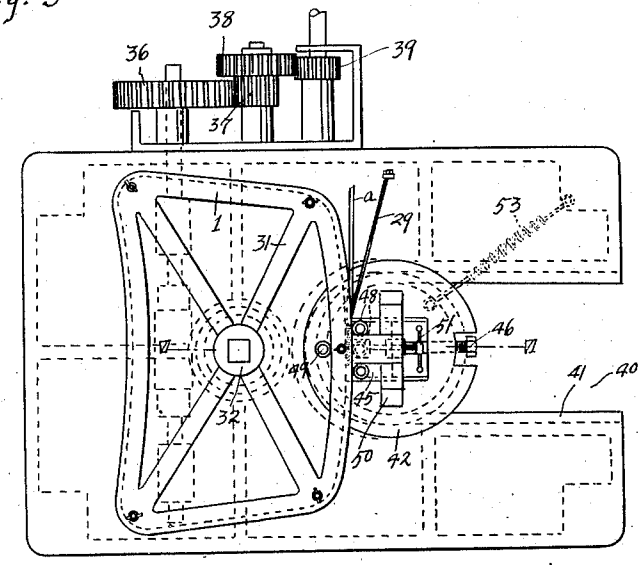


Fig. 6

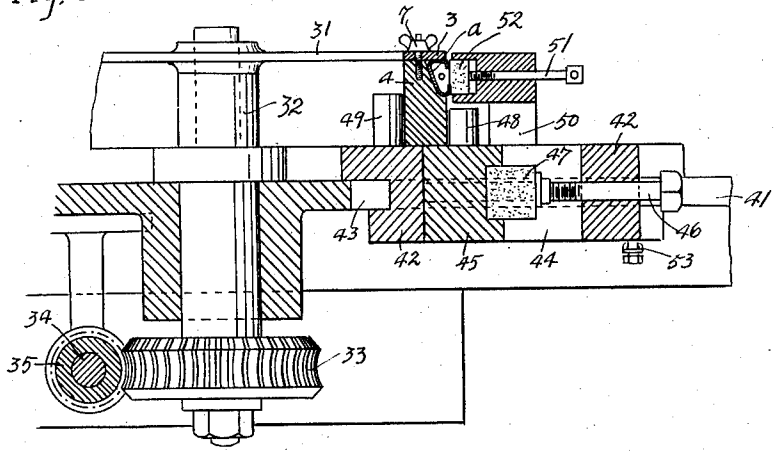


Fig. 7

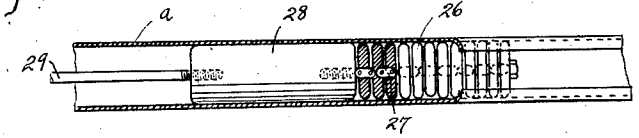
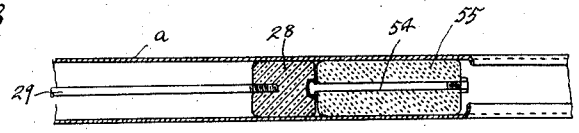


Fig. 8



Inventor
Tokeo Sato
by Connolly Bro
Atty

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BENDER FOR ROLLED-UP METAL STRIP

Takeo Sato, Tsurumi-ku, Yokohama, Japan; vested in the Alien Property Custodian

Application July 7, 1939, Serial No. 283,285

8 Claims. (Cl. 153—40)

This invention relates to a machine for bending hollow pipes and hollow strips into the proper shape to form a part of articles such as window frames, fuel tanks and the like.

It is an object of this invention to construct a bending apparatus of the class described, in which the frame mould is rotatable between a pair of rollers and in which the construction of the bending apparatus and its operation is more simple than in apparatus heretofore employed because the strip can be bent and finished accurately.

It is another object of this invention to construct a bending machine wherein a flexible mandrel, formed from a plurality of interconnected pieces of metal or hard rubber, is employed for preventing collapse of the pipe or strip at the bent portion.

The present invention comprises a mould frame of uniform width, said frame being provided with a peripheral groove adapted to receive the strip to be bent. A pair of rollers contact opposite sides of the mould and serve as a guiding and bending mechanism. When the mould and accompanying strip are moved between the pair of rollers, the strip is bent to conform to the groove in the mould. In one embodiment of this invention, the mould is rotated by frictional contact between a pair of driven rollers. In another embodiment of this invention, the mould is rotatable about a fixed axis and the rollers are mounted on a disc slidably mounted relative to said axis in such a manner that the rollers are always in contact with the side surfaces of the mould during the rotation of the mould. Some of the objects having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which

Fig. 1 is a plan view of one embodiment of this invention;

Fig. 2 is a sectional view, taken on the line II—II of Fig. 1;

Fig. 3 is an enlarged plan view showing one portion of the mould and a pair of rollers;

Fig. 3A is an enlarged sectional plan view showing a curved portion of the mould disposed between the bending rollers;

Fig. 4 is a sectional view, taken on the line IV—IV of Fig. 3;

Fig. 5 is a plan view of another embodiment of this invention;

Fig. 6 is an enlarged sectional view, taken on the line VI—VI of Fig. 5;

Fig. 7 is a side view of a flexible metallic mandrel inserted into a hollow strip, a portion of said strip being shown in section;

Fig. 8 is a sectional view similar to Fig. 7 and showing a modified form of mandrel made from fiber and rubber elements.

Referring to the drawings, 1 is a frame mould corresponding to a window frame, said mould comprising an upper member 3 and a lower member 4 detachably secured together by screws 7. The lower member 4 has a uniform width, and also has a peripheral groove 2 which is adapted to receive a strip *a* to be bent. Groove 2 is formed at the junction of members 3 and 4. Three U-shaped staples 5 are provided on the concave side 6 of the frame mould for holding the bent strip in the groove 2. One leg of each staple penetrates an aperture 8 in member 3 and passes downwardly along the inner side wall of member 4, whereas the other leg of each staple passes downwardly along the outer flush sides of members 3 and 4.

The numeral 9 designates a supporting table which has a rectangular recess 10 in which sliding plates 11 and 12 are fitted. Two rollers 13 and 14 are rotatably mounted on these sliding plates 11 and 12, said rollers being respectively mounted upon shafts 13' and 14' which in turn have intermeshing pinions 15 and 16 secured on the lower ends thereof below the table 9. The lower end of the shaft 13' of the roller 13 has a worm wheel 17 which meshes with a worm 18 secured upon one end of a driving shaft 19, and this driving shaft is driven by a suitable motor (not shown) through a pulley 20. The mould is frictionally gripped between the two rollers 13 and 14, and the roller 14 also serves to press the strip *a* into groove 2. A spring 22 is arranged between the sliding plate 12 and a retaining plate 21 for yieldingly urging roller 14 toward the frame. This retaining plate is slidably adjusted in the recess 10 by a screw rod 23; thus, the pressure of the roller 14 against the mould 1 can be regulated by the rotation of the screw rod. One end of the hollow U-shaped strip *a* is inserted in the groove 2 of the mould and is then secured to the lower member 4 by means of a screw 25 and a core 24 fitted into the strip *a* as shown in Figs. 3 and 4. The core 24 rigidly holds one end of the strip in the groove 2 of the mould during the bending motion. A mandrel 26 is inserted into the strip *a* as shown in Fig. 7, said mandrel comprising several metal pieces whose cross-sectional shape is the same as that of the interior of the hollow strip. The metallic members are connected in spaced relation by a flexible shaft 27. The inner

end of the flexible shaft 27 is screwed to a guide mandrel 28 whose outer boundary also conforms to the inside of the strip, and the outer end of the guide mandrel is connected to a rod 29. The other end of this rod 29 is secured to a suitable bracket 30 on the table 9.

The operation of this apparatus is as follows:

When the driving shaft 19 is rotated by the pulley 20, the pair of rollers 13, 14 is rotated through the worm 18, worm wheel 17 and pinions 15, 16. Then, the mould 1 is moved by the frictional contact with the rollers, therefore the strip *a* in the groove 2 of the mould can be bent in accordance with the curvature of the mould groove without any rumples because the mandrel prevents collapse of the strip while it is bent.

In the modification of this invention, as shown in Figs. 5 and 6, the mould 1 is rigidly connected with a rotating shaft 32 by the arm 31. The shaft 32 has a worm wheel 33 on the lower side of the table 9, and this worm wheel meshes with a worm 35 of a driving shaft 34, which shaft is driven by any suitable means, such as a motor (not shown) through gear wheels 36, 37, 38 and 39. On one side of the table, a rectangular opening 40 is formed, and a rib 41 is formed on the inner parallel edges of the opening 40. A sliding disc 42 is fitted into the opening 40 so that the rib 41 fits into a circular groove 43 formed on the outer periphery of the sliding disc. This sliding disc has a centrally disposed square hole 44 therein in which a plate 45 slidably fits. 47 is a rubber damping head secured to the end of a screw rod 46 which is threadably mounted in the sliding disc 42. It is therefore seen that the sliding plate 45 is always pressed towards the inner edge of the square hole 44 by the damping head. Three rollers 48 are mounted on the sliding plate 45 and one roller 49 is fixed to the sliding disc 42 on the opposite side of members 4 from the rollers 48; therefore, the rollers 48 and 49 hold the mould 1 between them. A bracket 50 is mounted on the sliding disc 42 across the hole 44, and a screw rod 51 is screwed into the upper central portion of the bracket. This screw rod 51 has a damping head 52 on the inner end, said damping head pressing the strip *a* in the groove 2 of the mould. 53 is a spring whose one end is fixed to the table 9 and the other end is attached to the sliding disc 42 so that the sliding disc will always be urged toward the mould, although the sliding disc may slide outwardly in the opening 40, as well as oscillate about its own axis of rotation.

Thus, the mould is rotated by the rotating shaft 32 while the sliding disc moves radially of the shaft along the opening in such a manner that the rollers 48 and 49 will always contact the mould; therefore, the strip *a* in the groove 2 of the mould can be bent in accordance with the curvature of the mould.

The modification of the mandrel as shown in Fig. 8 consists of a hard rubber mandrel 55 mounted on the flexible shaft 54 and a guide mandrel 28 made of fiber. This guide mandrel is articularly joined to the end of the flexible shaft 54.

The use, function and the relationship of the mandrels are explained as follows:

Hitherto, in many forms of mandrels, the tip is ball shaped, this tip is arranged within the hollow strip along the line connecting the centers of a pair of rollers. In such a case, the outside wall portion designated by the unstable angle θ in Fig. 3A is collapsed, due to the fact that the outside wall is not properly supported at the entire bent portion. At the same time, the inside wall portion of the strip at the unstable angle θ is rumpled by the compression. Therefore, the perfect form of the strip in the range of the unstable angle θ cannot be obtained by the mandrel supporting the bent portion at one point only. For the purpose of obviating such defect in the mandrel, according to this invention, several metal pieces 26 are articularly jointed together as shown in Fig. 7.

As a modified form of mandrel, a hard rubber piece 55, as shown in Fig. 8, may be connected to a fiber guiding mandrel 28. Mandrels of these types support the pipe over a substantial length at the bent portion of the pipe and thus prevent collapsing and rumpling in the arc designated by θ. The metallic mandrel shown in Fig. 7 may be used to bend a steel strip, while the rubber-fiber mandrel shown in Fig. 8 may be used to bend a strip made of aluminum, lead or some other soft metal where the inner wall of the strip is easily damaged.

The bending apparatus according to this invention has the advantage that the construction and treatment is very simple due to the rotation of the mould, and the strip can be bent accurately without any rumples or stress on the bending surface by means of the special mandrels.

While I have shown and described two embodiments of this invention, it will be apparent that these embodiments, as well as the detail construction of the several parts, may be varied without departing from the principle of my invention.

I claim:

1. A bending machine for preformed hollow strips comprising, a mould frame having a peripheral curved rib of uniform width, oppositely disposed guiding means engaging opposite sides of said rib, said rib having a curved groove therein for the reception of said hollow strip damping means for one of said guiding means, a flexible mandrel substantially conforming to the interior of said hollow strip, means for maintaining said mandrel within said hollow strip and in a relatively stationary position between said oppositely disposed guiding means, means partially closing said groove and independent of said mandrel for pressing said hollow strip and enclosed mandrel into said groove, a slidable member for supporting said pressing means and said damped guiding means, means removably secured to said frame for substantially closing the remainder of said groove at said pressing means, means for securing one end of said strip in said rib groove, and means for longitudinally moving said rib and attached strip relative to said guiding means, pressing means, and mandrel to thereby bend said strip into said groove.

2. A bending machine for preformed hollow strips comprising, a mould frame formed from two flat pieces, said frame being provided with a peripheral curved rib of uniform width, means for removably joining said pieces together, said frame having a groove therein formed at the junction of said pieces for the reception of said hollow strip, oppositely disposed guiding means engaging opposite sides of said rib, damping means for one of said guiding means, a flexible mandrel substantially conforming to the interior of said hollow strip, means for maintaining said mandrel within said hollow strip and in a relatively stationary position between said oppositely

disposed guiding means, means independent of said mandrel for pressing said hollow strip and enclosed mandrel into said groove, a slidable member for supporting said pressing means and said damped guiding means, and means for longitudinally moving said rib and strip relative to said guiding means, pressing means, and mandrel to thereby bend said strip into said groove.

3. A bending machine for preformed hollow strips having a U-shaped cross section with inturned flanges, comprising, a mould frame formed from two flat pieces, said frame being provided with a peripheral curved rib of uniform width, means for removably joining said pieces together, said frame having a U-shaped groove therein formed at the junction of said pieces for the reception of said U-shaped strip, oppositely disposed guiding means engaging opposite sides of said rib, a flexible mandrel substantially conforming to the interior of said hollow U-shaped strip, means for maintaining said mandrel within said hollow strip and in a relatively stationary position between said oppositely disposed guiding means, damping means for one of said guiding means, means movable with said damped guiding means and simultaneously engageable with both of said flanges for pressing said hollow strip and enclosed mandrel into said groove, said pressing means being separate and apart from said mandrel, a slidable member for supporting said pressing means and said damped guiding means, and means for longitudinally moving said rib and strip relative to said guiding means, pressing means and mandrel to thereby bend said strip into said groove.

4. A bending machine for preformed hollow strips having a U-shaped cross section with inturned flanges, comprising, a mould frame, said frame being provided with a peripheral curved rib of uniform width, said frame also having a U-shaped groove therein for the reception of said U-shaped strip, oppositely disposed guiding means engaging opposite sides of said rib, damping means for one of said guiding means, a flexible mandrel substantially conforming to the interior of said hollow U-shaped strip, means for maintaining said mandrel within said hollow strip and in a relatively stationary position between said oppositely disposed guiding means, means movable with said damped guiding means and simultaneously engageable with both of said flanges for pressing said hollow strip and enclosed mandrel into said groove, said pressing means being separate and apart from said mandrel, a slidable member for supporting said pressing means and said damped guiding means, and means for longitudinally moving said rib and strip relative to said guiding means, pressing means, and mandrel to thereby bend said strip into said groove.

5. A bending machine according to claim 1 wherein said guiding and moving means comprises a pair of spaced parallel rollers frictionally engaging opposite sides of said rib, and wherein one of said rollers also serves as said pressing means.

6. A bending machine according to claim 4 wherein said guiding and moving means comprises a pair of spaced parallel rollers frictionally engaging opposite sides of said rib, and wherein one of said rollers also serves as said pressing means.

7. A bending machine according to claim 2 including a framework, and means for rotatably mounting said mould frame on said framework, and wherein said member is oscillatably and slidably mounted on said framework for movement radially of the axis of rotation of said mould frame.

8. A bending machine according to claim 4 including a framework, and means for rotatably mounting said mould frame on said framework, and wherein said member is oscillatably and slidably mounted on said framework for movement radially of the axis of rotation of said mould frame.

TAKEO SATO.