Dec. 15, 1931. L. E. POOLE 1,836,502

METAL BENDING APPARATUS

Filed Sept. 16, 1929 7 Sheets-Sheet 1

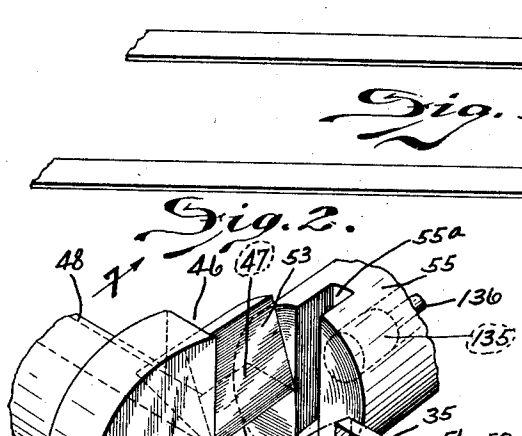


Fig. 1.




Fig. 2.




Fig. 3.

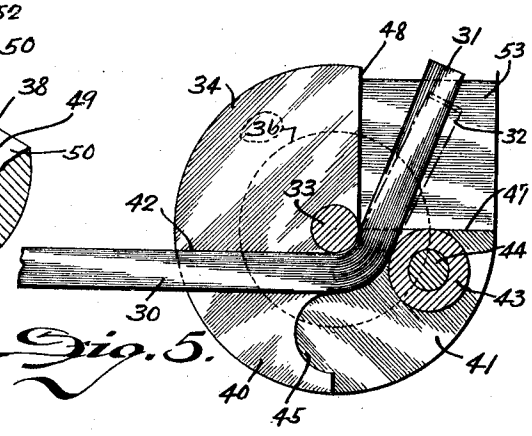


Fig. 5.

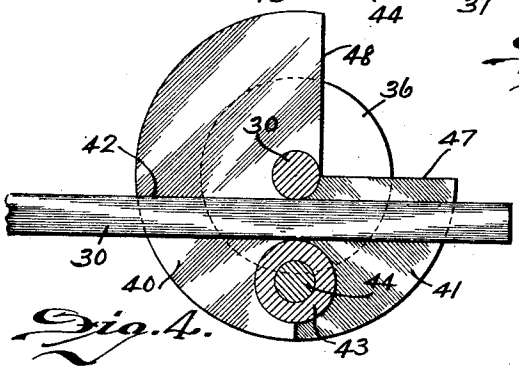


Fig. 4.

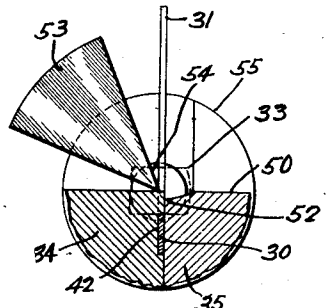


Fig. 7.

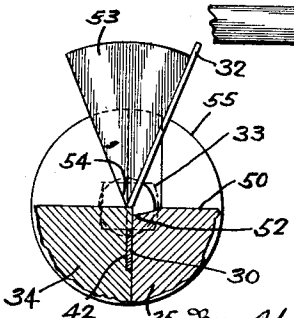


Fig. 8.

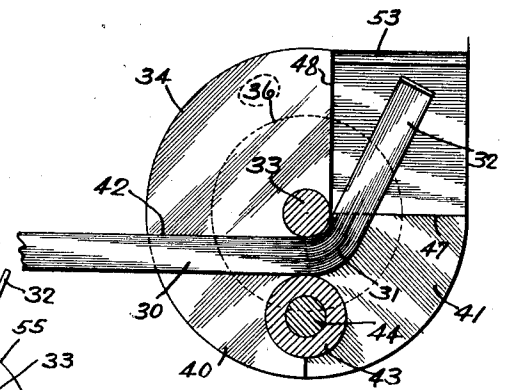


Fig. 6.

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METAL BENDING APPARATUS

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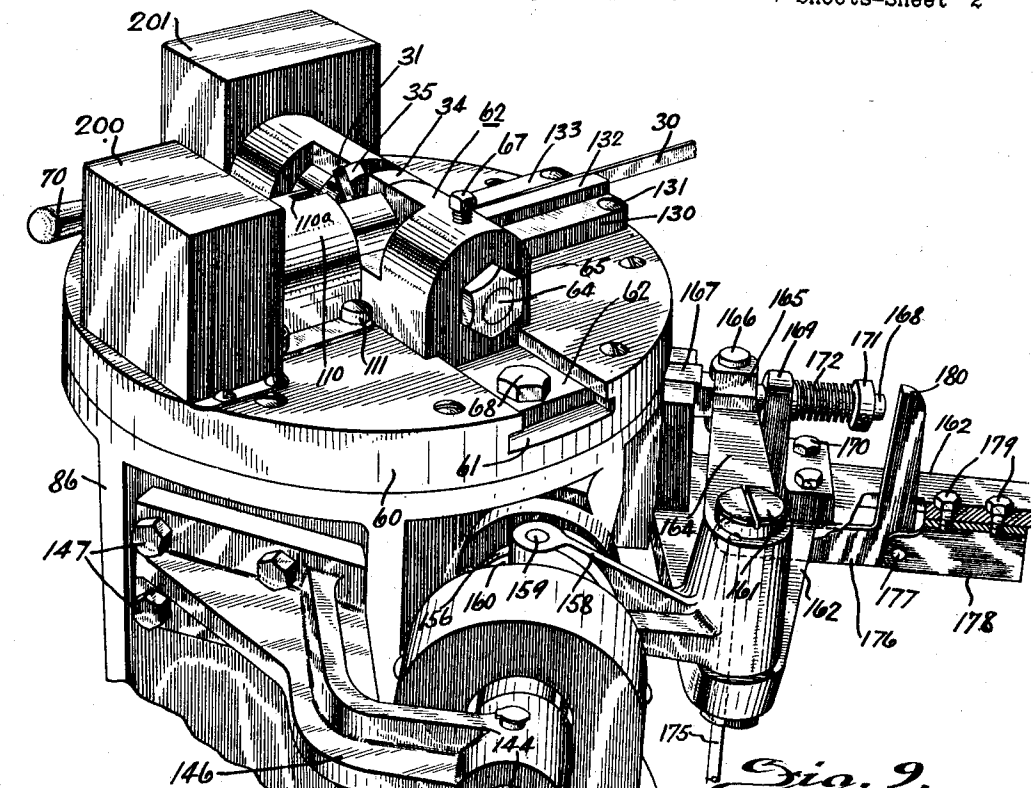


Fig. 9.

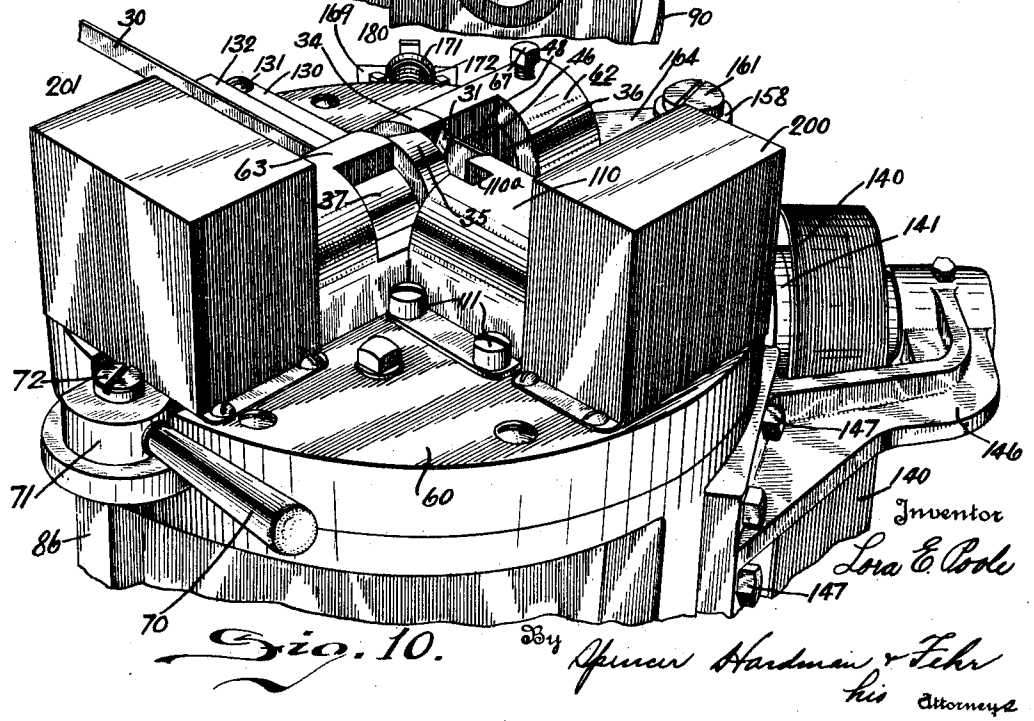


Fig. 10.

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METAL BENDING APPARATUS

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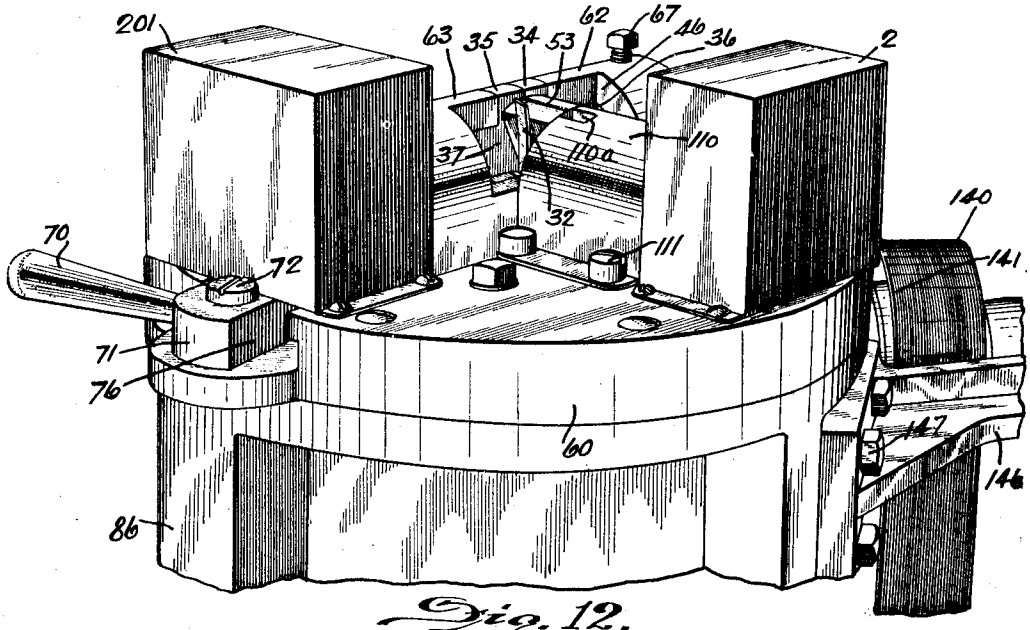


Fig. 12.

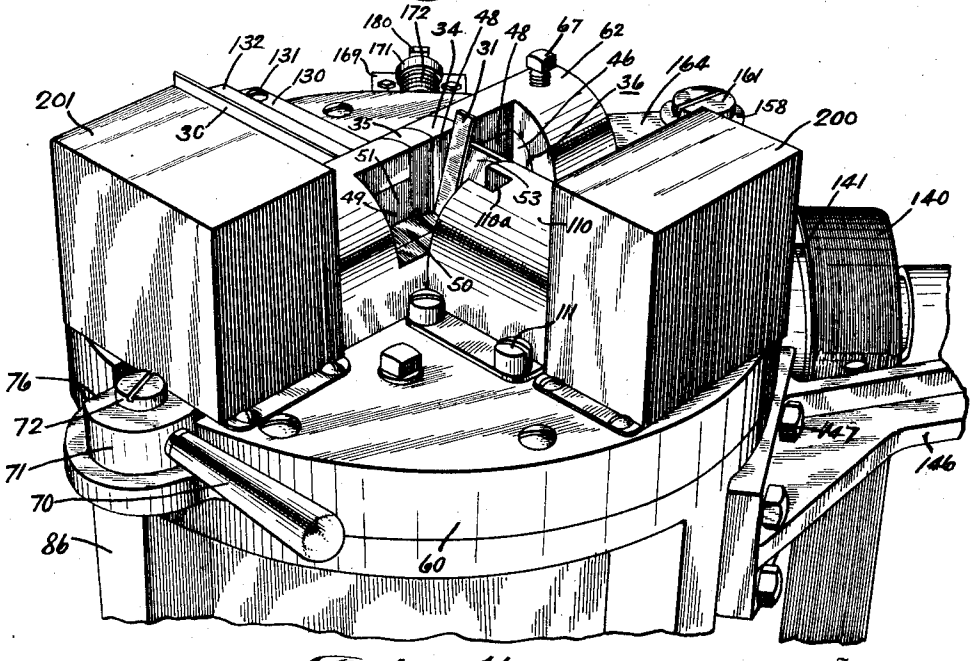


Fig. 11.

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METAL BENDING APPARATUS

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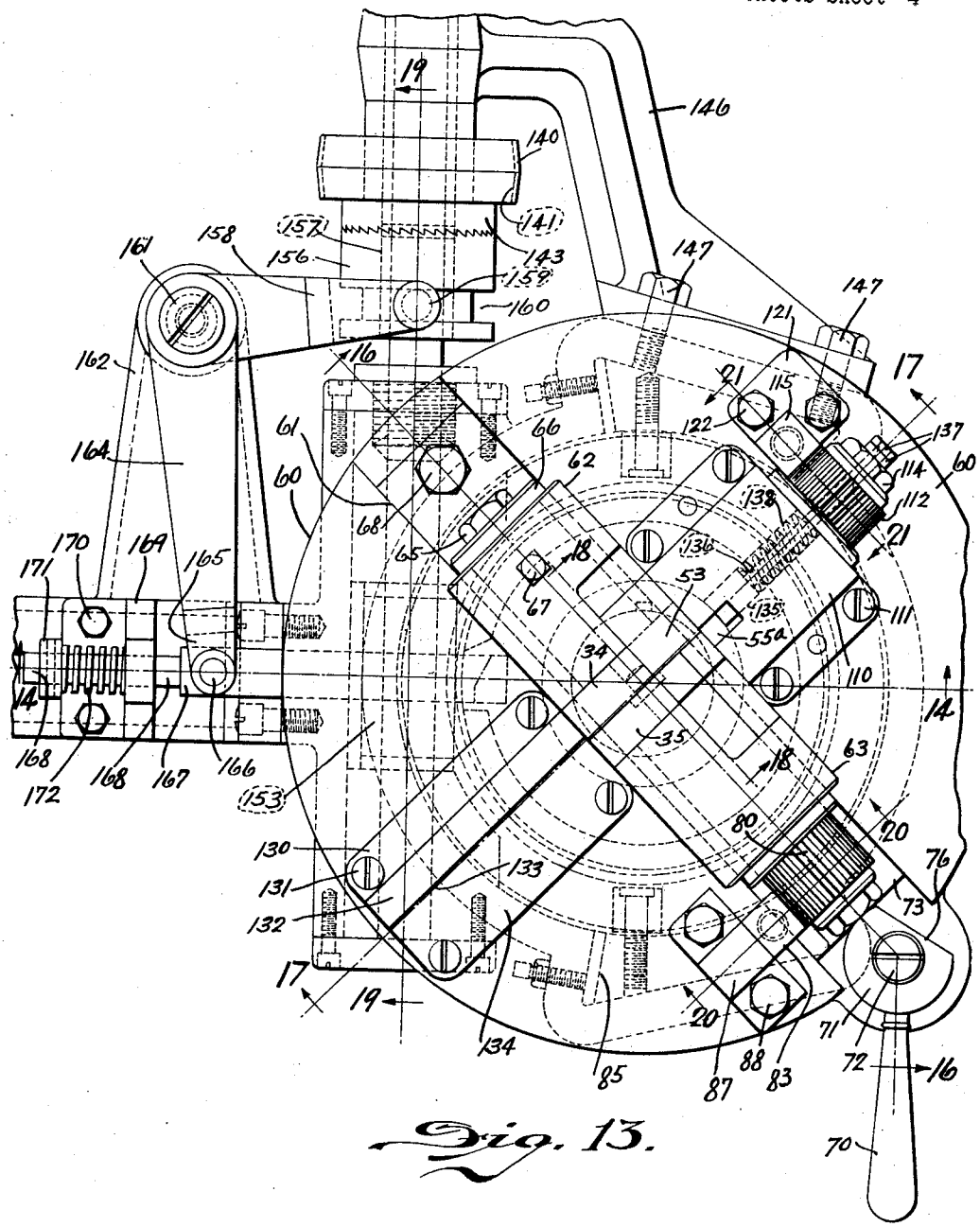


Fig. 13.

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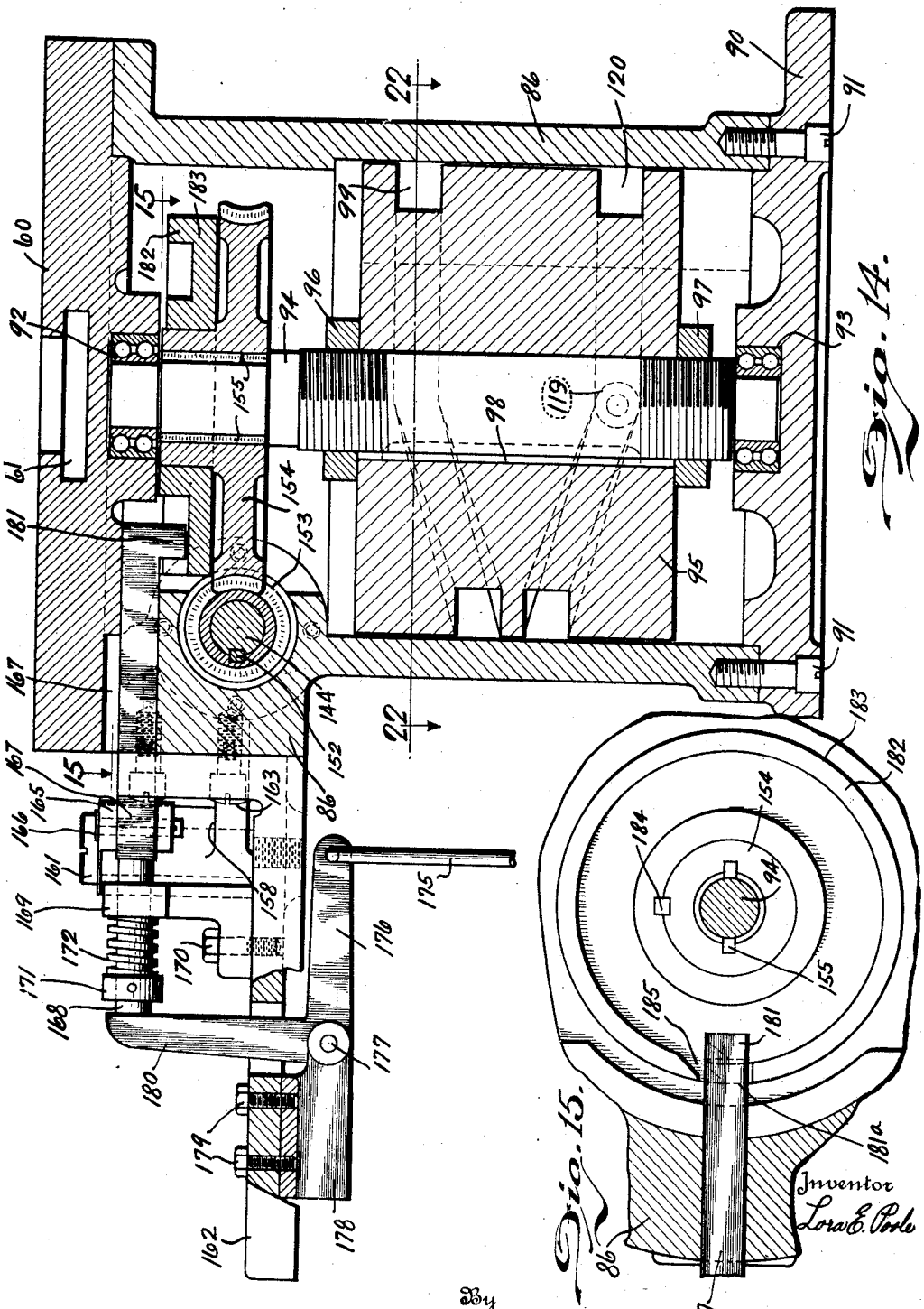


Fig. 14.

Fig. 15.

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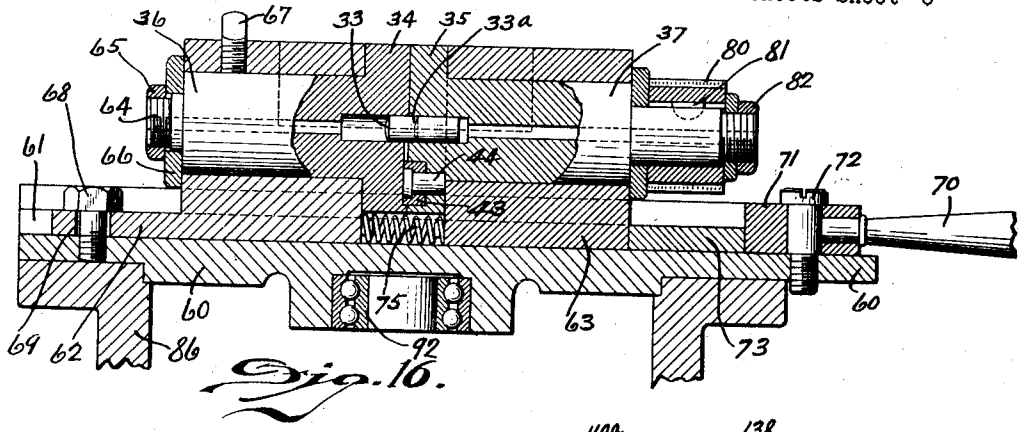


Fig. 16.

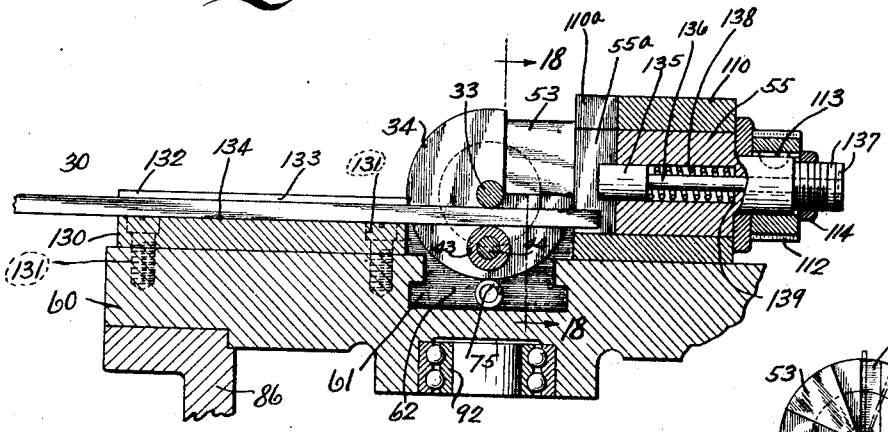


Fig. 17.

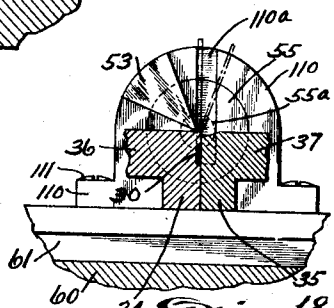


Fig. 18.

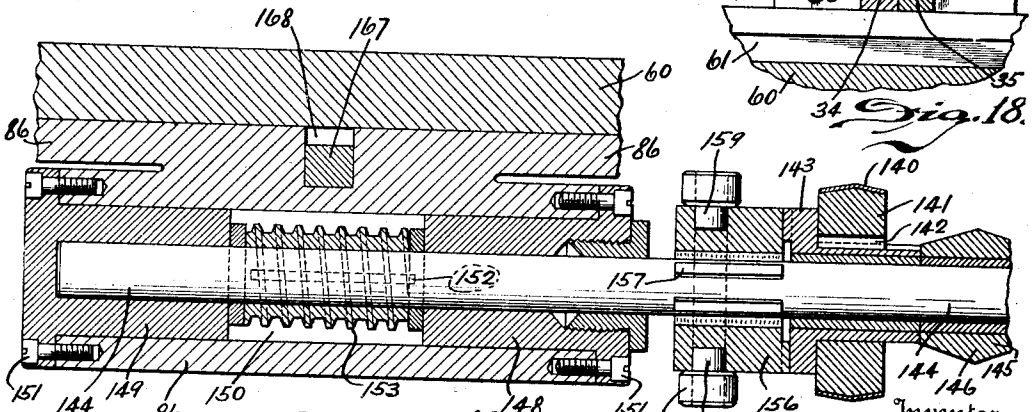


Fig. 19

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METAL BENDING APPARATUS

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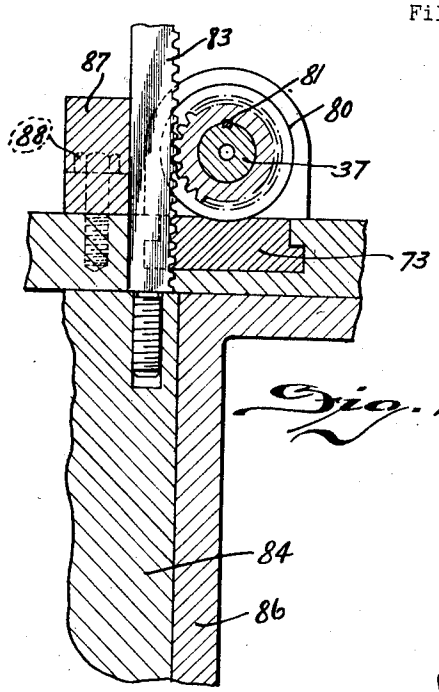


Fig. 20.

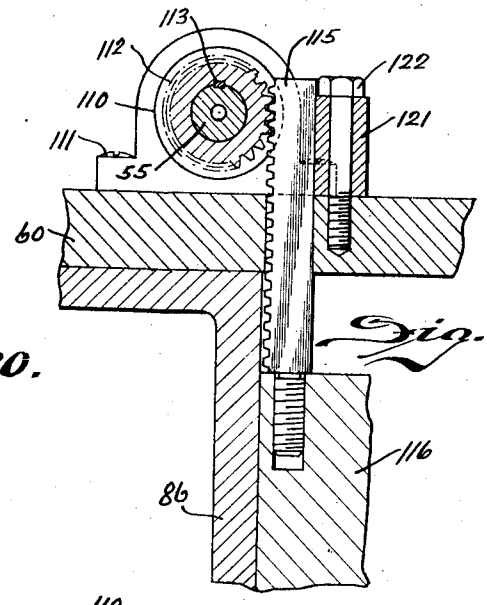


Fig. 21.

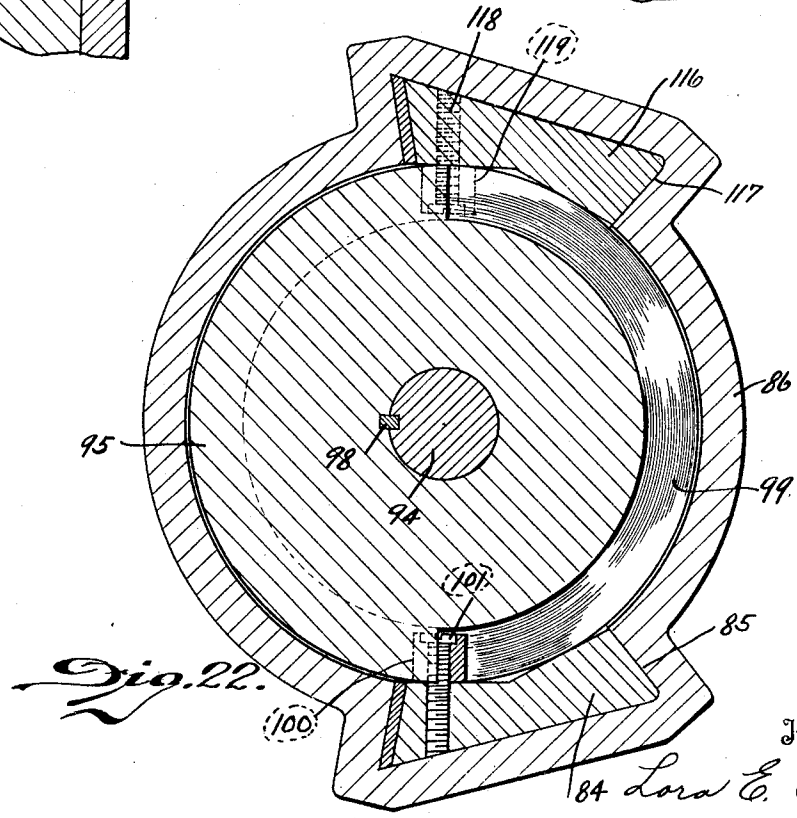


Fig. 22.

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Patented Dec. 15, 1931 1,836,502

# UNITED STATES PATENT OFFICE

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## METAL BENDING APPARATUS

Application filed September 16, 1929. Serial No. 392,926.

This invention relates to apparatus for bending a strip of metal in a plurality of directions, one of the uses of the present invention being that of shaping one end of a flat wire preparatory to winding the wire into a coil, the end so shaped being the inside lead of the coil.

One of the objects of the present invention is to provide an improved apparatus by which a bending operation of the type referred to may be performed efficiently and economically. This aim of the present invention is accomplished by providing apparatus which comprises a device for bending an end portion of a metal strip out of alignment with its main portion while holding the main portion fixed, a device for bending the end portion laterally with respect to the plane of the main portion, and mechanism for automatically causing the bending devices to operate successively.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a perspective view of a strip of metal or flat wire which has been bent by apparatus constructed in accordance with the present invention.

Fig. 2 is a perspective view showing an intermediate step performed in the formation of the wire shown in Fig. 1.

Fig. 3 is a fragmentary perspective view partly in longitudinal vertical section showing the devices for performing bending operations indicated by Figs. 1 and 2.

Figs. 4 to 6 are views looking in the direction of the arrow 4 of Fig. 3, and show diagrammatically the mode of operation of the devices shown in Fig. 3.

Figs. 7 and 8 are views looking in the direction of the arrow 7 of Fig. 3 certain parts being shown in vertical longitudinal section, these views showing diagrammatically how the second bending operation is performed.

Figs. 9 and 10 are perspective views of the apparatus showing the positions of the bending devices just after the first bending operation.

Fig. 11 is a perspective view of the apparatus showing position of the bending devices just before the second bending operation.

Fig. 12 is a perspective view of the apparatus showing position of the bending devices after the second bending operation.

Fig. 13 is a plan view of the bending apparatus.

Fig. 14 is a sectional view on line 14—14 of Fig. 13.

Fig. 15 is a sectional view on line 15—15 of Fig. 14.

Figs. 16, 17, 18, 19, 20, and 21 are sectional views taken respectively on lines 16—16, 17—17, 18—18, 19—19, 20—20, and 21—21 of Fig. 13. Fig. 18 is also a sectional view on line 18—18 of Fig. 17.

Fig. 22 is a sectional view on line 22—22 of Fig. 14.

Referring to Fig. 1 numeral 30 designates a main portion of a metal strip or flat wire having its end portion bent in two directions. The end portion designated as 31 in Fig. 2 is first bent around the axis $x$—$x$ and remains in the same plane as the main portion 30. In the second bending operation the portion 31 is bent along an axis $y$—$y$ laterally with respect to the plane of the main portion 30 to form the portion 32.

The first bending operation is performed by causing the wire to be bent edge-wise around a cylindrical form or peg 33 while the end portion 31 is maintained in the plane of the main portion 30. The parts 30 and 31 of the wire are maintained in the same plane by confining them between clamping disks 34 and 35 having cylindrical supporting shanks 36 and 37 respectively by which the disks are supported in alignment. The peg 33 is press-fitted into a hole 38 provided centrally in the disk 35 and is received by a hole 39 in the disk 34 when the disk 35 is moved into proximity with the outer face 40 of the disk 34. The disk 34 is provided with a surface 41 located in a plane parallel with the surface 40 and spaced from surface 40 a distance slightly greater the thickness of the metal strip. The

disk 34 provides a groove 42 receiving a part of the main portion 30, and the back wall of this groove is in the same plane with surface 41. The wire 30 is first placed in the groove 42 as shown in Fig. 4. Then the clamping disk 35 is moved against the disk 34. Thus the end portion to be bent is confined in a space between the end surface of the disk 35 and the surface 41 of the disk 34. Since the width of this space is only slightly greater than the thickness of the metal strip it is apparent that the parts 30 and 31 will remain in the same plane during the first bending operation.

The wire is caused to be bent around the peg 33 by hard metal roller 43 carried by a pin 44 and movable in an orbital path concentric with the axis 33. The roller 43 and pin 44 are carried by the disk 35. The roller 43 projects beyond the end face of the disk 35 a distance substantially equal to the thickness of the wire. When the disk 35 is moved against the disk 34 the roller 43 is received by a semi-cylindrical notch 45 provided by the disk 34, the back wall of the notch 45 lying in the plane of the surface 41. While the disk 34 remains fixed, the disk 35 is rotated in a counterclockwise direction looking in the direction of arrow 4 of Fig. 3 in order to move the roller 43 from the position shown in Fig. 4 to that shown in Fig. 5 in order to form the end portion 31. Following this, the disk 35 is rotated clockwise to return the roller 43 to normal position as shown in Fig. 6. Figs. 9 and 10 show the position of the disk 35 after having been rotated into a position for moving the roller 43 into the position shown in Fig. 5. Fig. 11 shows the end portion 31 after having been bent and the disk 35 returned to normal position corresponding to the position of roller 43 in Fig. 6. The disk 34 and its shank 36 are cut away to provide a notch 46 said notch being defined by a horizontal plane surface 47 and a vertical plane surface 48. The disk 35 and its shank 37 are cut away to provide a notch 49 normally in alignment with notch 46 and defined by a horizontal plane surface 50 and a vertical plane surface 51. The bent end 31 of the wire extends into the space provided by the notches 46 and 49. In this space the second bending operation takes place while the wire 30 remains clamped between the disks 34 and 35.

The device for performing the second bending operation includes a stationary form provided by the edge 52 of the disk 35 which, as shown in Figs. 3, 7, and 8, is located a slight distance below the plane of surface 50, and includes a movable form comprising a wedge-shaped member 53 or member forming a segment of a cylinder which is movable about an axis coincident with the edge 54 of the form 53, said edge being in the plane of surface 41. The form 53 is preferably integral with a rotatable supporting shank 55 which rotates first in a clockwise direction looking in the direction of arrow 7 in Fig. 3 in order to move from the position shown in Figs. 5 and 7 into the position shown in Figs. 6 and 8 to cause the end portion 31 of the wire to be bent around the axis $y$—$y$ to provide the portion 32. The axis $y$—$y$ is substantially parallel with and is in close proximity to the edge 52 of the disk 35. The form 53 is rotated back to normal position after the second bending operation. The form 53 oscillates in the space provided by the notches 46 and 49. Fig. 11 shows the location of form 53 in a position corresponding to that shown in Figs. 5 and 7 and Fig. 12 shows position of the form 53 corresponding to that shown in Figs. 6 and 8. After the work of the machine has been completed the disk 35 is retracted from the disk 34 so that the bent wire may be removed and a wire to be bent substituted.

Referring to Figs. 13, 14, 16, and 17, the machine includes a platform 60 provided with an undercut groove 61 which receives and guides brackets 62 and 63, the bases of which are shaped to conform with the groove 61. The brackets 62 and 63 support respectively the shanks 36 and 37 respectively of disks 34 and 35 and maintain these disks in alignment in any position of adjustment of the brackets. The shank 36 is provided with a threaded end 64 for receiving a nut 65. A washer 66 is located between the nut 65 and the bracket 62. The disk 34 is maintained stationary by tightening the nut 65 and a set screw 67 threaded through the bracket 62. The bracket 62 is located in proper position with respect to the forming member 53 and is then fixed in this position by tightening the screw 68 which passes through a slot 69 in the bracket 62 and threadly engages the platform 60.

The bracket 63 is moved toward the bracket 62 for the purpose of confining the wire between the disks 34 and 35 by turning a handle 70 into a position shown in Fig. 13. In this position of the handle the cylindrical periphery of its hub 71, which is pivotally supported by screw 72 threaded into platform 60, engages a block 73 slidable in the groove 61 and of such length as to cause the bracket 63 to move into the position shown in Figs. 13 and 16. A spring 75 located between the brackets and within the groove 61 tends to separate the bracket 63 from the bracket 62, and this separation takes place when the handle 70 is moved counterclockwise from the position shown in Fig. 13 until the flat face 76 of its hub 71 is adjacent the block 73.

The disk 35 is oscillated by means including a gear 80 connected by a key 81 with the shank 37 and retained by nut 82 threaded on the end of the shank, and including a rack 83 meshing with the gear 80 and supported for vertical movement by slide 84 vertically movable in a suitable groove 85 provided by a substantial cylindrical frame member 86 which sup-

ports the platform 60. The rack 83 is supported in mesh with gear 80 by bracket 87 attached to the platform 60 by screws 88. The frame 86 is supported by base 90 attached by screws 91. The platform 60 and base 90 support aligned ball bearings 92 and 93 in which a vertical shaft 94 is journalled. Shaft 94 carries a drum cam 95 which is confined between clamping washers 96 and 97 threadedly connected with the shaft 94. By adjusting these washers the vertical position of the cam 95 may be adjusted. The cam 95 is driven by the shaft 94 through a key 98. The cam 95 is provided with a race 99 which receives a roller 100 attached by screw 101 to the slide 84. The race 99 is shaped so that during one revolution of the cam 95 there will take place a vertical oscillation of the slide 84 down and up accompanied by one oscillation of the disk 35 and roller 43 for the purpose of performing the first bending operation in the manner described.

The shank 55 of the bending form 53 is supported for rotation by bracket 110 attached by screws 111 to the platform 60. Bracket 110 and shank 55 are provided with notches 110*a* and 55*a*, respectively, located normally in alignment for the purpose of providing a clearance space in which the wire end 31 is bent during the first bending operation. The shank 55 is caused to oscillate by means including a gear 112 fixed to the shank 55 by a key 113 and retained by nut 114 threaded on the end of the shank 55, and including a rack 115 attached to a vertically movable slide 116 guided by a vertical groove 117 in the frame 86 and carrying a screw 118 pivotally supporting a cam roller 119 received by a race 120 provided by the cam 95. The rack 115 is supported in engagement with the gear 112 by a bracket 121 attached by screws 122 to the platform 60. The cam race 120 is so shaped and so located with respect to the race 99 that during one revolution of the cam 95 there will take place, following the complete oscillation of the disk 35, one oscillation of the rack 115 (up and down) accompanied by an oscillation of the forming member 53.

The platform 60 supports a block 130 attached by screws 131 and having a ridge 132 a side surface 133 which is in alignment with the back wall of the notch 42 of disc 34 or with surface 41. Block 130 provides a surface 134 in horizontal alignment with the bottom side surface of the notch 42. The shank 55 carries a stop rod 135 having a stem 136 which passes centrally through the shank 55 and receives nuts 137. A spring 138, which is located between the head of the rod 135 and the back wall 139 of the recess in the shank 55 which receives the rod, urges the rod 135 toward the left to cause the nuts 137 to bear against the right end of shank 55. By turning the nuts 137 the distance between the peg 33 and the end of stop rod 135 may be varied. Before the clamping disc 35 is moved against the disc 34 the end of the wire to be bent is located against the stop rod 135, the main portion of the wire resting upon the ridge 132. It will be understood that this location of the wire is possible since the peg 33 is withdrawn from hole 39 in disc 34 a distance sufficient to permit passing the wire diametrically across the face 40 of disc 34 until the end of the wire strikes the stop rod 35. Then the wire is moved vertically downwardly upon the surface 134 of block 130 and then horizontally inwardly against the surface 133. This latter movement causes the wire to enter the groove 42. Then the handle 70 is turned to cause the clamp 35 to engage the clamp 34. This method of handling the wire including the step of moving it against a stop before clamping insures uniformity of product. By adjusting the position of the stop 135, the length of the portion 32 may be varied.

The apparatus is driven by a suitable source of power such as an electric motor (not shown) driving a belt 140 connected with a pulley 141 attached by a key 142 to the hub of a clutch member 143 loosely rotatable upon a shaft 144 journalled in a bearing 145 provided by a bracket 146 attached by screws 147 to the frame 86 and journalled in bearings 148 and 149 received by the cylindrical bore 150 provided by the frame 86 and secured by suitable screws 151. The shaft 144 is connected by key 152 with a worm 153 which meshes with a worm gear 154 connected by keys 155 with the shaft 94. A clutch member 156 is slidable on the shaft 144 and is connectable therewith by longitudinal splines 157. The clutch member 156 is moved into and out of engagement with the clutch member 143 by a bifurcated lever 158 the arms of which carry pins 159 which are received by a groove 160 in clutch member 156. Lever 158 is pivotally supported by a screw stud 161 threaded into a bracket 162 attached by screws 163 to the frame 86. The lever 158 is connected with a lever 164 having a forked end 165 carrying a pin 166 which pivotally connects the lever 164 with a sliding bar 167 received by suitable groove 168 provided by the frame 86 as shown in Fig. 19. The bar 167 has a cylindrical extension 168 which passes through a bracket 169 attached by screws 170 to the bracket 162. The extension 168 carries a collar 171; and a spring 172 which is located between the collar 171 and the bracket 169 tends to urge the levers 164 and 158 in a clockwise direction as viewed in Fig. 13 in order to move the clutch 156 out of engagement with the clutch 143. The clutch 156 is moved into engagement with the clutch 143 by suitable pedal (not shown) connected by a rod 175 with a bell crank lever 176 pivoted at 177 upon a bracket 178 attached to the bracket 162 by screws 179 as

shown in Figs. 14 and 9. The lever 176 has an arm 180 for engaging the extension 168 of sliding bar 167. Hence downward movement of the rod 175 will cause the bar 167 to move from a clutch disengaging position into a clutch engaging position shown in Figs. 13, 14 and 19. After a certain movement of the shaft 94 in a counterclockwise direction as viewed in Fig. 15 the bar 167 will be held in clutch engaging position by the reason of the fact that the hook end 181 of the bar 167 will be located inside an annular flange 182 provided by disk 183 attached to the gear 154 by a key 184. Normally the hook end 181 occupies the position 181*a* in Fig. 15 within a notch 185 provided by the annular flange 182. When the clutch is engaged by operation of the foot pedal the hook end will move into the full line position 181 shown in Fig. 15. After the disk 183 has been turned by the shaft 144 sufficiently to move the notch 185 out of radial alignment with the hook end 181, the operator may release the pedal since the clutch will now be maintained in engagement due to the fact that the hook end 181 must remain on the inside of the flange 182. At the end of one revolution of the cam 95 the notch 185 will have been turned into alignment with the hook end 181, whereupon the spring 172 will be released and will expand to cause the bar 167 to move into clutch disengaging position. In this way the machine is automatically caused to stop after having completed one cycle of operations accompanying one revolution of the shaft 94.

The perspective views, Figs. 9 to 12 show covers 200 and 201 for enclosing the cooperating gears and racks.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Metal bending apparatus comprising, in combination, a device for edgewise bending an end portion of a metal strip, which is oblong in cross section, out of alignment with its main portion, means for preventing twisting of the strip whereby both portions thereof are maintained in the same plane, a device for bending the end portion laterally with respect to the plane of the main portion while the main portion remains fixed, and mechanism for automatically causing the bending devices to operate successively.

2. Metal bending apparatus comprising, in combination, a cylindrical form, means for holding a metal strip against the form, a movable forming member for causing the strip to be bent around the cylindrical form, a device for moving the movable forming member in an orbit coaxial with the form, a device for bending the strip laterally with respect to the plane of first bending, and mechanism for automatically causing the devices to operate successively.

3. Metal bending apparatus comprising, in combination, a cylindrical form, means for holding a metal strip against the form and for confining it in a certain plane, said means including a form supporting member rotatable about the axis of the form, a movable forming member for causing the strip to be bent around the cylindrical form said movable forming member being carried by the rotatable form supporting member eccentrically of its axis, a device for bending the strip laterally with respect to the plane of first bending, and mechanism for automatically causing the movable forming member and lateral bending device to operate successively.

4. Metal bending apparatus comprising, in combination, a pair of members providing surfaces between which a metal strip may be confined while being bent, one of said members being rotatable, a cylindrical form about which the strip may be bent said form being supported by the rotatable member coaxially therewith, a movable forming member carried by said rotatable member eccentrically of its axis and adapted to engage the strip to cause it to be bent around the cylindrical form when the rotatable member is turned, a device for bending the strip laterally with respect to the plane of first bending, and mechanism for automatically causing the movable forming member and lateral bending device to operate successively.

5. Metal bending apparatus comprising, in combination, a pair of members providing surfaces between which a metal strip may be confined while being bent, one of said members being rotatable, a cylindrical form about which the strip may be bent said form being supported by the rotatable member coaxially therewith, a movable forming member carried by said rotatable member eccentrically of its axis and adapted to engage the strip to cause it to be bent around the cylindrical form when the rotatable member is turned, a device for bending the strip laterally with respect to the plane of first bending, said device comprising a stationary form provided by one of said pair of members, and a movable forming member cooperating therewith, and mechanism for automatically causing the movable forming members to operate in succession.

6. Metal bending apparatus comprising, in combination, a cylindrical bending form about which the end portion of a flat strip is bent edgewise out of alignment with its main portion, a pair of clamping members having facing, parallel, plane surfaces between which the strip is confined during edgewise bending, one of said clamping members being stationary and having a groove for re-

ceiving a part of the main portion of the strip, the end portion to be bent extending beyond the groove, the other of said clamping members being laterally movable to facilitate placing the strip in the groove and being rotatable coaxially with the cylindrical form, a movable form attached to the rotatable clamping member eccentrically thereof and operating to engage the strip and to cause it to be bent around the cylindrical form when the second clamping member is rotated, said clamping members being shaped so as to provide a space into which the end portion of the wire extends after having been bent; means for bending the end portion of the strip laterally with respect to the plane of first bending, said means comprising a stationary form provided by one of the clamping members, and a movable form movable in said space which receives the end portion of the strip; and mechanism for successively moving the movable bending forms.

7. Metal bending apparatus comprising, in combination, a cylindrical bending form about which the end portion of a flat strip is bent edgewise out of alignment with its main portion, a pair of clamping members between which the main portion is confined, in engagement with the cylindrical form, one of the clamping members being rotatable coaxially with respect to the cylindrical form, a movable form carried by the rotatable clamping member for causing the end portion of the wire to be bent about the cylindrical form when the rotatable clamping member is rotated, said clamping members being shaped so as to provide a space into which the end portion of the wire extends after having been bent; means for bending the end portion of the strip laterally with respect to the plane of first bending, said means comprising a stationary form provided by one of the clamping members and a movable form movable in said space which receives the end portion of the strip and rotatable about an axis at right angles to the axis of the rotatable clamping member; and mechanism for successively moving the movable bending forms.

8. Metal bending apparatus comprising, in combination, a cylindrical bending form about which the end portion of a flat strip is bent edgewise out of alignment with its main portion, a pair of clamping members between which the main portion is confined in engagement with the cylindrical form, one of the clamping members being rotatable coaxially with respect to the cylindrical form, a movable form carried by the rotatable clamping member for causing the end portion of the wire to be bent about the cylindrical form when the rotatable clamping member is rotated, said clamping members being shaped so as to provide a space into which the end portion of the wire extends after having been bent; means for bending the end portion of the strip laterally with respect to the plane of first bending, said means comprising a stationary form provided by one of the clamping members and a movable form movable in said space which receives the end portion of the strip and rotatable about an axis at right angles to the axis of the rotatable clamping member; gears connected respectively with the movable bending forms; parallel racks each having a cam roller and each cooperating with a gear; a drum cam having races respectively receiving the cam rollers and rotatable about an axis parallel to the movement of the racks; a clutch for connecting the cam with a power shaft; and means for automatically disconnecting the clutch at the end of one revolution of the cam.

9. A machine of the character described, comprising in combination, a device for bending an end portion of a metal strip out of alignment with its main portion while holding the main portion fixed, a device for bending the end portion laterally with respect to the plane of the main portion, means for operating the bending devices successively, a power shaft, a clutch for connecting the bending devices with said power shaft to be operated thereby, means for automatically disconnecting the clutch at the end of one cycle of operation of the machine, and for preventing disengagement thereof until the completion of said one cycle of operation.

In testimony whereof I hereto affix my signature.

LORA E. POOLE.