

May 12, 1953

L. B. GREEN
BENDING MACHINE HAVING OSCILLATING ANVIL
DIE AND RECIPROCABLE IRONING DIE

2,638,142

Filed Feb. 14, 1951

7 Sheets-Sheet 1

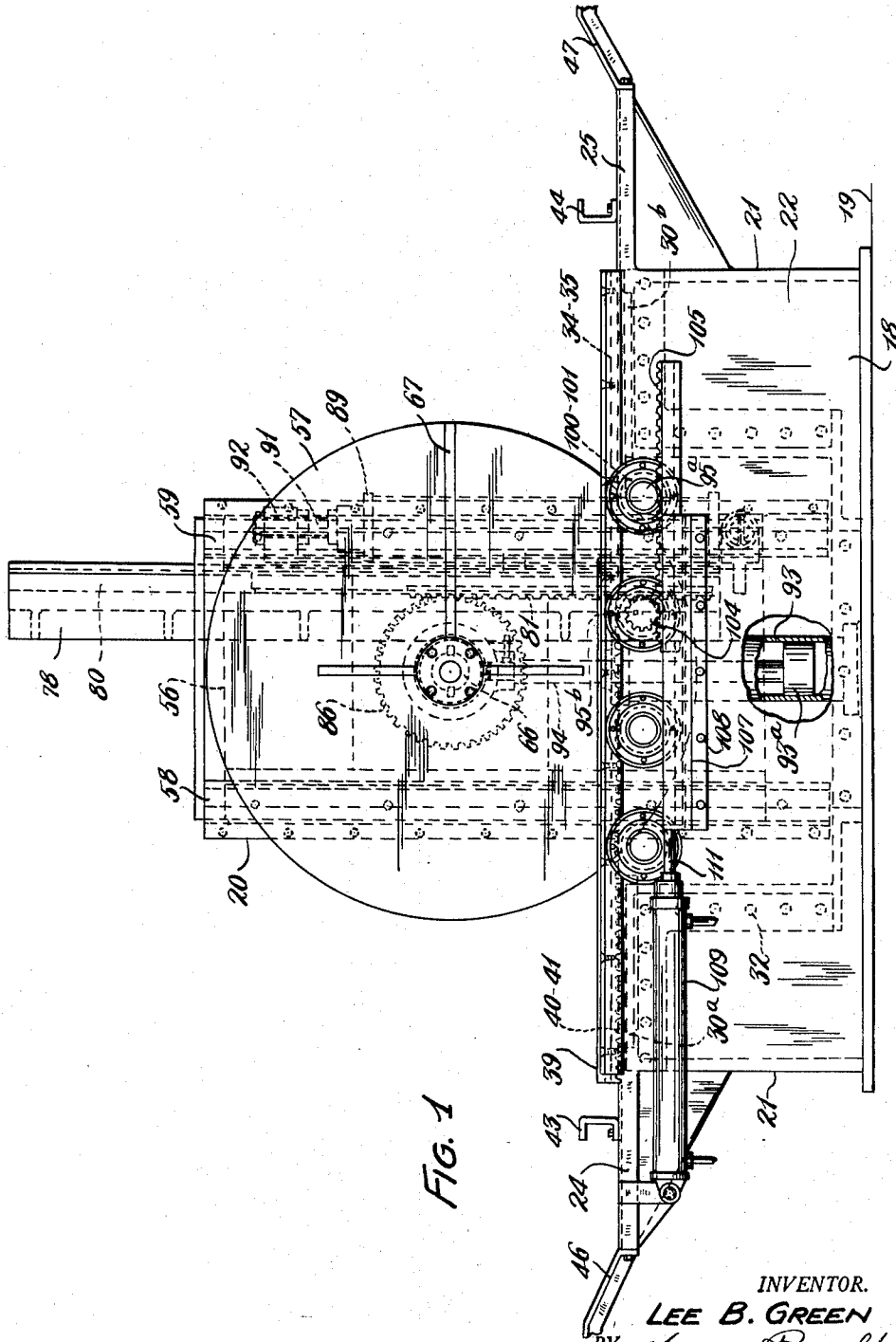


FIG. 1

INVENTOR.

LEE B. GREEN

BY

Hudson, Doughton

Williams, David & Hoffmann.

ATTORNEYS

Filed Feb. 14, 1951

7 Sheets-Sheet 3

7 Sheets-Sheet 3



FIG. 3

LEE B. GREEN

BY *Hudson, Brighton*
James, David & Hoffmann
ATTORNEYS

May 12, 1953

L. B. GREEN
BENDING MACHINE HAVING OSCILLATING ANVIL
DIE AND RECIPROCABLE IRONING DIE

2,638,142

Filed Feb. 14, 1951

7 Sheets-Sheet 4

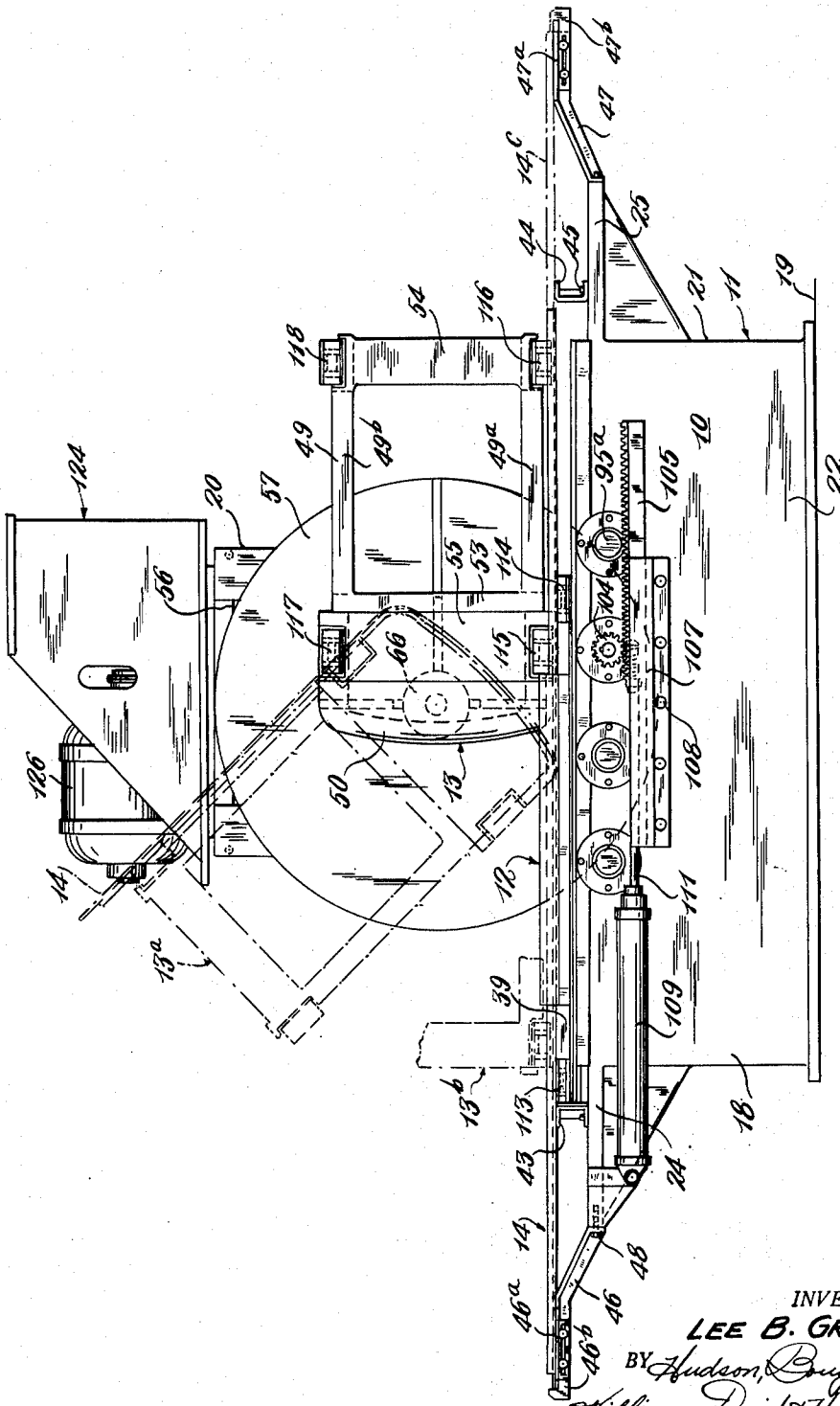


FIG. 4

INVENTOR.
LEE B. GREEN
BY *Hudson, Boughton,*
Williams, David & Hoffmann
ATTORNEYS

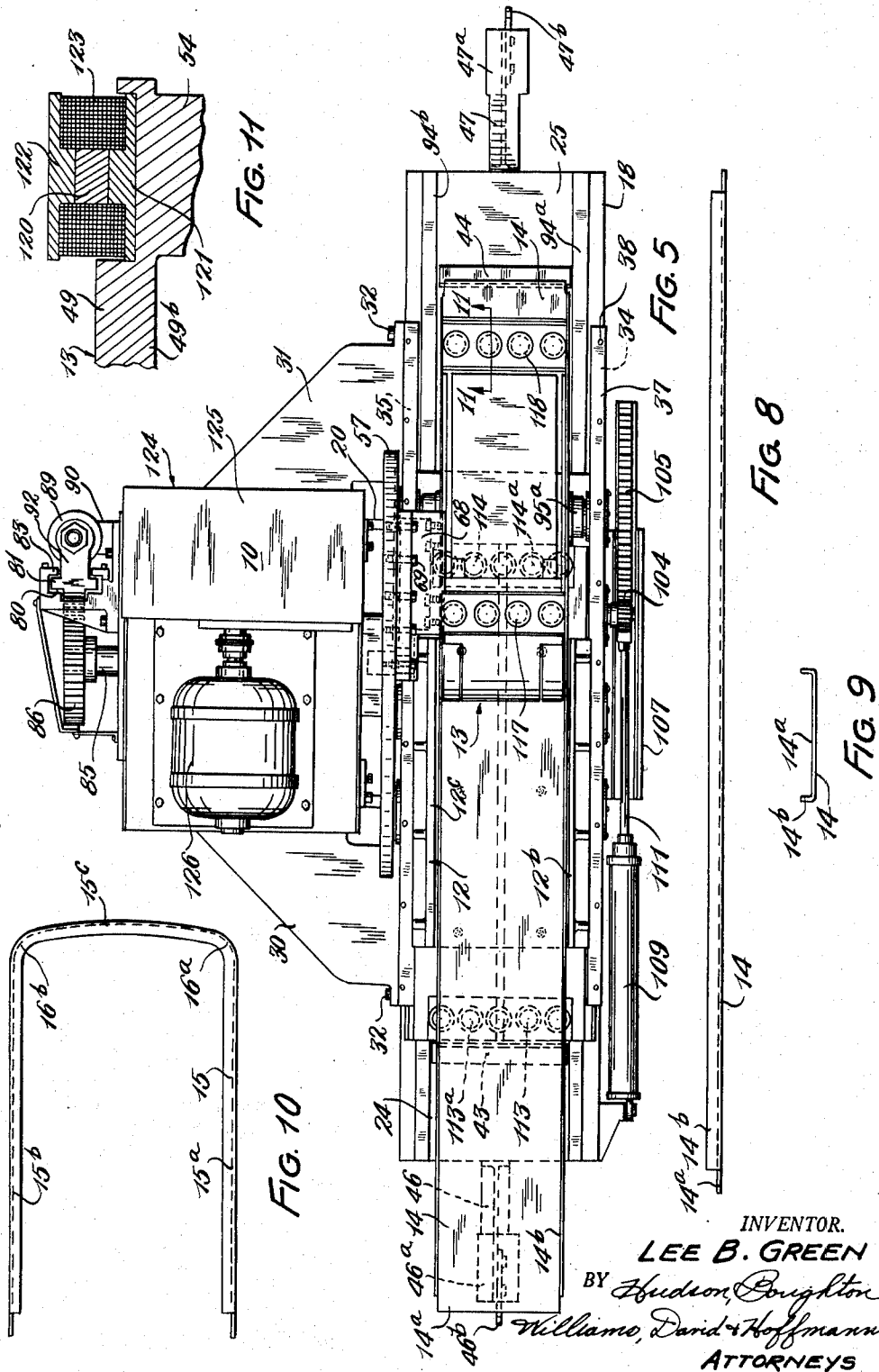
May 12, 1953

L. B. GREEN
BENDING MACHINE HAVING OSCILLATING ANVIL
DIE AND RECIPROCABLE IRONING DIE

2,638,142

Filed Feb. 14, 1951

7 Sheets-Sheet 5



May 12, 1953

L. B. GREEN
BENDING MACHINE HAVING OSCILLATING ANVIL
DIE AND RECIPROCABLE IRONING DIE

2,638,142

Filed Feb. 14, 1951

7 Sheets-Sheet 6

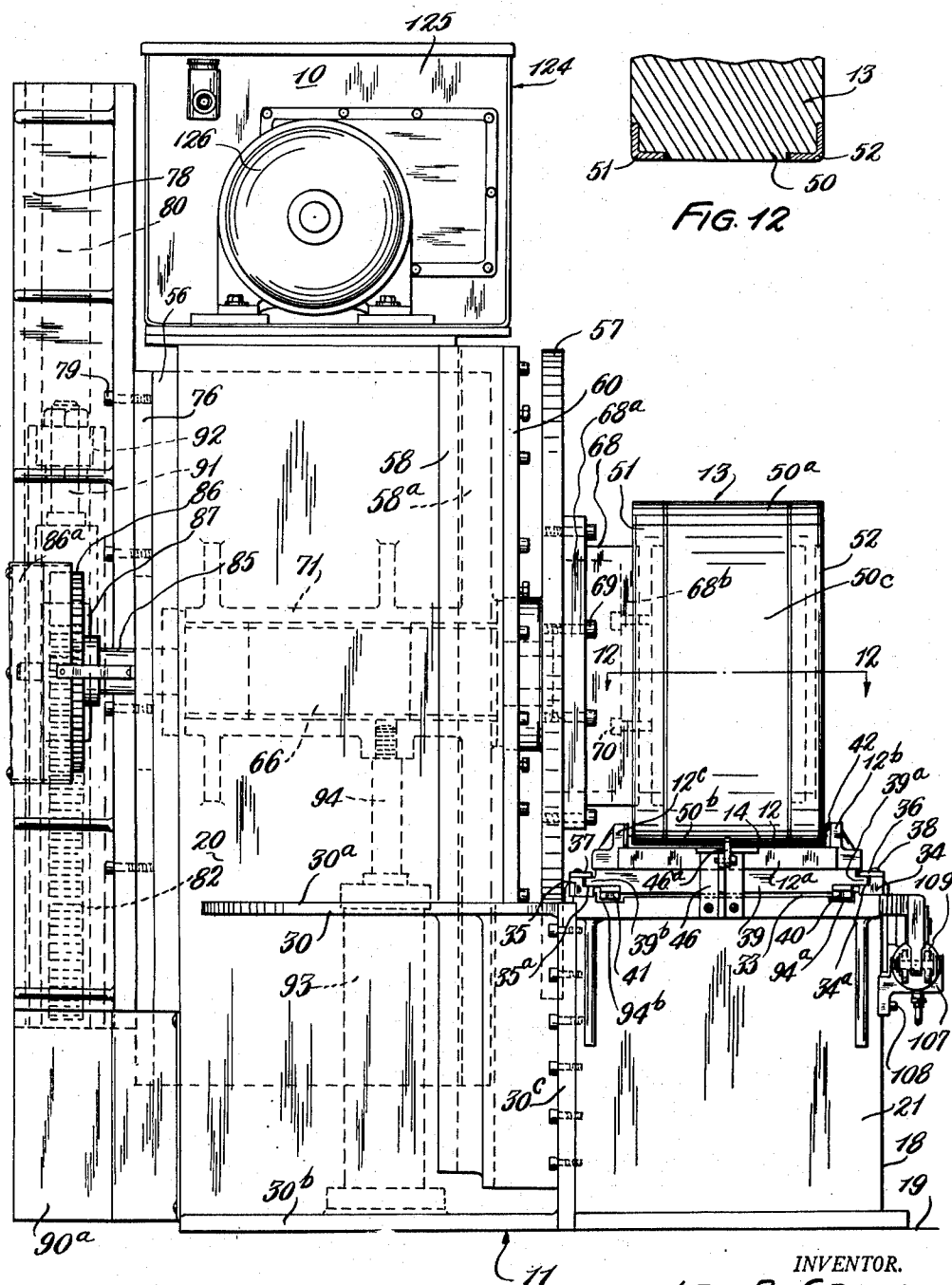


FIG. 6

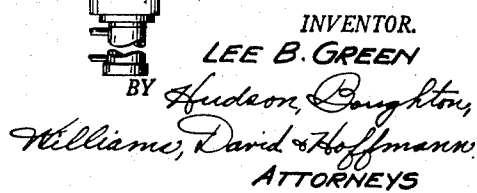
INVENTOR.
LEE B. GREEN

BY *Hudson, Boughton*
Williams, David & Hoffmann
ATTORNEYS

Filed Feb. 14, 1951

2,638,142

7 Sheets-Sheet 7



UNITED STATES PATENT OFFICE

2,638,142

BENDING MACHINE HAVING OSCILLATING
ANVIL DIE AND RECIPROCABLE IRONING
DIE

Lee B. Green, Lakewood, Ohio

Application February 14, 1951, Serial No. 210,965

9 Claims. (Cl. 153—43)

1

This invention relates to bending machines of the kind which carry out bending operations on metal workpieces, and particularly on workpieces having web and flange portions, and wherein the web portion is bent out of its own plane and the flange portion is bent within its own plane without wrinkling or buckling.

The bending machines of this kind which have been devised heretofore have accomplished generally satisfactory results but this applicant has recognized that room for further improvement existed with respect to the provision of a different and more satisfactory die means and with respect to a form of bending machine having a more rapid rate of production.

As one of its objects, the present invention accordingly provides an improved bending machine of the character mentioned above in which the novel die means comprises an ironing die member adapted for rectilinear translatable movement and an anvil die member having rocking cooperation with the ironing die member during the rectilinear translatable movement thereof and around which anvil die member the workpiece is bent by such rocking cooperation.

Another object of this invention is to provide an improved bending machine of this character wherein the frame of the machine has a guideway thereon along which the ironing die member is movable in an edgewise or endwise direction.

A further object is to provide an improved bending machine of the character referred to in which the frame of the machine has a second guideway thereon extending in a direction substantially normal to the first guideway and carrier means for the anvil die member is movable along the second guideway for causing opening and closing of the anvil die member relative to the ironing die member.

As still another object, this invention provides an improved bending machine of the kind mentioned above in which the carrier means on the second guideway includes a pivoted support or face plate for the anvil die member by which the rocking cooperation of this die member with the ironing die member is obtained.

Yet another object is to provide an improved bending machine of this character in which a much more rapid rate of production is obtainable by reason of the fact that the die members are adapted to cause the bending of a workpiece during each half cycle of die operation such that two fully formed workpieces are produced for each complete cycle of the machine.

2

Another object is to provide an improved bending machine of the kind above referred to in which the second guideway is located adjacent the midpoint of the first guideway such that the rocking cooperation of the anvil die member and the ironing die member in moving from an initial die position to a second die position accomplishes the complete bending operation on one workpiece, and the rocking cooperation of these die members in moving from such second die position back to the initial die position accomplishes the complete bending operation on a second workpiece.

As a further object this invention provides an improved bending machine of the character mentioned in which control means, preferably a braking means, for the ironing die member is effective to control the rate and direction of the movement thereof during the bending operation.

This invention also provides a novel arrangement of work gripping devices, preferably of the electromagnetic type, in association with the above-mentioned anvil and ironing die members.

An additional object of this invention is to provide an improved construction for a bending machine of the kind here under consideration in which the anvil die member is non-symmetrical having, for example, a convex die surface of progressively varying curvature.

It is likewise an object of this invention to provide a bending machine having the characteristics mentioned above and in which a stretching of the workpiece is accomplished simultaneously with the bending thereof.

The invention can be further briefly summarized as consisting in certain novel combinations and arrangements of parts hereinafter described and particularly set out in the claims hereof.

In the accompanying sheets of drawings,

Fig. 1 is a front elevation of a bending machine embodying the present invention but showing the machine with a portion thereof broken away and with the anvil and ironing die members and the hydraulic pumping unit omitted;

Fig. 2 is a partial plan view of the machine showing the same with the anvil and ironing die members and the hydraulic pumping unit omitted;

Fig. 3 is a vertical section taken through the machine substantially as indicated by section line 3—3 of Fig. 2;

Fig. 4 is another front elevation showing the

improved bending machine complete with anvil and ironing die members;

Fig. 5 is another plan view showing the machine complete with anvil and ironing die members;

Fig. 6 is a left end view of the complete machine of Figs. 4 and 5;

Fig. 7 is a larger scale transverse sectional detail view corresponding with a portion of Fig. 3 and further illustrating the ironing die member and the supporting and control means therefor;

Fig. 8 is a side elevation showing one form of workpiece on which bending operations can be performed by this improved machine;

Fig. 9 is an end view of the workpiece;

Fig. 10 is an elevation showing an article produced by the bending operation which is carried out on the workpiece of Figs. 8 and 9;

Fig. 11 is a partial vertical section taken through one of the electromagnetic work gripping devices substantially as indicated by section line 11—11 of Fig. 5;

Fig. 12 is a transverse sectional detail taken through the head of the anvil die member as indicated by section line 12—12 of Fig. 6;

Fig. 13 is a front elevation of a modified form of the improved bending machine;

Fig. 14 is a partial vertical section taken through the modified machine, as indicated by section line 14—14 of Fig. 13; and

Figs. 15 and 16 are side and end views, respectively, showing one form of workpiece on which bending operations can be performed by the modified bending machine.

The embodiment of the improved bending machine 10 which is illustrated in Figs. 1 to 7 inclusive comprises, in general, a main frame 11 and a pair of cooperating die members consisting of an ironing die member 12 supported on the frame for translatable rectilinear movement and an anvil die member 13 supported on the frame for opening and closing movements relative to the ironing die member and also for swinging movement in rocking cooperation with the ironing die member during the translatable movement of the latter.

The cooperating die members 12 and 13 carry out a bending operation on an elongated longitudinally flanged metal workpiece 14 received therebetween. Although the improved bending machine 10 can be used for carrying out bending operations on a great variety of different workpieces, the workpiece 14 here shown by way of example is an elongated sheet metal body having a substantially flat web portion 14a and longitudinal edge flanges 14b. As will be explained in greater detail hereinafter, the bending operation converts the elongated workpiece 14 into a substantially U-shaped housing member or cabinet section 15, as shown in Fig. 10, and which can be used to form a portion of the housing or cabinet of an electric refrigerator, or for any other desired use.

As shown in Fig. 10, the cabinet section 15 has substantially parallel side portions 15a and 15b which are formed by the end portions of the workpiece 14, and also has an end or top portion 15c connecting the parallel side portions 15a and 15b and formed by the intermediate portion of the workpiece. The bending operation carried out by the improved machine 10 in producing the cabinet section 15 from the workpiece 14 makes two relatively small radius bends 16a and 16b in the workpiece at longitudinally spaced

points. These bends are shown in Fig. 10 in which the bend 16a forms the junction between the portions 15a and 15c of the cabinet section 15 and the bend 16b forms the junction between the portions 15b and 15c of this cabinet section.

Depending upon the shape desired for the final product in which the cabinet section 15 is used, the end or top portion 15c can be a flat portion or can be given a longitudinally bowed shape forming an arch extending between and connecting the bends 16a and 16b, as shown in Fig. 10. The formation of the bends 16a and 16b in the workpiece 14, and the bending of the workpiece to produce the longitudinally bowed condition of the end portion 15c, are carried out smoothly and rapidly by this improved machine during which the web portion 14a of the workpiece is bent out of its own plane and the marginal longitudinal flanges 14b are bent within their own planes without having any wrinkling or buckling occur therein and without requiring any preparatory notching or cutting of these flanges.

The main frame 11 of the bending machine 10 comprises a laterally elongated front frame member 18 adapted to stand on a supporting floor or foundation 19 and an upright rear frame member 20 also adapted to stand on the floor or foundation 19 and located in the rear of, but closely adjacent to, the front frame member and substantially opposite the intermediate portion of the latter. The front frame member 18 is of a hollow box-like form having upright end walls 21 and spaced upright front and rear walls 22 and 23. The front frame member 18 is also provided adjacent the ends thereof with substantially horizontally disposed top walls or table portions 24 and 25. The table portions 24 and 25 extend longitudinally of the front frame member 18 and are in aligned relation with each other, as shown in Figs. 2 and 5. The inner or adjacent ends of the table portions 24 and 25 are spaced apart a substantial distance, as shown in Fig. 2, leaving a center opening 26 in the intermediate portion of the front frame member 18 and substantially opposite the upright rear frame member 20.

The rear frame member 20 extends in an upright relation behind the intermediate portion of the front frame member 18, as mentioned above and as shown in the drawings, and is in the form of a rigid unitary hollow member having spaced upright full-height side walls 20a and 20b and a vertical space or passage 27 therein between these side walls. The rear frame member 20 is also provided, for a portion of its height, with an upright front wall 28 which extends between and connects the upright side walls 20a and 20b. As shown in Fig. 2, the rear frame member 20 is connected with the front frame member 18 by having its upright partial front wall 28 connected to the upright rear wall 23 of the front frame member as by means of the screws 29.

The rear frame member 20 is also connected with the front frame member 18 at longitudinally spaced points of the latter by means of the laterally and forwardly projecting connecting brackets 30 and 31 of this rear frame member. These connecting brackets have their inner or adjacent ends integrally connected with the upright side walls 20a and 20b of the rear frame member 20 and have their front or outer ends connected with the upright rear wall 23 of the front frame member 18 as by means of the screws 32. As shown in Fig. 6, the bracket 30 comprises a pair of vertically spaced substan-

5

tially horizontal upper and lower webs 30a and 30b and an upright front wall 30c extending between and connecting the webs and through which front wall the screws 32 extend. Similarly, the bracket 31 comprises horizontal webs 31a and 31b and a vertical front wall 31c connecting these webs.

The front frame member 18 is provided with a longitudinally extending guideway 33 (see Figs. 2, 3 and 7) along which the ironing die member 12 is movable with endwise rectilinear movement, as will be further explained hereinafter. This longitudinal guideway is formed by a pair of front and rear guide rails 34 and 35 which are preferably formed integral with the front frame member 18 and extend longitudinally thereon above the front and rear upright walls 22 and 23. These guide rails are of a length such that they span the center opening 26 of the front frame member 18 with their ends extending for some distance along the table portions 24 and 25, as shown in Fig. 2.

The guide rails 34 and 35 have longitudinally extending recesses or rabbets 34a and 35a formed in their adjacent edges which define the front and rear edges of the guideway 33. The guide rails 34 and 35 are provided with longitudinal cover strips 36 and 37 which are secured thereto by suitable screws 38 and which overhang the recesses 34a and 35a, as shown in Fig. 6.

An ironing die carrier 39 (see Figs. 2, 3, 6 and 7) having the ironing die member 12 mounted thereon is movable in the longitudinal guideway 33 of the front frame member 18. The ironing die carrier 39 is here shown as comprising an elongated substantially flat metal plate having longitudinal edge flanges 39a and 39b along its front and rear edges and which flanges are slidable in the guide recesses 34a and 35a of the guide rails 34 and 35 and are retained in these guide recesses by the cover strips 36 and 37. For a purpose to be explained hereinafter the ironing die carrier 39 is provided with a pair of longitudinally extending racks 40 and 41 on the underside thereof and located adjacent the front and rear edge flanges 39a and 39b.

The ironing die member 12 is an elongated channel-shaped die member (see Figs. 6 and 7) which is bolted or otherwise secured to the top face of the ironing die carrier 39. In this instance the ironing die member 12 is formed by a plurality of connected sections comprising a substantially flat intermediate plate member 12a and a pair of longitudinal side members 12b and 12c extending along and connected to the front and rear edges of the intermediate plate member. The upper longitudinal portions of the side members 12b and 12c cooperate with the plate member 12a in defining the longitudinal channel recess of the ironing die member 12 in which the workpiece 14 is received. These upper portions of the longitudinal side members 12b and 12c are preferably provided with hardened flat longitudinal wear strips 42 secured against their inner faces and which cooperate with and confine the flanges 14b of the workpiece during the bending operation.

The endwise longitudinal rectilinear movement of the bending die member 12 and the bending die carrier 39 takes place between a pair of stops 43 and 44 mounted on the table portions 24 and 25 of the front frame member 18 and extending transversely of these table portions. The anvil die stops 43 and 44 are here shown as being in the form of channel-shaped bars which are se-

6

cured to the table portions 24 and 25 by bolts 45, or the like, extending through one of the side flanges of the bars. The workpiece 14 is usually of a greater length than the ironing die member 12 such that its end portions project beyond the ends of this die member and, in which case, the stops 43 and 44 also serve as supports for these projecting end portions of the workpiece.

For locating and holding the workpiece or workpieces in proper position in the machine, the front frame member 18 is provided at opposite ends thereof with a pair of work supports 46 and 47 (see Figs. 1, 4 and 5). These work supports are here shown as being in the form of brackets secured to the outer ends of the table portions 24 and 25 by bolts 48, or the like, and having straight flat portions 46a and 47a whose upper surfaces lie substantially in the same horizontal plane as the top surface of the plate section 12a of the ironing die member 12.

These straight flat portions 46a and 47a of the work supports 46 and 47 receive and support the outer ends of the workpieces 14 when such workpieces are received in the channel recess of the ironing die member 12. Hook-shaped locating fingers 46b and 47b are provided on the work supports 46 and 47 and form stops against which the outer ends of the workpieces are adapted to be abutted. These locating fingers have adjustable connection with the work supports 46 and 47 which permits the fingers to be shifted in or out relative to the work supports and to be clamped in the desired position of adjustment.

The anvil die member 13 comprises a frame or body 49 (see Figs. 4 and 5) and a convexly curved head 50 secured to such frame at one end thereof. The convexly curved head 50 comprises spaced end portions 50a and 50b having a relatively short radius of curvature and an intermediate or connecting portion 50c which extends between and merges smoothly into the curved end portions 50a and 50b and which is convexly bowed to a much larger radius of curvature than the end portions. The radius of curvature of the intermediate portion 50c corresponds with the relatively long radius of curvature which is formed on the connecting portion 15c of the cabinet section 15 being produced. The head 50 is preferably also provided with inset hardened wear strips 51 and 52 along its longitudinal side edges which are of an angular cross-sectional shape, as shown in Fig. 12, and at their ends have a convex curvature corresponding with the convex curvature of the end portions 50a and 50b of the head.

The frame 49 of the anvil die member 13 can be an open structure having parallel sides 49a and 49b connected by end bars 53 and 54. The frame 49 also comprises a filler portion or block 55 disposed between the end bar 53 and the head 50 and by which the head is connected with the frame 49. The head 50 of the anvil die member 13 is of a width such that it will be received between the flanges 14b of the workpiece 14 and will hold these flanges firmly against the upright wear strips 42 of the ironing die member 12.

The anvil die member 13 is mounted on the rear frame member 20 so as to be capable of translatable closing and opening movements relative to the ironing die member 12 for clamping or releasing the workpiece 14. The anvil die member 13 is also mounted on the rear frame member 20 so as to be capable of a swinging movement for rocking cooperation with the ironing die member 12 substantially simultaneously with the endwise rectilinear movement of the latter.

To provide for such an opening and closing movement of the anvil die member 13, as well as such a swinging movement thereof, a mounting means is employed for this die member comprising a carrier or slide 56 reciprocably movable in the upright passage 27 of the rear frame member 20 and a support 57 which is pivotally connected with the carrier 56 so as to be capable of a pivoted or oscillating movement. The carrier 56 comprises a vertically elongated unitary rigid body of a generally square cross-sectional shape which is reciprocably movable in an endwise direction in the passage 27 of the rear frame member 20.

The side walls 29a and 29b of the rear frame member 20 are provided along their upright front edges with a pair of laterally spaced upright guide rails 58 and 59 containing recesses or rabbets 58a and 59a defining an upright guideway for the carrier 56. This guideway is also formed, in part, by cover strips 60 and 61 which are secured to the guide rails 58 and 59 as by means of the screws 62. The cover strips 60 and 61 are here shown as having hardened wear strips 63 secured against the inner faces thereof as by the screws 64. The carrier 56 is provided at the front thereof with a solid plate portion 56a whose upright side edges are slidable in the guide recesses 58a and 59a and are retained therein by the cover strips 60 and 61.

The support 57 is here shown as comprising a vertical face plate or disk which is mounted on the carrier 56 at the front thereof and in substantially parallel relation to the plate portion 56a by means of a laterally extending rockshaft 66. The support 57 has a substantially flat front face 57a which is provided with one or more dovetail slots 67. The anvil die member 13 is secured to the flat front face 57a of the support 57 as by means of a hollow mounting bracket 68 having a rear flange 68a and an upright front wall 68b. The mounting bracket 68 is secured to the support 57 by means of screws 69, or the like, extending through the rear flange 68a, and the anvil die member 13 is secured to the mounting bracket by means of screws 70, or the like, extending through the front wall 68b of the bracket and engaging the frame 49 and the filler block 55.

As shown in Fig. 3, the carrier 56 is provided at an intermediate point of its height with a tube portion or sleeve 71 extending rearwardly from the front wall 56a. The rockshaft 66 is mounted in the sleeve 71 by suitable bushings 72 and 73 and has a reduced front end portion 74 which extends into a substantially central opening 75 of the support 57 and to which the support is keyed or otherwise connected for rotation with this rockshaft.

At the rear thereof the carrier 56 is provided with an upright flat plate 76 which is secured thereto as by means of screws 77, or the like. The carrier 56 also includes an elongated upright guide member 78 which, in this instance, is a separate part secured to the rear plate 76 as by means of screws 79, or the like. The guide member 78 is provided with a channel-shaped upright longitudinal guideway 80 in which a slide 81 is reciprocably movable and carries a rack 82. The guideway 80 is formed, in part, by cover strips 83 secured to the guide member by means of screws 84 and which retain the slide 81 in the guideway 80.

As shown in Fig. 3, the rear plate 76 of the carrier 56 is provided with an opening 76a and the rockshaft 66 is provided with a reduced shaft

portion 85 which projects rearwardly from the carrier and extends through this opening. The guide member 78 is connected with the rear plate 76 so as to be located adjacent the shaft extension 85, but to the right thereof as shown in Figs. 2 and 5. A gear 86 mounted in fixed relation on the shaft extension 85 meshes with the rack 82 to be driven thereby. The meshing engagement of the gear 86 with the rack 82 takes place through a slot 87 formed in the guide member 78 at a point opposite the shaft extension 85.

The above-mentioned rocking cooperation of the anvil die member 13 with the ironing die member 12 is produced by swinging of the anvil die member about the axis of the rockshaft 66 and this swinging of the anvil die member is produced by actuation of the rockshaft. Rocking movement is imparted to the shaft 66 by reciprocation of the rack 82 in meshing engagement with the gear 86.

For actuation of the rack 82 a power cylinder 89, preferably a hydraulic cylinder, is provided on the carrier 56 and in this instance is shown located in upright relation adjacent the guide member 78. The cylinder 89 is a double-acting cylinder having its lower end connected with a bracket 90 projecting rearwardly from the rear plate 76 of the carrier 56. A piston (not shown) operable in the cylinder is connected with a piston rod 91 which projects from the upper end of the cylinder and is connected with a projecting lug 92 of the slide 81. As shown in Fig. 6, sheet metal guards 93a and 93b can be provided on the back of the machine for the gear 86 and for the lower ends of the guide member 78 and the rack 82.

From the construction above described it will be seen that when hydraulic pressure fluid is supplied to one end of the cylinder 89, for example the lower end, the rack 82 will be moved upwardly to cause actuation of the rockshaft 66 and swinging of the anvil die member 13 in a counter-clockwise direction. When hydraulic pressure fluid is supplied to the upper end of cylinder 89, the rack 82 will be moved downwardly to thereby actuate the rockshaft 66 and cause a clockwise swinging movement of the anvil die member 13.

The above-mentioned closing and opening movements of the anvil die member 13 relative to the ironing die member 12 are produced by downward and upward movements of the carrier 56 in the guideway of the rear frame member 20. For producing such movements of the carrier 56, a power cylinder 93, preferably a hydraulic cylinder, is provided in upright relation in the rear frame member 20 as shown in Figs. 3 and 6. The lower end of the cylinder 93 is connected in fixed relation with the lower portion of the rear frame member 20. A piston 93a operable in the cylinder 93 (see Fig. 1) is connected with a piston rod 94 which projects from the upper end of the cylinder. The upper end of the piston rod 94 is provided with a threaded portion 94a by which this end of the rod is connected in fixed relation to the sleeve 71 of the carrier 56.

From the arrangement just described above, it will be seen that when hydraulic pressure fluid is supplied to the lower end of the cylinder 93 the carrier 56 will be moved upwardly to cause opening movement of the anvil die member 13 relative to the ironing die member 12 to permit the insertion of a workpiece 14 therebetween and removal of the cabinet section 15 resulting from the bending operation performed on the work-

piece. Hydraulic pressure fluid supplied to the upper end of the cylinder 93 causes a downward movement of the carrier 56 and a corresponding closing movement of the anvil die member relative to the ironing die member 12 for clamping the workpiece 14 between these die members in preparation for and during the bending operation.

As explained above, the ironing die carrier 39 is slidable in the guideway 33 of the front frame member 13 and is movable back and forth across the center opening 26 of the front frame member. For also supporting the ironing die carrier 39 and absorbing the thrust of the anvil die member 13, the front frame member 18 is provided with a group of rolls located in the opening 26 and extending between the front and rear walls 22 and 23 of the front frame member 18. In this instance this group of rolls comprise three idler rolls 95a and a roll 95b which is adapted to be driven or have its rotation controlled, as hereinafter explained. During this reciprocating movement of the ironing die carrier 39, the racks 40 and 41 thereof are accommodated by front and rear longitudinal clearance grooves 94a and 94b formed in the table portions 24 and 25.

The roll 95b and each of the rolls 95a are provided with reduced front and rear end shaft portions 96 and 97 which are journaled in suitable front and rear bearings 98 and 99 carried by the front and rear walls 22 and 23 of the front frame member 18. The roll 95b is also provided with a pair of front and rear gears 100 and 101 which are secured in fixed relation on the reduced front and rear end shaft portions 96 and 97 of these rolls. The gears 100 and 101 are continuously in meshing engagement with the front and rear racks 40 and 41 of the ironing die carrier 39.

The bodies of the rolls 95 are of a smooth cylindrical shape and have rolling engagement with the flat lower surface 102 of the ironing die carrier 39. The cylindrical bodies of the rolls 95 form an anti-friction support for the ironing die carrier 39 and particularly for the portion of the ironing die carrier to which a heavy downward clamping force is being applied by the anvil die member 13. In addition to providing an anti-friction support for the anvil die carrier, the rolls 95 prevent downward deflection of the anvil die member 12, and the meshing engagement of the front and rear gear members 100 and 101 of the roll 95b with the front and rear racks 40 and 41 of the ironing die carrier 39 prevents misalignment or skewing of the ironing die carrier during its endwise movement in the guideway 33 of the front frame member 18.

For controlling the endwise movement of the anvil die member 12, the roll 95b is constructed with a front shaft extension 103 having a gear 104 mounted in fixed relation thereon and the front frame member 18 is provided with a movable rack 105 having meshing engagement with this gear. The rack 105 is reciprocably slidable in a guideway 106 formed by the longitudinal channel-shaped recess of an elongated bracket or guide rail 107 which is secured to the front wall 22 of the front frame member 18 by means of screws 108, or the like.

The rack 105 is sometimes actuated by a double-acting power cylinder 109, preferably a hydraulic cylinder. One end of the cylinder 109 is anchored on the front frame member 18 by means of the bracket 110. A piston (not shown) reciprocably operable in the cylinder 109 is con-

nected with a piston rod 111 which projects from the other end of the cylinder and is attached to the adjacent end of the rack 105.

The rocking cooperation of the anvil die member 13 with the ironing die member 12 during the bending operation on the workpiece 14 tends to cause translatory movement of the ironing die member along the guideway 33. By controlling the rate at which pressure fluid is released from the cylinder 109, the axial movement of the rack 105 can be controlled so as to cause the gear 104 and the gears 100 and 101 of the roll 95b to resist this translatory movement of the ironing die member 12. The controlled release of pressure fluid from the left-hand end of the cylinder 109 will produce a holding or braking force resisting translatory movement of the ironing die member toward the right and, conversely, the controlled release of pressure fluid from the right-hand end of the cylinder will produce a holding or braking force resisting translatory movement of the ironing die member toward the left. Such a braking action on the translatory movement of the ironing die member is desirable because it increases the effectiveness of the ironing function of the die member 12 on the workpiece 14 and also causes the workpiece to be subjected to a drawing or stretching action during the bending thereof by which the workpiece is made to conform more smoothly and accurately to the convex contour of the anvil die member with minimum spring-back effect.

If desired, the cylinder 109 can also be used to cause a positive actuation of the ironing die member 12 in either direction during the bending operation. Thus, if a positive movement of the ironing die member 12 toward the right is desired, pressure fluid would be supplied to the right-hand end of the cylinder 109 to apply a positive actuating force to the ironing die carrier 39 through the rack 105 and through the gears 104, 100 and 101 of the driven roll 95b. Similarly, if a positive movement of the ironing die member 12 toward the left is desired, pressure fluid would be supplied to the left-hand end of the cylinder 109. Such a positive actuation of the ironing die member will increase or decrease the stretching action being produced on the workpiece during the bending thereof, depending upon the direction and magnitude of the force applied to the rack 105.

The improved bending machine 10 is provided with work gripping devices which are associated with the ironing die member 12 and with the anvil die member 13 and are adapted to grip the workpiece 14 during the bending operation thereon. Although any one of various kinds of work gripping devices could be used, the gripping devices here shown, and which will now be described, are of the electromagnetic type.

The work gripping devices associated with the ironing die member 12 consist of two groups of electromagnetic grippers or chucks 113 and 114 mounted on the ironing die carrier 39 adjacent the opposite ends thereof. As shown in Figs. 2 and 5, the group 113 comprises a row of electromagnetic chucks 113a, in this instance five such chucks, extending across the ironing die carrier 39 at or closely adjacent the left-hand end thereof. The group 114 comprises a similar row of electromagnetic chucks 114a extending across the ironing die carrier 39 at or closely adjacent its right-hand end. Suitable energizing circuits and control switch means (not

shown) are provided by which the groups of magnetic chucks 113 and 114 can be energized and deenergized independently of each other.

The work gripping devices associated with the anvil die member 13 consist of two groups of electromagnetic grippers or chucks mounted in longitudinally spaced relation on each side of the anvil die member. The chucks provided on the lower side of the anvil die member 13 as seen in Fig. 4 consist of the groups 115 and 116 and the chucks provided on the opposite side of the anvil die member consist of the groups 117 and 118. As shown in Figs. 4 and 5, each of the chuck groups 115, 116, 117 and 118 of the anvil die member 13 consists of four individual electromagnetic chucks disposed in a row extending transversely of the anvil die member. The individual chucks of these groups are designated, respectively, 115a, 116a, 117a and 118a. Suitable energizing circuits and control switch means (not shown) are provided by which the chuck groups 115 and 116 can be energized and deenergized independently of the chuck groups 117 and 118.

The individual electromagnetic chucks employed in the various groups 113 to 118 identified above can be of any suitable construction such as that illustrated in Fig. 11. As shown in this view, these electromagnetic chucks may consist of a central core means 120 including a pair of pole members 121 and 122, and an energizing winding or coil 123 located between the pole members and disposed around the core means 120. These individual electromagnetic chucks are mounted on the ironing die carrier 39 and the anvil die member 13 such that the pole members 122 thereof will be exposed for engagement by the workpiece 14 and, when the chucks of the various groups are electrically energized, they will exert a strong magnetic pull on the workpiece which will result in the workpiece being held in a firmly gripped relation.

The improved bending machine 10 is also provided with hydraulic pressure generating mechanism 124 for supplying actuating fluid to the cylinders 89, 93 and 109. This hydraulic mechanism is here shown as comprising a reservoir 125 adapted to contain a supply of oil, or other suitable liquid, and a suitable pump located in the reservoir and connected with an electric motor 126 to be driven thereby.

The detailed operation of the improved bending machine 10 will now be described. Let it be assumed, first, that the ironing die member 12 is in a position adjacent the left-hand end of the front frame member 16 and the anvil die member 13 is in a position above the right-hand end of the front frame member, as shown in Fig. 4, but with the anvil die member in an elevated or open position relative to the ironing die member. In this position of these die members the head 50 of the anvil die member 13 overlaps the adjacent end of the ironing die member 12.

A first workpiece 14 is now inserted into the machine between the anvil die member 13 and the ironing die member 12 and is supported on the latter die member in the position shown in Fig. 4. In this position the workpiece 14 is also supported partially by the stops 43 and 44 and is located longitudinally of the ironing die member 12 by the abutting engagement of the left-hand end of the workpiece with the hook-shaped stop 46b of the work support 46. In this position the workpiece also overlies the groups 113 and 114 of the electromagnetic chucks of the ironing die member. The chucks of the group 113 are now

energized to grip the left-hand end of the workpiece 14 and attach the same to the left-hand end of the ironing die carrier 39.

By supplying pressure fluid to the upper end of the cylinder 93, the carrier 56 is now moved downwardly to cause closing of the anvil die member 13 relative to the ironing die member 12 for clamping the workpiece 14 therebetween. The positions of the ironing die member 12 and the anvil die member 13 at this time are the full line positions shown in Fig. 4 and which can be conveniently referred to as their initial position. While the anvil die member 13 is in this initial position the right-hand end of the workpiece 14 extends across the magnetic chucks of the groups 115 and 116. The chucks of these groups are now electrically energized to grip the right-hand end of the workpiece and connect the same with the anvil die member such that the workpiece can be wrapped around the anvil die member during the rocking cooperation of the latter with the ironing die member 12.

Pressure fluid is now supplied to the lower end of the cylinder 99 to cause the rockshaft 86 and the support 57 to swing the anvil die member 13 in a counterclockwise direction as seen in Fig. 4, through a half cycle of movement by causing this die member to travel through the broken line position 13a to the broken line position 13b. The completion of this half cycle of swinging movement results in the anvil die member arriving at the broken line position 13b which can be conveniently referred to as the second position of the anvil die member. During this swinging of the anvil die member from its full line initial position to the second position 13b, the convexly curved head 50 remains in continuous rocking engagement with the workpiece 14 and the ironing die member 12 causing the intermediate portion of the workpiece to be wrapped around the head of the anvil die member, as is shown for the dotted line position 13a of the anvil die member. In the case of an anvil die member, such as the anvil die member 13, whose work-engaging convex surface is not concentric as to all portions thereof with the axis of the pivot shaft 66, the carrier 56 and the support 57 move up and down, as is permitted by the power cylinder 93, during rocking of such convex surface of the anvil die member on the workpiece. During this bending operation the ironing die member 12 moves in an endwise direction longitudinally of the guideway 33, that is to say toward the right as seen in Fig. 4, and at the completion of the bending operation has arrived at what can be conveniently termed a second position above the right-hand end of the front frame member 16 and in engagement with the stop 44. During this endwise travel of the ironing die member 12 the workpiece moves with it toward the right and away from the locating stop 46b of the work support 46a.

By the bending operation accomplished on the workpiece 14 during this rocking cooperation of the anvil die member 13 with the ironing die member 12, the workpiece is bent to the substantially U-shaped form of the cabinet section 15 shown in Fig. 10. During this bending operation the web 14a of the workpiece is bent out of its own plane by the forming of the bends 16a and 16b and the flanges 14b are simultaneously bent within their own planes. The wear strips 42 of the ironing die member hold the flanges 14b of the workpiece against the wear strips 52 of the anvil die member and prevent wrinkling or

13

buckling of these flanges during the formation of the bends 16a and 16b.

While the ironing die member 12 and the anvil die member 13 remain in the second position described above, the magnetic chucks of the groups 115 and 116 of the anvil die member 13 and the magnetic chucks of the group 113 of the ironing die member are deenergized. Pressure fluid is now supplied to the lower end of the cylinder 93 to cause the anvil die member 13 to be lifted or opened relative to the ironing die member 12. The cabinet section 15 resulting from the bending operation just performed on the first workpiece is now removed from the anvil die member 13 and a second workpiece 14c is inserted between the anvil die member and the ironing die member so as to be supported on the latter with its right-hand end in abutting engagement with the hook-shaped stop 47b of the work support 47. The right-hand end of the workpiece 14c overlies the magnetic chucks of the group 114. The chucks of the group 114 are now electrically energized to grip the workpiece for attaching the same to the ironing die carrier 39.

Fluid pressure is now supplied to the upper end of the cylinder 93, causing the anvil die member 13 to be moved downwardly to a closed position relative to the ironing die member 12 for clamping the second workpiece 14c therebetween. When the anvil die member has been thus moved to its closed position it will occupy the above-mentioned second position represented by the broken line position 13b of Fig. 4. At this time the magnetic chucks of the anvil die member which constitute the groups 117 and 118 will also be in engagement with the workpiece 14c. The chucks of the groups 117 and 118 are now electrically energized to grip the second workpiece 14c for attaching the same to the anvil die member.

By supplying pressure fluid to the upper end of the cylinder 89 the anvil die member 13 will be now swung in a clockwise direction, as seen in Fig. 4, in rocking cooperation with the ironing die member 12 to carry out a similar bending operation on the second workpiece 14c. During this swinging movement the anvil die member 13 travels through a second half cycle from the second position 13b through the broken line position 13a back to its initial full line position above the right-hand end of the front frame member 18. During this return swinging movement of the anvil die member 13, the ironing die member 12 likewise travels back from its second position to its initial full line position above the left-hand end of the front frame member 18 and in engagement with the stop 43.

When the anvil die member 13 and the ironing die member 12 have been thus returned to their initial positions, the magnetic chucks of the groups 114, 117 and 118 are deenergized to release their gripping action on the workpiece. Pressure fluid is now supplied to the lower end of the cylinder 93 to again move the anvil die member to an open position, whereupon the cabinet section 15 resulting from the bending operation performed on the second workpiece 14c is removed from the anvil die member and the machine is then ready to begin another cycle of operation.

From the foregoing detailed description of the operation of the bending machine 10 it will be seen that each swinging movement of the anvil die member 13 in rocking cooperation with the ironing die member 12, and the corresponding

14

endwise rectilinear movement of the ironing die member accomplishes a half cycle of the performance of the machine and results in a complete bending operation being performed on one workpiece. Similarly, the swinging movement of the anvil die member and the corresponding rectilinear movement of the ironing die member back to their initial positions accomplishes another half cycle of operation during which a complete bending operation is carried out on a second workpiece. It will therefore be seen that by each full cycle of operation of the machine, two complete bending operations are carried out to produce two of the cabinet sections 15 in succession from two of the workpieces 14.

During the carrying out of the bending operations just described above, pressure fluid is supplied to the cylinder 109 in timed relation to the operation of the die members 12 and 13 such that the rack 105 and the roller 95b driven thereby will cause either a positive actuation of the ironing die member or will cause a holding or braking action on the ironing die member, depending upon the requirements of the particular workpiece being operated upon and whether the pressure fluid supplied to the cylinder 109 is being used as an actuating medium or as a braking medium. The braking action thus applied to the ironing die member 12 during the bending operation results in a more effective ironing action by this die member and in the workpiece being smoothly and accurately shaped around the convex contour of the anvil die member. A positive actuation of the ironing die member may be advantageous for certain workpieces and, if desired, can be in a direction opposite to that in which this die member normally tends to move during the bending operation, in which case the workpiece will be subjected to stretching simultaneously with the bending thereof.

In Figs. 13 and 14 of the drawings a modified bending machine 130 is shown which is generally similar to the bending machine 10 and is adapted to carry out a bending operation on a workpiece 131 so as to produce a bend of a progressively varying curvature and to also produce a stretching of the workpiece simultaneously with the bending thereof. As shown in Figs. 15 and 16, the workpiece 131 may be a channel-shaped metal member or bar having a web portion 131a and a pair of longitudinal edge flanges 131b.

The modified machine 130 is similar to the machine 10 in that it is provided with a main frame 11 comprising a laterally elongated front frame member 18 having a longitudinal guideway 33 thereon, and a vertically elongated upright frame member 20 located in the rear of the front frame member at substantially the midpoint of the latter. Components of the modified machine 130 which are substantially the same as corresponding components of the machine 10 have been designated by the same reference characters. The modified bending machine 130 also includes a carrier 56 adapted to be reciprocated in a guideway of the rear frame member 20 by a power cylinder 93, and a support or face plate 57 mounted on a rockshaft 66 which is journaled in the carrier 56. In this modified bending machine the rockshaft 66 is actuated in the same manner as in the bending machine 10, that is to say, by gearing which includes a vertically movable rack 82 adapted to be actuated by a power cylinder 89. This modi-

fied bending machine is also similar to the bending machine 10 in that it is provided with a group of supporting rolls 95 of which the rolls 95a are idler rolls and the roll 95b is adapted to be driven or controlled through gearing which includes a rack 105 actuated by a power cylinder 109.

As shown in Figs. 13 and 14, the modified bending machine 130 is provided with an elongated ironing die member 132 mounted on the ironing die carrier 39 for endwise reciprocating movement along the guideway 33. The ironing die member 132 is here shown as being relatively narrow as compared with the ironing die member 12 and is in the form of a channel-shaped member having a longitudinal die recess 132a defined between a pair of parallel flanges 132b and adapted to receive the workpiece 131.

For cooperation with the ironing die member 132, the bending machine 130 is provided with an anvil die member 133 which is also of a different form than the anvil die member 13 of the machine 10. The anvil die member 133 is non-symmetrical and comprises a convexly curved body 134 and a convexly curved rib 135 projecting from such body and engageable in the channel recess 132a of the ironing die member 132 for rocking cooperation with the latter. The convex curvature of the rib 135 is such that this rib comprises a portion 135a of a relatively small radius of curvature and a portion 135b of a relatively large radius of curvature. The curvatures of the portions 135a and 135b merge smoothly with each other and are preferably of a progressively varying value throughout the length of the rib 135 and may, for example, conform to the shape of an involute curve.

The anvil die member 133 is mounted on the support 57 as by means of the filler block 136 such that this anvil die member will be swung by the oscillating movement imparted to the support 57 by the rockshaft 66. When the workpiece 131 has been placed in the ironing die member 132 and the anvil die member 133 has been moved to its closed position in clamping cooperation with the ironing die member and workpiece, as shown in Fig. 13, the machine is ready for carrying out the bending operation by a counterclockwise swinging of the anvil die member by movement supplied by the power cylinder 89.

During this counterclockwise swinging of the anvil die member, the rib 135 rocks in the channel-recess of the ironing die member 132, causing the workpiece to be wrapped around the convexly curved rib and to assume the same curvature as this rib. During this bending operation the web 131a of the workpiece is bent out of its own plane and the flanges 131b are bent within their own planes and are held between the adjacent faces of the die members so that wrinkling or buckling of these flanges is prevented.

As shown in Fig. 13, the various surface portions of the top of the rib 135 are at varying radial distances from the rotation axis 137 of the support 57 and during the rocking cooperation of the anvil die member 133 with the ironing die member 132 the support 57 is permitted to move upwardly as is indicated by the broken line positions 57a. During this upward movement of the anvil die member 133 the clamping pressure thereof against the workpiece 131 and the ironing die member 132 is maintained by the power cylinder 93. The broken line position

133a shows the location of the ironing die member at the completion of the bending operation being carried out on the workpiece 131.

In carrying out this bending operation it will be understood, of course, that the ironing die member 132 travels toward the right along the guideway 33 and that such movement can be controlled by the power cylinder 109. The control provided by the power cylinder 109 can be a positive actuation of the ironing die carrier in either direction or can be a braking action which resists movement of the ironing die member 132 during the bending operation. The control thus provided by the cylinder 109 for the movement of the ironing die member 132 during the bending operation permits this operation to be carried out so as to produce merely a simple bending of the workpiece 131, that is to say, a bending of the workpiece with substantially no longitudinal stretching thereof, or to be carried out so as to produce a longitudinal stretching of the workpiece during the bending thereof.

The modified bending machine 130 also differs from the bending machine 10 in regard to the work gripping means provided for gripping the workpiece 131. As shown in Fig. 13 the ironing die carrier 39 is provided at the left end thereof with a mechanical gripping device or chuck 139, in this instance a hydraulic chuck, which is adapted to grip the left-hand end of the workpiece. The anvil die member 133 is also provided with a mechanical gripping device or chuck 140, in this instance a hydraulic chuck, which is adapted to grip the right-hand end of the workpiece 131. The chuck 140 is suitably mounted for movement with the anvil die member 133, such as by being attached to this die member or to a filler block 141 carried by the support 57, and is located immediately adjacent the end of the portion 135a of the rib of the anvil die member. During the rocking of the anvil die member in carrying out the bending operation on the workpiece 131, the chuck 140 moves upwardly to the dotted line position thereof shown in Fig. 13.

Upon the completion of the bending operation carried out by the modified machine 130, the chuck 139 is deenergized and at substantially the same time or immediately thereafter the anvil die member 133 is lifted slightly to release the clamping pressure on the workpiece. The ironing die member 132 is then moved to the left back to its initial position by means of the cylinder 109, thereby disengaging the previously deenergized chuck 139 from the workpiece 131. The anvil die member 133 is then raised clear of the ironing die member 132 and, at substantially the same time, the chuck 140 is deenergized and the bent workpiece 131 is removed from the machine.

In both of the bending machines 10 and 130 the work gripping means has been shown and described as being movable with the ironing die carrier but bends can be carried out on many workpieces without need for these gripping devices. When these gripping devices are omitted from the ironing die carrier or are not used, the clamping pressure exerted by the anvil die member produces a drag between the workpiece and the ironing die member which is sufficient for carrying out the bending operation on the workpiece. At this time the translatory movement of the ironing die member is produced or controlled by the action of the power cylinder 109.

Likewise, in both of the bending machines 10

and 130 the work gripping means mounted on the ironing die carrier 39 can be used to connect the workpiece with this carrier, such that during the rocking of the anvil die member a pull will be transmitted through the workpiece to the carrier for causing the translatory movement of the ironing die member. When the machines are operated in this manner the cylinder 109 and the rack and pinion elements 105 and 104 can be omitted or can be used merely to return the ironing die member to its initial position.

From the accompanying drawings and the foregoing detailed description it will now be understood that this invention provides improved bending machines capable of rapidly and smoothly carrying out desired bending operations on various workpieces, and particularly on an elongated longitudinally flanged workpiece by the bending of the web portion of the workpiece out of its own plane and the bending of the flanges within their own planes without wrinkling or buckling thereof. It will also be seen that only two die members of a relatively simple form are needed in the improved machines and that the mechanism for supporting and actuating the die members is also relatively simple. Additionally, it will be seen that this invention makes possible the bending of such workpieces in one form of the improved machine at a relatively rapid rate and with the accomplishment of a complete bending operation during each half cycle of operation of the machine. It will also be understood that the present invention provides for carrying out such a bending in which a simultaneous stretching of the workpiece is accomplished during the bending thereof. It will be understood, furthermore, that in the bending operations carried out in accordance with this invention a swinging movement is imparted to the anvil die member to cause a rocking cooperation of this die member with the ironing die member during which the ironing die member has an edgewise or endwise rectilinear translatory movement. In brief, it will now be recognized that the present invention provides an improved bending machine in which the bending dies and the actuating mechanism therefor are greatly simplified and function in a much more direct and satisfactory manner than in the bending machines of the swinging-type which have been proposed and used heretofore.

Having thus described my invention, I claim:

1. In a bending machine of the character described, a frame, means on said frame defining a longitudinal guideway, table portions on said frame extending longitudinally of said guideway and having their adjacent ends spaced apart to define a frame opening, an ironing die means adapted to receive a workpiece thereon and being adapted for rectilinear movement along said guideway and over said frame opening, an anvil die means, means mounting said anvil die means on said frame in a transversely extending relation to said guideway and for closing and opening movements relative to said ironing die means for clamping or releasing said workpiece, said mounting means also providing for swinging of said anvil die means in rocking cooperation with said ironing die means for bending the workpiece therebetween and around a portion of said anvil die means, first and second power devices operable to cause said opening and closing movements and said swinging movement of said anvil die means in succession, gripping devices asso-

ciated with said ironing die means and said anvil die means and adapted for gripping engagement with said workpiece at spaced points thereof, roller means located in said frame opening and adapted to support said ironing die means against deflection by the clamping action of said anvil die means, cooperating gear elements interconnecting said ironing die means with said roller means, a double acting fluid pressure cylinder device mounted on said frame, and cooperating gear elements forming an operative connection between said cylinder device and said roller means.

2. In a bending machine of the character described, a frame, means defining a laterally extending longitudinal guideway on said frame, means defining a substantially vertical guideway on said frame adjacent the midpoint of said longitudinal guideway, a pair of cooperating die members comprising an anvil die member and an ironing die member adapted to receive elongated workpieces therebetween in succession to be bent, said ironing die member being elongated in the direction of said longitudinal guideway and reciprocably movable endwise therealong from an initial position to a second position and then back to said initial position, carrier means movable along said vertical guideway, a support mounted on said carrier means so as to be capable of oscillating movement about an axis extending transversely of said longitudinal guideway, said anvil die member having a convexly curved surface portion and being carried by said support in overhanging relation to said longitudinal guideway for movement by said carrier means into clamping cooperation with said ironing die member for clamping said workpieces against the latter and to be oscillated by said support with said convexly curved surface portion in rocking cooperation with said ironing die member from an initial anvil die position to a second anvil die position for bending a first workpiece between said die members and around said anvil die member and then from said second anvil die position back to said initial anvil die position for bending a second such workpiece between said die members and around said anvil die member, a first actuating means connected with said carrier means for causing said movement thereof along said vertical guideway, a second actuating means mounted on said carrier and operable to impart said oscillating movement to said support, said ironing die member being movable to and from its second position simultaneously with the swinging of said anvil die member to and from said second anvil die position, and a double acting fluid pressure cylinder device effective on said ironing die member for controlling the rate of endwise movement thereof during the bending of said workpieces.

3. In a bending machine of the character described, a frame, a first guideway on said frame, a second guideway on said frame and extending in a direction substantially normal to the first guideway at a point intermediate the ends of the latter, carrier means movable along said second guideway and including an oscillatable support, a pair of cooperating die members comprising an anvil die member and an ironing die member adapted to receive elongated workpieces therebetween in succession to be bent, said ironing die member being elongated in the direction of said guideway and reciprocably movable endwise therealong from an initial position to a second position and then back to said initial position,

said anvil die member being carried by said support for movement by said carrier into and out of work clamping cooperation with said ironing die member and adapted to be swung by said support in rocking cooperation with said ironing die member from an initial anvil die position to a second anvil die position for bending a first workpiece between said die members and around said anvil die member and then from said second anvil die position back to said initial anvil die position for bending a second such workpiece between said die members and around said anvil die member, pairs of grippers associated with said ironing die member and said anvil die member for gripping engagement of one gripper of each die member with said first and second workpieces in succession, means operable to move said carrier means along said second guideway, means operable to impart oscillating movement to said support, said anvil die member being movable to and from its second position simultaneously with the swinging of said anvil die member to and from said second anvil die position, and combined braking and actuating double acting pressure fluid cylinder means operatively connected between said frame and said ironing die member and effective to impart braking and actuating forces to the latter.

4. In a bending machine of the character described, a frame comprising a laterally elongated front frame member and an upright frame member at the rear of the intermediate portion of said front frame member, means defining a laterally extending longitudinal guideway on said front frame member, means defining a substantially vertical guideway on said upright frame member, ironing die means adapted to receive thereon a workpiece to be bent and being adapted for rectilinear movement along said longitudinal guideway, a slide movable along said vertical guideway, a face plate, pivot shaft means mounting said face plate on said slide for pivotal movement about an axis extending transversely of said longitudinal guideway, an anvil die member carried by said face plate in overhanging relation to said ironing die means, actuating means adapted to move said slide along said vertical guideway for causing opening and closing of said anvil die member relative to said ironing die means and to cause clamping of said workpiece against the latter, said anvil die member being adapted for rocking cooperation with said ironing die means by the pivotal movement of said face plate for bending said workpiece around said anvil die member, a power cylinder movable with said slide, and means operably connecting said power cylinder with said pivot shaft means for causing the pivotal movement of said face plate.

5. In a bending machine of the character described, a frame comprising a laterally elongated front frame member and an upright frame member at the rear of the intermediate portion of said front frame member, means defining a laterally extending longitudinal guideway on said front frame member, means defining a substantially vertical guideway on said upright frame member, ironing die means adapted to receive thereon a workpiece to be bent and being adapted for rectilinear movement along said longitudinal guideway, a slide movable along said vertical guideway, a face plate, pivot shaft means mounting said face plate on said slide for pivotal movement about an axis extending transversely of said longitudinal guideway, an anvil die member carried by said face plate in overhanging relation

to said ironing die means, actuating means adapted to move said slide along said vertical guideway for causing opening and closing of said anvil die member relative to said ironing die means and to cause clamping of said workpiece against the latter, said anvil die member being adapted for rocking cooperation with said ironing die means by the pivotal movement of said face plate for bending said workpiece around said anvil die member, a power cylinder movable with said slide, means operably connecting said power cylinder with said pivot shaft means for causing the pivotal movement of said face plate, roller means on said front frame member adapted to support said ironing die means and being located in said longitudinal guideway at a point substantially opposite said vertical guideway, gear elements connecting said ironing die means with said roller means, and a double acting pressure fluid cylinder power device operably connected with said roller means and effective on said ironing die means through said gear elements.

6. In a bending machine of the character described, a frame comprising a laterally elongated front frame member and an upright frame member at the rear of the intermediate portion of said front frame member, means defining a laterally extending longitudinal guideway on said front frame member, means defining a substantially vertical guideway on said upright frame member, ironing die means, adapted to receive thereon a workpiece to be bent and being adapted for rectilinear movement along said longitudinal guideway from an initial position to a second position and then back to said initial position, a slide movable along said vertical guideway, a face plate, pivot shaft means mounting said face plate on said slide for pivotal movement about an axis extending transversely of said longitudinal guideway, an anvil die member carried by said face plate in overhanging relation to said ironing die means, actuating means adapted to move said slide along said vertical guideway for causing opening and closing of said anvil die member relative to said ironing die means and to cause clamping of said workpiece against the latter, said anvil die member having thereon a convexly curved surface portion adapted for rocking cooperation with said ironing die member by the pivotal movement of said face plate for swinging said anvil die member from an initial position to a second position and thereby bending a first workpiece around said anvil die member and from said second position back to said initial position for bending a second workpiece around said anvil die member, a pair of work gripping devices movable with said ironing die means and located adjacent opposite ends thereof, a pair of work gripping devices movable with said anvil die member and located on opposite sides thereof, said gripping devices being effective for gripping engagement of one gripping device of each pair with said first and second workpieces in succession, a power cylinder movable with said slide, means operably connecting said power cylinder with said pivot shaft means for causing the pivotal movement of said face plate, and a double acting fluid pressure cylinder device operatively connected between said frame and said ironing die means.

7. In a bending machine of the character described, a frame including a laterally elongated front frame portion and an upright frame portion located adjacent said front frame portion and intermediate the ends thereof, a first guide-

way extending laterally along said front frame portion, an upright second guideway extending along said upright frame portion and in a direction substantially normal to said first guideway, a laterally elongated ironing die means adapted to receive an elongated workpiece thereon and being movable along said first guideway, carrier means movable along said second guideway, a support, means mounting said support on said carrier means for oscillatable movement about an axis extending transversely of said first guideway, anvil die means carried by said support and disposed in overhanging relation to said first guideway and being movable by said carrier means into clamping cooperation with said ironing die means for clamping said workpiece therebetween, said anvil die means having a convexly curved surface portion which is rockable against said ironing die means by the oscillatable movement of said support for bending said workpiece between said ironing die means and said anvil die means and around the latter, actuating means operable to cause movement of said carrier means along said second guideway, and a second actuating means located on said carrier means and operable to cause the oscillatable movement of said support.

8. In a bending machine of the character described, a frame, a first guideway on said frame, a second guideway on said frame and extending in a direction substantially normal to the first guideway at a point intermediate the ends of the latter, ironing die means adapted to receive a workpiece thereon and being movable along said first guideway, carrier means movable along said second guideway and including an oscillatable support carried thereby, anvil die means carried by said support so as to be disposed in a transversely extending relation to said first guideway and being movable by said carrier means into clamping cooperation with said ironing die means for clamping said workpiece therebetween, gripping devices associated with said ironing die means and said anvil die means and adapted to grip said workpiece at spaced points thereof, said anvil die means having a convexly curved surface portion which is rockable against said ironing die means by an oscillating movement of said support for bending said workpiece between said ironing die means and said anvil die means and around the latter, actuating means operable to cause movement of said carrier means along said second guideway, a second actuating means operable to cause the oscillating movement of said support, and a combined braking and actuating double acting fluid pressure cylinder device operatively connected between said frame and said ironing die means and effective to impart braking actuating forces to the latter.

9. In a bending machine of the character described, a frame including a laterally elongated front frame portion and an upright frame portion located adjacent said front frame portion and intermediate the ends thereof, said front frame portion having longitudinally aligned table portions and a frame opening between the adjacent ends of said table portions, a first guideway extending longitudinally of said aligned table portions, an upright second guideway extending along said upright frame portion and in a direction substantially normal to said first guideway, a laterally elongated ironing die means adapted to receive an elongated workpiece thereon and being movable along said first guideway and across said frame opening, carrier means movable along said second guideway, a support, means mounting said support on said carrier means for oscillatable movement about an axis extending transversely of said first guideway, anvil die means carried by said support and disposed in overhanging relation to said first guideway and being movable by said carrier means into clamping cooperation with said ironing die means for clamping said workpiece therebetween, said anvil die means having a convexly curved surface portion which is rockable against said ironing die means by the oscillatable movement of said support for bending said workpiece between said ironing die means and said anvil die means and around the latter, roller means mounted on said frame and supporting said ironing die means at the location of said frame opening, actuating means operable to cause movement of said carrier means along said second guideway, a second actuating means located on said carrier means and operable to cause oscillating movement of said support, and a double acting fluid pressure cylinder device mounted on said frame and operatively connected with said ironing die means through said roller means.

LEE B. GREEN.

References Cited in the file of this patent UNITED STATES PATENTS

Number	Name	Date
9,392	Slocum	Nov. 9, 1852
1,126,982	Goss	Feb. 2, 1915
1,714,083	Frank	May 21, 1929
1,935,604	Abramson	Nov. 21, 1933
1,971,116	Mohan	Aug. 21, 1934
2,022,915	Jensen	Dec. 3, 1935
2,287,933	Green	June 30, 1942
2,342,745	Maize	Feb. 29, 1944
2,400,151	Kirsch	May 14, 1946
2,444,718	Bath	July 6, 1948
2,536,738	Green	Jan. 2, 1951