

Aug. 5, 1958

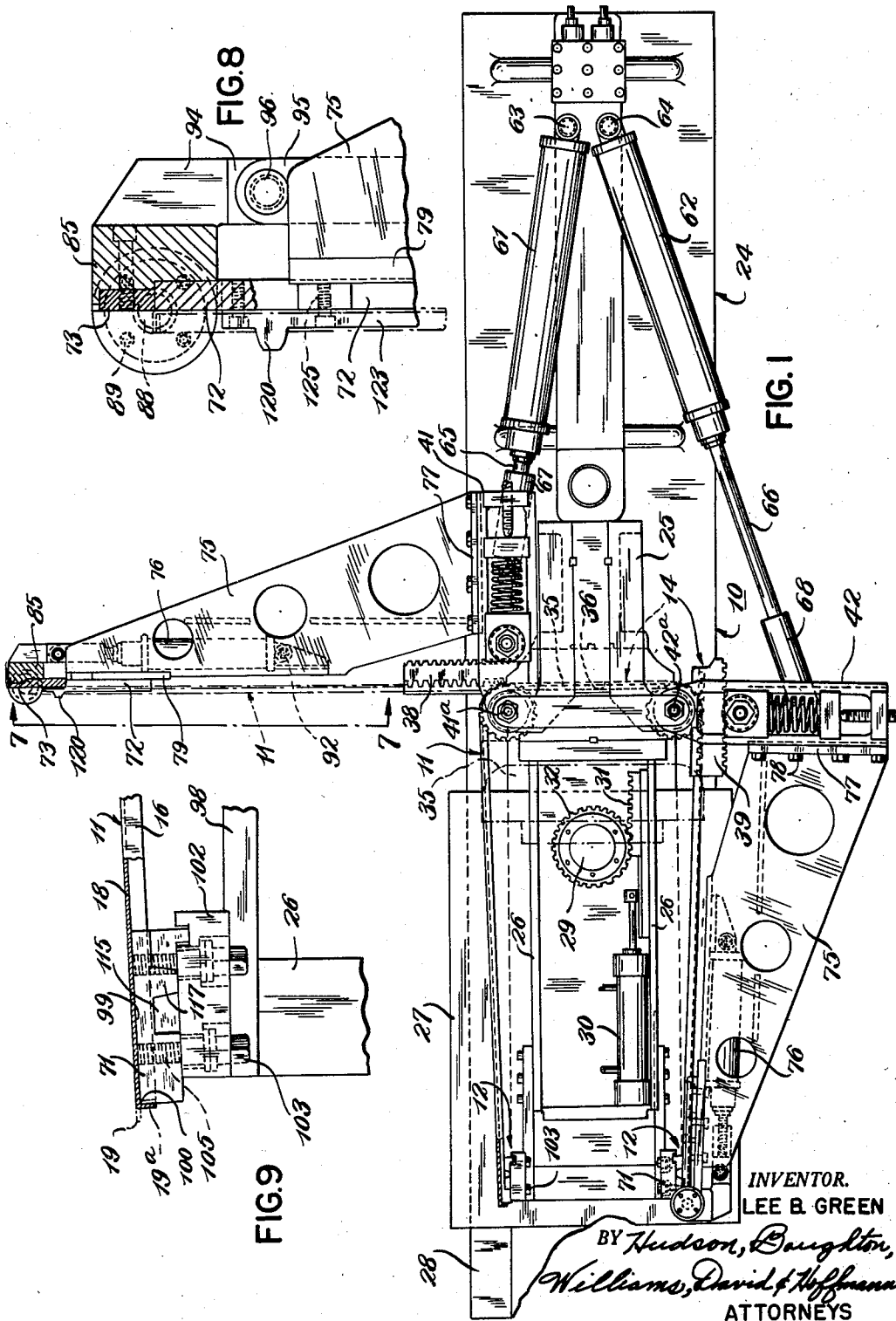
L. B. GREEN

2,845,981

TANGENT BENDER WITH AUXILIARY BENDING MEANS

Filed June 22, 1955

5 Sheets-Sheet 1



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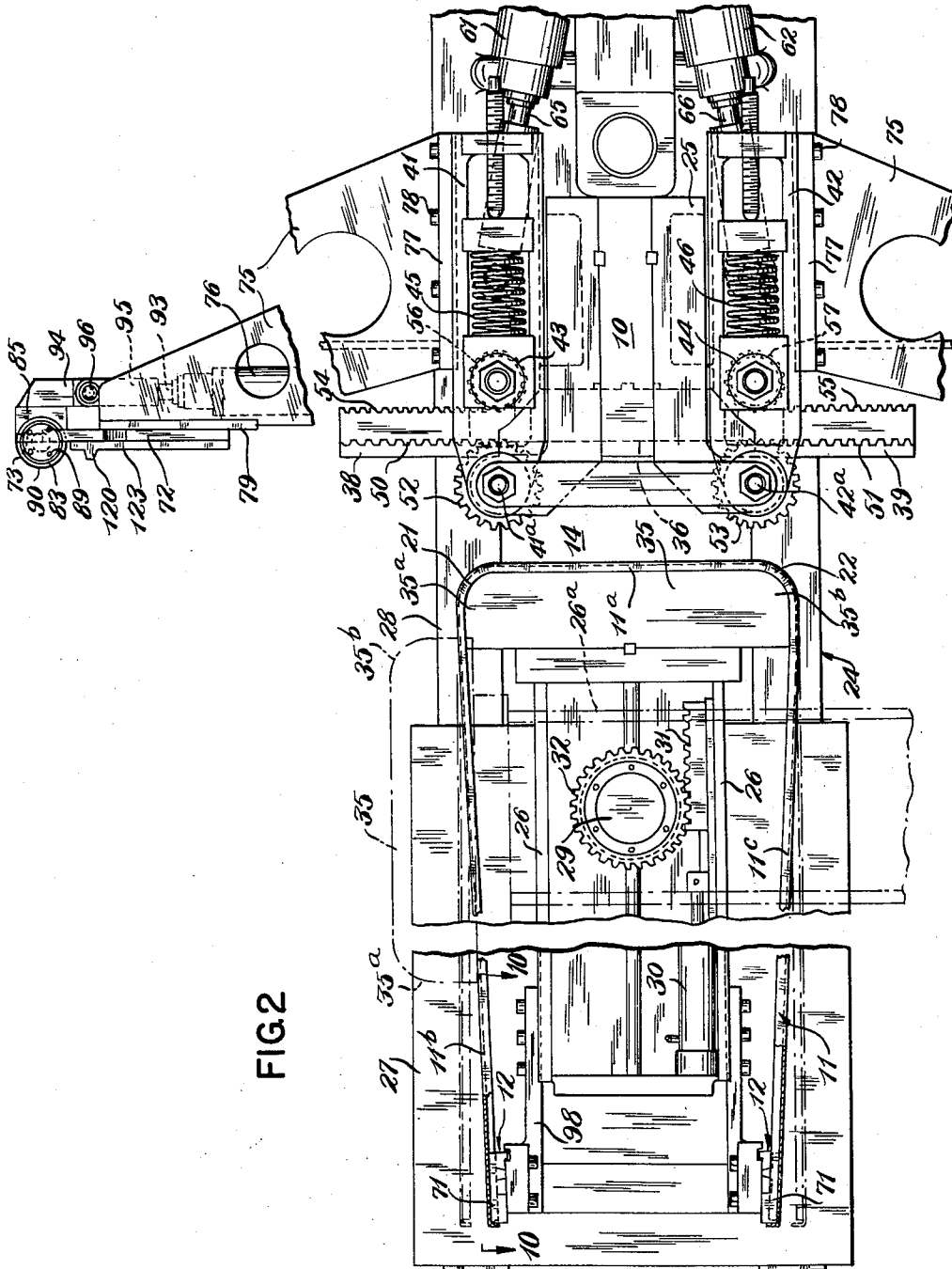


FIG 2

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5 Sheets-Sheet 3

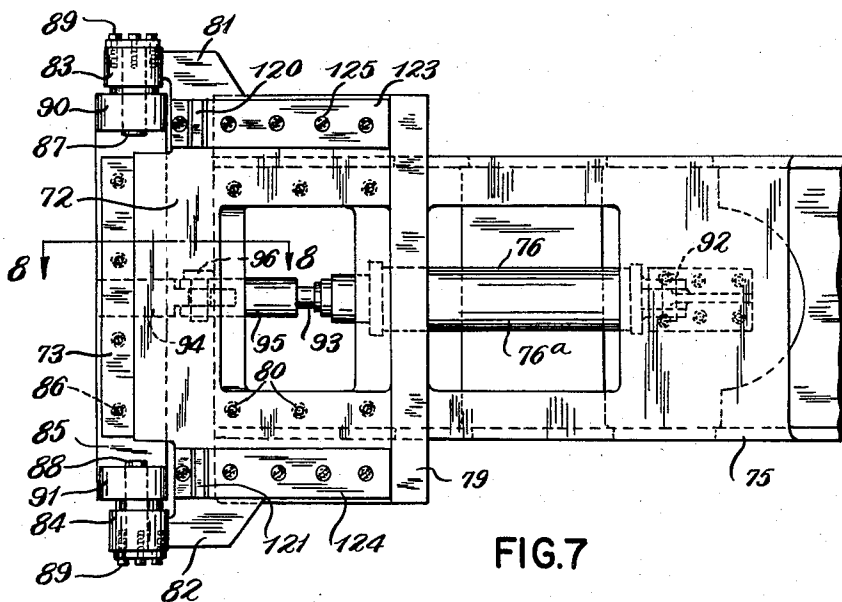


FIG. 7

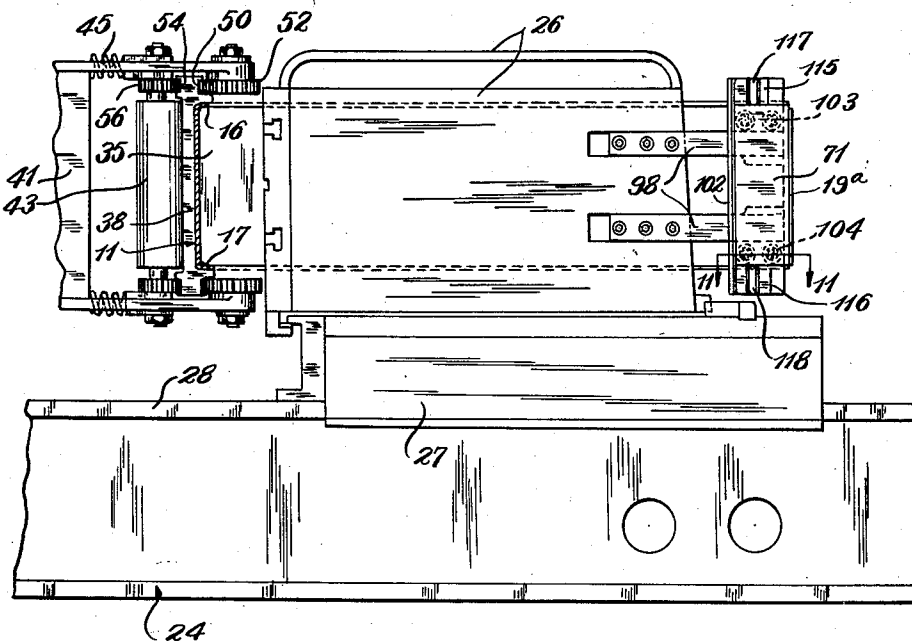


FIG. 3

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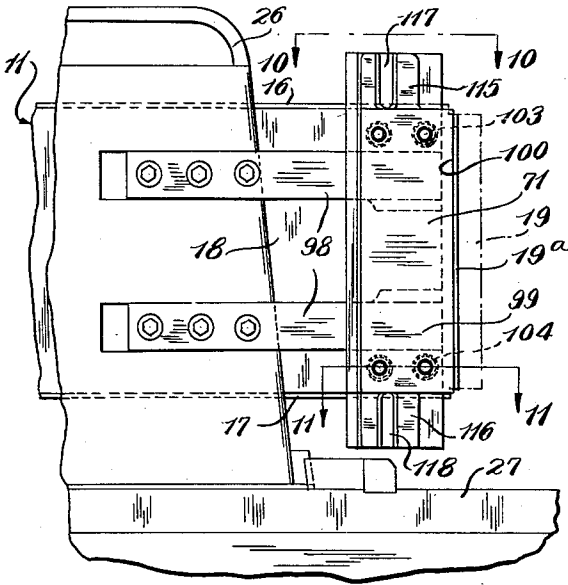


FIG. 4

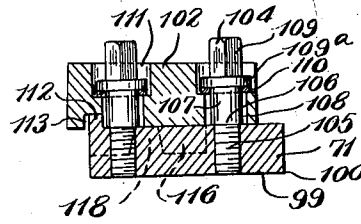


FIG. II

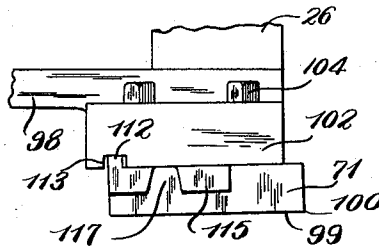


FIG. 10



FIG. 12

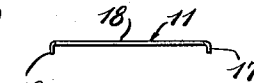


FIG. 13

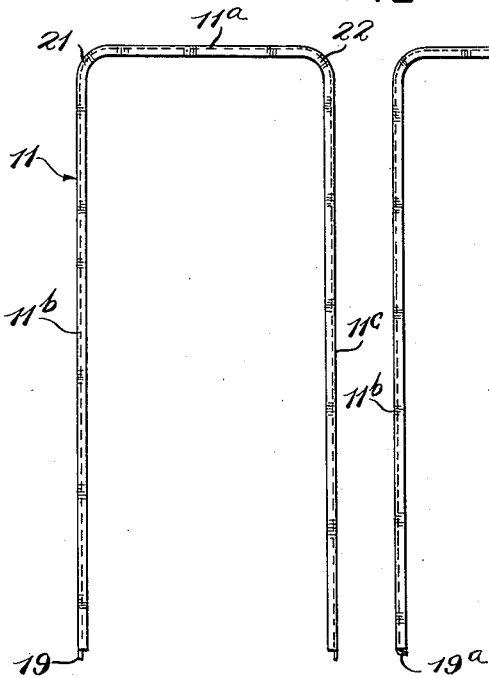


FIG. 14

FIG. 15

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5 Sheets-Sheet 5

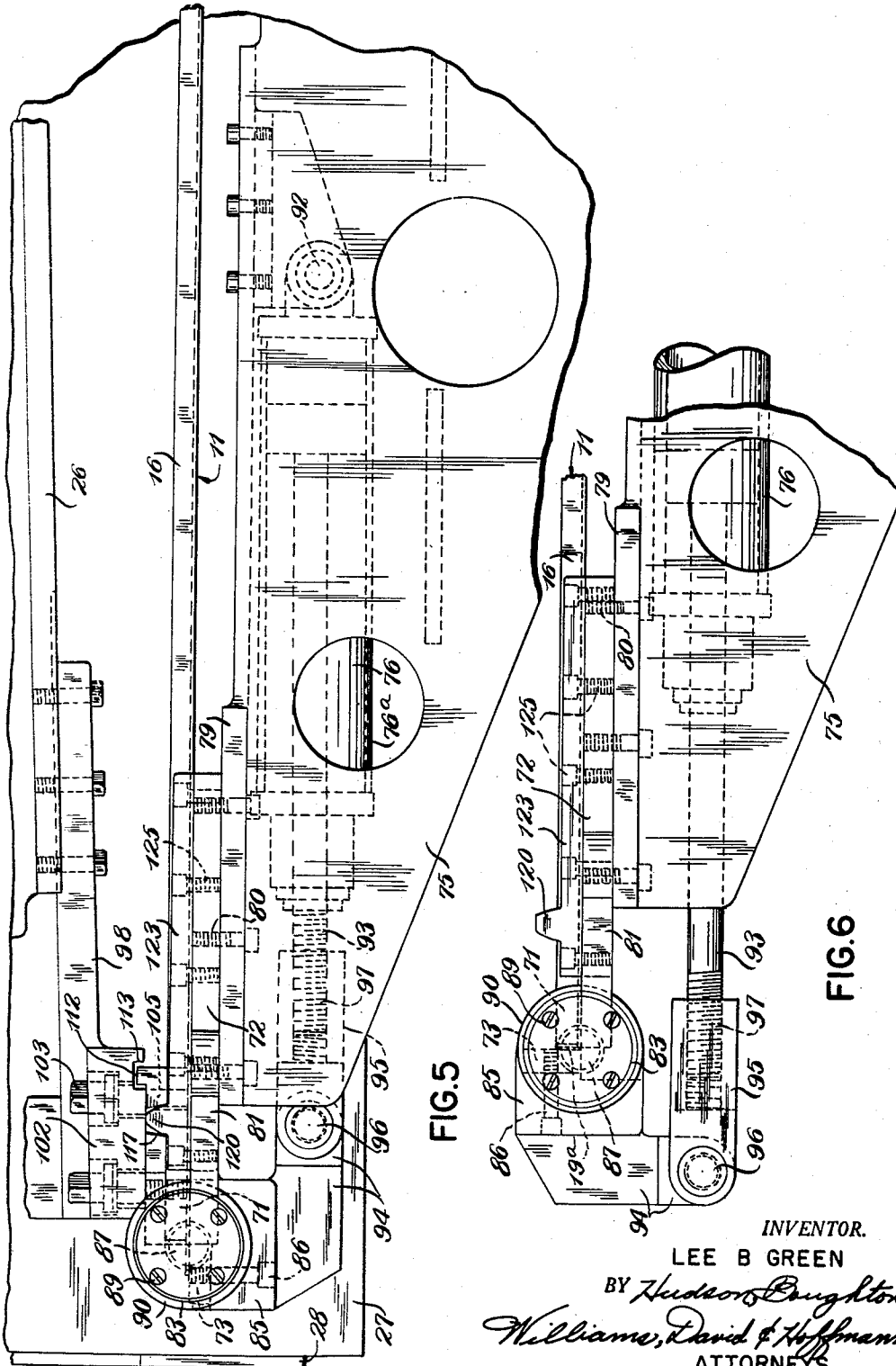


FIG. 5

FIG. 6

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## TANGENT BENDER WITH AUXILIARY BENDING MEANS

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Application June 22, 1955, Serial No. 517,291

12 Claims. (Cl. 153—4)

This invention relates to bending machines of the kind used in bending metal workpieces, and particularly flanged metal workpieces, to desired shapes substantially without wrinkling or buckling of the metal at the location of the bend.

In my earlier patent, 2,446,824, granted August 10, 1948, a bending machine of this kind is disclosed by which the intermediate portion of a flanged metal strip is bent around an anvil die by a rockable bending die while such intermediate portion is being held in a clamped condition between the anvil die and a clamping die. During the bending operation thus carried out on the intermediate portion of the workpiece, the end portions usually remain unclamped and relatively free and are subject to some relative shifting by a lengthening or shortening of the workpiece, depending upon the behavior of the metal being bent.

It is often desirable to perform an additional bending operation on the same workpiece, such as the forming of an end flange on one or both of such end portions. One instance of where this is desirable is where the workpiece is being shaped into a shell for a refrigerator cabinet and end flanges are needed on the lower ends of the sides of the shell.

If the desired additional or auxiliary bending operation, such as that for forming the above-mentioned end flanges, could be carried out in the same bending machine and in a sequential relation to the main bending operation, important advantages would be realized in the way of decreased handling of the workpiece, relatively fewer machines needed, shorter processing time, reduced floor space requirement, and greater accuracy and uniformity of the product. However, because of the variable effect of the main bending operation on the unclamped portions of the workpiece, it has not been feasible heretofore to carry out such an additional or auxiliary bending operation in a practical and satisfactory manner because of the difficulty in properly locating the work portion, on which the additional bend is to be formed, relative to the auxiliary dies.

Although the matter of relatively locating the work portion to be bent and the dies for forming the bend therein, has been referred to above as a problem encountered where the bending operation in question is additional to a main bending operation on the workpiece, there are various fabricating procedures where it would be highly advantageous to have a definite and assured relative positioning between a workpiece portion and the dies which are to perform a bending operation thereon. The invention is therefore not limited solely to such relative positioning for auxiliary bending dies, but also contemplates that this relative positioning may be carried out equally well with respect to the sole or main bending dies of a machine.

The present invention accordingly provides, as one of its objects, a novel bending machine having dies which include an anvil die and a bending die rockable relative thereto, and in which cooperable positioning elements

associated with the bending and anvil dies are effective to cause a positioning movement of one of such dies relative to the other just prior to the performance of the bending operation thereby.

Another object is to provide such a bending machine in which the dies also include a clamping die movable toward the anvil die for clamping a portion of the workpiece therebetween, and in which the positioning elements are brought into an engaged condition during the relative closing movement between the clamping die and the anvil die.

A further object is to provide a bending machine of the kind just above mentioned, in which the positioning elements have a wedging cooperation, one of the elements preferably being a recess and the other preferably being a projection adapted for a self-centering engagement in such recess.

Yet another object is to provide a bending machine of the kind having a die mount supporting an anvil die and also having a swingable carrier or wing supporting clamping and bending dies for cooperation with the anvil die, and in which the cooperable positioning elements are associated with the anvil and clamping dies and are effective in accurately establishing the location at which the bend is to be formed on the workpiece.

Still another object is to provide a bending machine of the character indicated in which the anvil die is connected with a die mount so as to have limited shifting relative thereto, as by means of the above-mentioned cooperable positioning elements.

It is also an object of this invention to provide a novel bending machine having main dies for performing a main or primary bending operation on one portion of a workpiece while another portion of the workpiece is sequentially subjected to an auxiliary bending operation by auxiliary dies of the machine, and in which the performance of the auxiliary bending operation is such as to accommodate changes occurring in the length of the workpiece as the result of the main bending operation, such that a flange or the like formed on the workpiece by the auxiliary bending dies will be accurately located with respect to the main or initial bend formed therein.

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 forming a part of this specification:

Fig. 1 is a plan view of a bending machine embodying the present invention, the machine being shown with certain of the dies on one side thereof in their bending position and with the dies on the other side in a partially retracted position;

Fig. 2 is a plan view showing portions of the machine on a larger scale and with the dies in their duly retracted position;

Fig. 3 is a partial side elevation showing the cooperation of one of the main bending dies with the main anvil die, and also showing one of the auxiliary anvil dies;

Fig. 4 is another partial side elevation showing one of the auxiliary anvil dies on a larger scale;

Fig. 5 is a partial plan view showing the auxiliary clamping and anvil dies on one side of the machine in their closed condition but prior to actuation of the associated auxiliary bending die;

Fig. 6 is a partial plan view further illustrating one of the auxiliary clamping dies and showing the associated bending die in its fully actuated position;

Fig. 7 is a fragmentary elevational view taken as indicated by the direction line 7—7 of Fig. 1 and showing the carrier for one pair of associated auxiliary clamping and bending dies;

Fig. 8 is a fragmentary sectional view taken through the associated auxiliary clamping and bending dies of Fig. 7 as indicated by section line 8—8 thereof;

Fig. 9 is a fragmentary plan view corresponding with a portion of Fig. 1 and showing one of the auxiliary anvil dies on a larger scale and with the workpiece lying thereagainst;

Fig. 10 is a fragmentary plan view similar to that of Fig. 9 but with the workpiece removed from the auxiliary anvil die;

Fig. 11 is a transverse fragmentary sectional view taken through one of the auxiliary anvil dies as indicated by section line 11—11 of Figs. 3 and 4;

Fig. 12 is a side elevation showing a flanged metal workpiece of the kind on which the present bending machine is intended to operate;

Fig. 13 is an end view of the workpiece;

Fig. 14 is a side elevation of the workpiece after the main bending operation has been performed thereon by the main bending dies of the machine; and

Fig. 15 is a side elevation of the workpiece showing the same after the auxiliary bending operation has been performed thereon by the auxiliary bending dies of the machine.

The accompanying drawings show a metal bending machine 10 of the same general type as that disclosed in the above-mentioned earlier patent and which is intended to carry out bending operations on a flanged metal workpiece 11. The machine 10 is provided with two sets 12 of cooperating bending dies located on opposite sides thereof and which are here shown as being auxiliary to a set 14 of cooperating main bending dies.

Before proceeding with a detailed description of the machine 10, the workpiece 11 and the bending operations performed thereon will be briefly described. As shown in Figs. 12 and 13, the workpiece 11 is an elongated sheet metal member having substantially parallel longitudinal side flanges 16 and 17. At the ends of the workpiece the web 18 extends beyond the side flanges 16 and 17 as unflanged end portions 19.

During the main bending operation carried out by the machine 10, the set 14 of cooperating main bending dies forms bends 21 and 22 in the intermediate portion 11<sup>a</sup> of the workpiece 11 by which the web 18 is bent out of its own plane and the side flanges 16 and 17 are bent within their own planes. Fig. 14 of the drawings shows the workpiece 11 as being a substantially U-shaped refrigerator cabinet shell having depending legs formed by the end portions 11<sup>b</sup> and 11<sup>c</sup> of the workpiece and which shell has resulted from such a main bending operation performed on the workpiece of Fig. 12. In Fig. 14 the end projections 19 of the workpiece remain straight, and, heretofore, the bending of these straight end projections into in-turned flanges 19<sup>a</sup>, as shown in Fig. 15, has been difficult of accomplishment. By the present invention, however, the in-turned flanges 19<sup>a</sup> are formed on the workpiece 11 by the two sets 12 of auxiliary bending dies while the workpiece remains in the bending machine 10.

The bending machine 10 is provided with a laterally elongated frame 24 having stationary and movable die mounts 25 and 26 thereon, of which the movable die mount 26 is carried by a slide 27. The frame 24 is provided with a longitudinal guideway 28 extending laterally in a direction away from the stationary die amount 25, and on which the slide 27 is reciprocally movable.

The die mount 26 is also swingable relative to the slide 27 by swinging movement in a substantially horizontal plane about the axis of a vertical pivot post 29 carried by the slide. In Figs. 1 and 2 the die mount 26 is shown in full lines in its closed and open working positions in longitudinal alignment with the stationary die mount 25. The broken line position 26<sup>a</sup> of Fig. 2 shows the die mount swung to its transverse position, which is the un-

loading position, for removal of the bent workpiece 11 from the machine. Swinging of the die mount 26 between its full-line position and its broken-line position is accomplished by a power cylinder device 30 supported on the mount and having a reciprocable rack 31 drivingly engaged with a fixed gear 32 provided on the pivot post 29.

The set 14 of main bending dies comprises cooperating main anvil and clamping dies 35 and 36, of which the main clamping die 36 is a stationary die member fixed on the stationary die mount 25. The main anvil die 35 is carried by the movable die mount 26 and has curved side portions 35<sup>a</sup> and 35<sup>b</sup> around which portions of the workpiece 11 are bent in forming the bends 21 and 22. The main anvil die 35 is movable toward and away from the main stationary clamping die 36 for clamping or releasing the intermediate portion 11<sup>a</sup> of the workpiece 11, and this clamping and releasing of the workpiece by the main anvil die is produced by movements of the slide 27 along the guideway 28.

The set 14 of main dies also includes a pair of main bending dies 38 and 39 which are rockable about the curved portions 35<sup>a</sup> and 35<sup>b</sup> of the main anvil die 35 for forming the bends 21 and 22 in the workpiece 11. As shown in Fig. 3, the main bending dies 38 and 39 are of a substantially channel-shaped cross-section so as to have side flanges which overlie top and bottom portions of the main anvil die 35 for confining the side flanges 16 and 17 of the workpiece and preventing buckling or wrinkling of those flanges during the forming of the bends 21 and 22.

The main bending dies 38 and 39 are carried and actuated by a pair of die carriers in the form of wings 41 and 42, which are mounted on the frame 24 for swinging about pivot axes 41<sup>a</sup> and 42<sup>a</sup>. The wings 41 and 42 have openings therein through which the main bending dies 38 and 39 extend, and are provided with pressure rollers 43 and 44 which bear against the rear surface of the main bending dies and hold the latter against the curved anvil portions 35<sup>a</sup> and 35<sup>b</sup> during the rocking of the bending dies therearound. The pressure by which the rollers 43 and 44 are held against the bending dies 38 and 39 is provided by sets of coil springs 45 and 46 located in the wings 41 and 42.

Slipping of the main bending dies 38 and 39 relative to the anvil die portions 35<sup>a</sup> and 35<sup>b</sup>, during the rocking of these bending dies therearound, is prevented by racks 50 and 51 provided on the bending dies and having meshed engagement with fixed gears or gear sectors 52 and 53 provided on the frame 24. Relative slipping between the dies 38 and 39 and their associated rollers 43 and 44, is also prevented by providing racks 54 and 55 on the bending dies on the rear side thereof which have meshed engagement with gears 56 and 57 provided on the rollers.

The wings 41 and 42 have working strokes through which they are swung about the pivot axes 41<sup>a</sup> and 42<sup>a</sup> from their initial or retracted full-line position shown in Fig. 2 to an actuated position corresponding with the full-line actuated position in which the wing 42 is shown in Fig. 1. During this working stroke of the wings 41 and 42, the main bending dies 38 and 39 are rocked about the anvil die portions 35<sup>a</sup> and 35<sup>b</sup> to form the bends 21 and 22 in the workpiece 11. During this working stroke of the wings 41 and 42, the oppositely extending end portions 11<sup>b</sup> and 11<sup>c</sup> (see Fig. 12) of the workpiece are made to assume the substantially parallel relation in which the depending leg portions of the workpiece are shown in Figs. 14 and 15.

Actuation of the wings 41 and 42 during their working and return strokes is produced by a pair of double-acting power cylinder devices 61 and 62 connecting between the wings and the frame 24. The cylinders of the power cylinder devices 61 and 62 are connected to the frame by pivot members 63 and 64 and the piston rods

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65 and 66 have their outer ends pivotally connected with the wings by suitable yoke members 67 and 68.

The two sets 12 of auxiliary bending dies each comprise a group of three die members which are of substantially the same construction and are actuated in a similar manner for both sets, and hence, it will only be necessary to describe in detail one set of these dies and the actuating means therefor. In describing these sets 12 of auxiliary bending dies the same reference characters have been applied to the same corresponding parts.

Each such set 12 of auxiliary bending dies comprises an auxiliary anvil die 71, an auxiliary clamping die 72 and an auxiliary bending die 73. The auxiliary anvil die 71 is carried by the movable die mount 26 and is a shiftable or floating die member which is mounted thereon in a manner to be explained hereinafter. The auxiliary clamping die 72 and the auxiliary bending die 73 are both supported by a carrier which is here shown as being in the form of a bracket projection 75 of one of the wings, such that the auxiliary clamping die is actuated by the working and return strokes of the wing as will be further explained hereinafter. The auxiliary bending die 73 is actuated through its working and return strokes by a power cylinder device 76 provided on the bracket projection 75.

As shown in the drawings, the bracket projection 75 is mounted on the front side of the wing so as to project therefrom at substantially right angles to the plane of the wing. The projection 75 is mounted on the wing in this relation by being provided with a flanged base portion 77, which is secured to the wing by bolts 78. As shown in Figs. 5, 6 and 7, the projection 75 is provided at the outer end thereof with a pad 79 on which the auxiliary clamping die 72 is mounted by means of the screws 80. The auxiliary clamping die 72 is provided on the top and bottom edges thereof with bracket arms 81 and 82 having hollow bosses 83 and 84 thereon.

The auxiliary bending die 73 is mounted on a movable die support or bending die carrier 85 by means of the attaching screws 86 and the bending die carrier is swingably mounted on the auxiliary clamping die 72 between the bracket arms 81 and 82 of the latter. For this pivotal mounting of the bending die carrier 85, pivot pins 87 and 88 have their heads secured to the bosses 83 and 84 by the screws 89 and have the inner ends of their stems projecting from the bosses in an axially aligned relation. The bending die carrier 85 has lugs 90 and 91 thereon in which the pivot pins 87 and 88 engage for swinging of the bending die carrier on the latter.

In the bending operations carried out by the sets 12 of auxiliary bending dies for forming the end flanges 19<sup>a</sup> on the workpiece 11, the auxiliary bending die 73 is rockable about the common axis of the pivot pins 87 and 88 relative to the auxiliary anvil and clamping dies 71 and 72 while the end portion of the workpiece is being held between the latter dies. This rocking of the bending die 73 is produced by a swinging of the bending die carrier 85 by the power cylinder device 76.

The cylinder 76<sup>a</sup> of the power cylinder device 76 has the rear end thereof pivotally connected to the projection 75 by a pivot pin 92, and the piston rod 93 of this power cylinder device is connected with an arm portion 94 of the bending die carrier 85 by a yoke 95. The yoke 95 is pivotally connected with the arm portion 94 of the bending die carrier by a pivot pin 96 and is connected with the outer end of the piston rod 83 by the threaded connection 97.

As shown in Figs. 3 and 4, the auxiliary anvil die 71 is a vertically elongated member located on one side of the movable die mount 26 and connected with the latter by a pair of support arms 98. The anvil die 71 is provided with a flat outer face 99 which is engaged by a portion of the inner surface of the web 18 of the

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workpiece 11 immediately adjacent to the end projection 19. The upright rear edge 100 of the anvil die 71 defines the bending line along which the web 18 of the workpiece will be bent in deflecting the end projection 19 into an in-turned flange 19<sup>a</sup>.

The auxiliary clamping die 72 has a flat front face thereon which engages the outside or back surface of the web portion 18 of the workpiece adjacent the end projection 19 for clamping the end portion against the flat face 99 of the auxiliary anvil die 71. When the end portion of the workpiece 11 is thus clamped between the auxiliary anvil die 71 and the auxiliary clamping die 72, the end projection 19 overhangs the rear edge 100 of the auxiliary anvil die, as shown in Figs. 4, 5 and 9. Then, when the auxiliary bending die 73 has been actuated through its working stroke by the power cylinder device 76 to its actuated position shown in Fig. 6, the straight end projection 19 of the workpiece is deflected inwardly to the position of the in-turned flange 19<sup>a</sup>.

As has been indicated above, the auxiliary anvil die 71 is shiftable and the positioning of this die, relative to the workpiece 11 just prior to the forming of the end flange 19<sup>a</sup>, is very important because of variations occurring in the length of the workpiece as the result of the main bending operation performed thereon by the set of main dies 14, and also for the purpose of always assuring a correct positioning of this anvil die which will be independent of accumulated minor errors due to wear and lost motion in the supporting and actuating means for the carriage 26 and due to deflections and length variations in the frame members of the machine. To provide for such relative positioning of the auxiliary anvil die 71, this die member is mounted on a support member 102 so as to have limited shifting relative thereto. The support member 102 is welded or otherwise secured to the support arms 98 and extends in a vertical position corresponding with the vertical position desired for the auxiliary anvil die 71.

The auxiliary anvil die 71 is mounted on the front face of the support 102 by upper and lower pairs of shouldered screws 103 and 104 which have threaded end portions 105 engaged in threaded openings of this anvil die. These screws have shoulders 106 thereon (see Fig. 11) engaging the rear face of the auxiliary anvil die 71 and also have plain stem portions 107 of a length such that when these plain stem portions extend through enlarged openings or slots 108 of the die support 102, this anvil die will be relatively freely shiftable on the front face of the die support. The screws 103 and 104 have heads 109 provided with flanges 109<sup>a</sup> under which slip washers 110, of brass or the like, are located in rear recesses 111 of the die support 102.

The extent of the shifting of the auxiliary anvil die 71 relative to its support 102 is limited by an edge flange or key 112 provided on the rear of this anvil die and engaging in a relatively wider vertical slot or keyway 113 of the die support. When the auxiliary anvil die 71 has been shifted in one direction or the other relative to its support 102 to the extent permitted by the cooperating flange and slot elements 112 and 113, this anvil die will then be held by these elements against further shifting, and shearing or bending of the screws 103 and 104 will be prevented, although the slots 108 and the keyway 113 afford an extent of shifting of this auxiliary anvil die which is sufficient for all normal operating conditions.

The relative positioning of the auxiliary anvil die 71 for properly locating the rear edge 100 thereof is accomplished by the auxiliary clamping die 72 during the final portion of the closing movement of the latter. For this purpose the auxiliary anvil die 71 is provided with upper and lower end projections 115 and 116 which are vertically spaced apart to extend above and below the side flanges 16 and 17 of the workpiece 11. The projections



115 and 116 are provided with vertically extending front recesses 117 and 118 whose side walls slope in an inwardly-converging relation, as shown in Figs. 9 and 10.

The auxiliary clamping die 72 is provided with upper and lower vertically disposed teeth 120 and 121 which are engageable in the recesses 117 and 118 of the auxiliary anvil die 71. The teeth 120 and 121 are of a wedge shape, such that the engagement thereof in the recesses 117 and 118 will be a self-centering action by which the auxiliary anvil die 71 will be shifted on the support 102 by the camming action of the sloping sides of the teeth against the sloping side faces of the recesses. By this camming action of the teeth the auxiliary anvil die 71 will be shifted and held with its fulcrum edge 100 located at the correct dimensional distance from the pivot axis of the wing by the time that the auxiliary clamping die 72 has been moved to its fully closed position for clamping the end portion of the workpiece 11 against the auxiliary anvil die.

The positioning teeth 120 and 121 of the auxiliary clamping die 72 can be formed directly on this clamping die but, as shown in Figs. 5, 6 and 7, are preferably formed on strips 123 and 124 which are secured to this clamping die adjacent the top and bottom edges thereof by the screws 125.

By having the recesses 117 and 118 and their associated positioning teeth 120 and 121 spaced apart vertically a greater distance than the width of the workpiece 11, it will be seen that in their engaged condition these teeth and recesses straddle the workpiece. The vertical spaced relation of the recesses 117 and 118 of the auxiliary anvil die 71 and the corresponding vertical spacing of the teeth 120 and 121 of the auxiliary clamping die 72 also causes the auxiliary anvil die to be maintained in a vertical position during the lateral shifting thereof, thereby avoiding a condition in which the auxiliary anvil die would be tilted or cocked.

The above-explained engagement of the teeth 120 and 121 of the auxiliary clamping die 72 in the recesses 117 and 118 of the auxiliary anvil die 71 shifts the latter so as to locate the fulcrum edge 100 thereof at a desired exact distance from the pivot axis of the wing, and accordingly, the end flange 19<sup>a</sup> will be formed on the workpiece at a corresponding desired exact distance from the intermediate straight portion 11<sup>a</sup> of the workpiece. If elongation of the workpiece occurs during the bending of the end portions 11<sup>b</sup> and 11<sup>c</sup> thereof to their generally parallel relation of Fig. 11, the length increase merely causes the end projection 19 to extend for a correspondingly greater distance beyond the fulcrum edge 100.

Since the forming of the bends 21 and 22 in the workpiece 11 is substantially completed by the time that the teeth 120 and 121 engage in the recesses 117 and 118, the elongation of the workpiece will have caused the end projection 19 to move past the fulcrum edge 100 for the full extent of such elongation, before the workpiece is clamped against the auxiliary anvil die 71 by the auxiliary clamping die 72. The above-explained shifting of the anvil die 71 by the engagement of the teeth 120 and 121 in the recesses 117 and 118 also takes place before the workpiece becomes clamped between the dies 71 and 72.

By thus providing for a positioning of the anvil die 71, in the manner just explained, relative to the pivot axis of the main wing this anvil die will always be correctly located for each bending of an end flange 19, regardless of any accumulation of minor errors which would otherwise result in a variable or inaccurate positioning of this anvil die if it were rigidly secured to the carriage 26. The minor errors included in such an accumulation comprise lost motion, wear and deflection occurring in the means for supporting and actuating the carriage 26, as well as deflections and length variations occurring in the main frame 24.

With respect to the location of the auxiliary anvil die

71 of the two die sets 12 provided on opposite sides of the die mount 26, it will be observed that the spacing of these auxiliary anvil dies transversely of the machine 10 is a relatively closer spacing than that of the curved side portions 35<sup>a</sup> and 35<sup>b</sup> of the main anvil die 35. Because of this relatively closer spacing for the auxiliary anvil dies 71, it will be seen that the end portions 11<sup>b</sup> and 11<sup>c</sup> of the workpiece 11 will assume a convergently tapered relation, as shown in Fig. 2, when these end portions are moved into engagement with the flat outer faces 99 of the auxiliary anvil dies. When the end portions 11<sup>b</sup> and 11<sup>c</sup> of the workpiece are made to assume this convergently inclined relation shown in Fig. 2, the workpiece is being subjected to overbending, such that when the end portions of the workpiece are released from the auxiliary anvil dies 71 by the movement of the auxiliary clamping dies 72 away from the latter, the end portions of the workpiece will spring away from the auxiliary anvil dies and will assume the broken-line positions shown in Fig. 2, which is an exactly parallel relationship such as is desired for the depending leg portions of the completed article shown in Fig. 15.

When the workpiece 11 has been formed to the shape shown in Fig. 15 by the above-explained bending operations, the dies are actuated to their open position shown in Fig. 2, after which the die mount 26 is swung to its 90-degree broken-line position for the removal of the formed workpiece.

From the accompanying drawings and the foregoing detailed description it will now be readily understood that this invention provides a set of bending dies comprising three cooperating die members and in which the anvil die member of the group, around which a portion of a workpiece is to be bent, is shiftable by the action thereon of positioning elements associated with one of the other die members of the group. It will now also be understood that the bend line for the bendable portion of the workpiece will be exactly located relative to some other portion of the workpiece or relative to a pivot axis, or the like, of the bending machine with the result that the bent portion will be correctly located on each article produced. Additionally, it will be understood that the present invention provides such a group of die members in auxiliary relation to a group of main die members, such that the auxiliary die members will perform their bending operation on a portion of the same workpiece as that upon which the main die members operate, with the result that decreased handling of the workpiece is needed and also with the result that an end flange, or the like, being formed on the workpiece by the auxiliary die members will be correctly located relative to the bend or the like being formed in the workpiece by the main die members.

Although the novel bending machine and bending dies of the present invention have been illustrated and described herein to a somewhat detailed extent, it will be understood, of course, that the invention is not to be regarded as being limited correspondingly in scope but includes all changes and modifications coming within the terms of the claims hereof.

Having thus described my invention, I claim:

1. In a bending machine of the character described, a frame supporting a die mount, a first die member on said mount, a second die member adapted for work-clamping cooperation with said first die member, a third die member adapted for work-bending cooperation with said first die member, a carrier supported by said frame and having said second die member thereon, said carrier being movable for causing closing and opening of said second die member relative to said first die member for clamping or releasing the work, means for actuating said carrier, a die support having said third die member thereon and being movable on said carrier for causing said work-bending cooperation of said third die member with said first die member, means for actuating said die support,

and cooperable positioning elements associated with said mount and carrier and having an engaged condition for causing a relative positioning movement between said first die member and said third die member during the die-closing actuation of said carrier.

2. In a bending machine of the character described, a frame supporting a die mount, a first die member on said mount, a second die member adapted for work-clamping cooperation with said first die member, a third die member adapted for work-bending cooperation with said first die member, a carrier supported by said frame and having said second die member thereon, said carrier being movable for causing closing and opening of said second die member relative to said first die member for clamping or releasing the work, means for actuating said carrier, a die support having said third die member thereon and being movable on said carrier for causing said work-bending cooperation of said third die member with said first die member, means for actuating said die support, means connecting said first die member with said mount and providing for limited shifting of said first die member relative thereto, and cooperable aligning elements associated with said first die member and carrier and having an engaged condition for shifting said first die member to locate the same for the bending operation.

3. A bending machine as defined in claim 2 in which said aligning elements have tapered portions adapted to wedgingly shift said first die member in response to the die-closing movement of said carrier.

4. In a bending machine of the character described, a set of main dies comprising a pair of main work-clamping dies one of which is movable toward and away from the other and one of which main clamping dies is a main anvil die, and a main bending die rockable relative to said main anvil die for bending a portion of a workpiece around the latter; means for actuating the movable main clamping die to clamp or release said workpiece; a set of auxiliary dies comprising an auxiliary anvil die and an auxiliary clamping die for work-clamping cooperation with said auxiliary anvil die, and an auxiliary bending die rockable relative to said auxiliary anvil die for bending another portion of said workpiece around the latter; movable carrier means supporting said main bending die and said auxiliary clamping die; a common actuating means effective through said carrier means for causing the work-bending rocking movement of said main bending die and the work-clamping movement of said auxiliary clamping die; a power device operable to actuate said auxiliary bending die; a die mount supporting said main anvil die; means connecting said auxiliary anvil die with said mount and providing for limited shifting of said auxiliary anvil die relative thereto; and cooperable positioning elements associated with said auxiliary anvil die and said carrier means and having an engaged condition for shifting said auxiliary anvil die to locate the same for the bending operation on said other portion of the workpiece.

5. A bending machine as defined in claim 4 in which said carrier means includes a swingable member having said auxiliary bending die thereon, and in which the power device for said auxiliary bending die is mounted on said carrier means and includes a relatively movable part connected with said swingable member.

6. A bending machine as defined in claim 4 in which said positioning elements have tapered portions adapted to wedgingly shift said auxiliary anvil die, and in which the engaged condition of said positioning elements is produced by the work-bending and clamping movement of said carrier means.

7. In a bending machine of the character described, a frame having a substantially fixed die mount thereon and a guideway extending away from said fixed mount, a movable die mount, a pair of cooperating main work-clamping dies on said fixed and movable die mounts and one of which main dies is movable toward and

away from the other and one of which main clamping dies is a main anvil die, said movable die mount being movable along said guideway for causing said main work-clamping dies to clamp or release a workpiece, means for actuating said movable die mount, a swingable wing, a main bending die carried by said wing and being rockable relative to said main anvil die during a work stroke of said wing for bending a portion of the workpiece around said main anvil die, a power device for actuating said wing, an auxiliary anvil die, means connecting said auxiliary anvil die with the die mount of said main anvil die and providing for limited shifting of said auxiliary anvil die relative to the last-mentioned die mount, a projection carried by said wing and movable toward said last-mentioned die mount during the work stroke of said wing, an auxiliary clamping die on said projection and adapted to clamp a portion of said workpiece against said auxiliary anvil die in response to the work stroke of said wing, an auxiliary bending die swingably supported by said projection and being rockable relative to said auxiliary anvil die for bending another portion of said workpiece around the latter, a second power device carried by said projection and operably connected with said auxiliary bending die to actuate the latter, and cooperable positioning elements associated with said auxiliary clamping die and said auxiliary anvil die and effective for shifting the latter relative to said last-mentioned die mount in response to actuation of said auxiliary clamping die to its work-clamping position.

8. In a bending machine, a frame supporting a die mount, an anvil die on said mount, a bracket arm having an inner end and a free outer end, means pivotally connecting said inner end with said frame for swinging of said outer end toward and away from said mount, a clamping die on said arm adjacent said outer end and being movable by said arm into clamping cooperation with one portion of said anvil die for clamping an end portion of a workpiece against the latter, a power device connected between said frame and said arm for swinging the latter, a bending die mounted on said outer end and adapted to overhang said anvil die when said workpiece is clamped against the latter by said clamping die, said bending die being swingable on said outer end for cooperation with another portion of said anvil die in bending the end of said end portion against the latter, other power means carried by said arm and connected with said bending die for actuating the latter, means connecting said anvil die with said mount and providing for limited shifting of the anvil die relative to said mount, and cooperable positioning elements associated with said mount and carrier and having an engaged condition for locating said anvil die on said mount just prior to the bending of said end of the workpiece by said bending die.

9. In a bending machine of the character described, a die mount, an anvil die having a work-engageable intermediate portion of a given dimension corresponding substantially with the width of a workpiece to be bent and including a fulcrum edge, said anvil die having spaced portions on opposite sides of and extending away from said intermediate portion so as to project beyond the sides of the workpiece, a die carrier having a relatively fixed pivot axis and being swingable toward and away from said mount, a clamping die on said carrier and engageable with said workpiece for clamping the latter against said intermediate portion of said anvil die with a portion of the workpiece overhanging said fulcrum edge, a pair of members on said carrier in associated relation to said clamping die and spaced apart so as to project beyond the sides of the clamped workpiece to be in a substantially opposed relation to the spaced projecting portions of said anvil die, means for swinging said carrier, a bending die on said carrier and actuatable relative thereto for bending the overhanging workpiece portion around said fulcrum edge, means on said carrier for actuating said bending die, means connecting said anvil

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die with said mount such that the anvil die is shiftable relative thereto, and cooperable elements on the projecting portions of said anvil die and on said pair of members and having an engaged condition adapted to cause shifting of said anvil die for locating said fulcrum edge at a given distance from said pivot axis.

10. A bending machine as defined in claim 9 in which said cooperable elements comprise recesses on said projecting anvil die portions and tooth projections on said pair of members and adapted for wedging engagement in said recesses.

11. In a bending machine of the character described, a laterally elongated frame having a substantially fixed die mount thereon and a longitudinal guideway extending away from said fixed mount, a movable die mount, a pair of cooperating main dies comprising a main clamping die on said fixed mount and a main anvil die on said movable die mount, said movable die mount being movable along said guideway for cooperation of said main anvil die with said main clamping die in clamping therebetween an intermediate portion of an elongated metal workpiece to be bent, means for actuating said movable die mount, a pair of swingable wings, main bending dies carried by said wings and being rockable relative to said main anvil die during a work stroke of said wings for bending outwardly extending portions of said workpiece around said main anvil die, power means for actuating said wings, auxiliary anvil dies on said movable mount on opposite sides thereof, projections carried by said wings and movable toward said movable mount during the work stroke of said wings, auxiliary clamping dies on said projections and adapted to clamp end portions of said workpiece against said auxiliary anvil dies in response to the work stroke of said wings, auxiliary bending dies swingably supported by said projections and being rockable relative to said auxiliary anvil dies for forming end flanges on said end portions of the workpiece, power devices carried by said projections and operably connected with said auxiliary bending dies to actuate the latter, means connecting said auxiliary anvil dies with said movable mount and providing for limited relative positioning movement of said auxiliary anvil dies, and cooperable positioning elements associated with said auxiliary clamping dies and said auxiliary anvil dies and effective to position the latter relative to said main anvil die in response to the work stroke of said wings.

12. In a bending machine of the character described, a laterally elongated frame having a substantially fixed die mount thereon and a longitudinal guideway extending away from said fixed mount, a movable die mount, a pair of cooperating main dies comprising a main clamping die on said fixed mount and a main anvil die on said

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movable die mount, said movable die mount being movable along said guideway for cooperation of said main anvil die with said main clamping die in clamping therebetween an intermediate portion of an elongated metal workpiece to be bent, means for actuating said movable die mount, a pair of swingable wings, main bending dies carried by said wings and being rockable relative to said main anvil die during a work stroke of said wings for bending outwardly extending portions of said workpiece around said main anvil die, power means for actuating said wings, auxiliary anvil dies on opposite sides of said movable mount and each comprising a work-engageable intermediate portion of a given dimension corresponding substantially with the width of the end portions of said workpiece and also including a fulcrum edge and spaced portions on opposite sides of and extending away from the intermediate anvil die portion so as to project beyond the sides of the workpiece, projections carried by said wings and being movable toward said movable mount during the work stroke of said wings, auxiliary clamping dies on said projections and engageable with said workpiece for clamping end portions thereof against the intermediate portions of said auxiliary anvil dies with portions of the workpiece overhanging the fulcrum edges, pairs of members on said projections in associated relation to said auxiliary clamping dies and spaced apart so as to project beyond the sides of the clamped workpiece to lie in a substantially opposed relation to said spaced portions of said auxiliary anvil dies, auxiliary bending dies on said projections and being actuable relative thereto for bending the overhanging workpiece portions around said fulcrum edges of the auxiliary anvil dies, means associated with said projections for actuating said auxiliary bending dies, means connecting said auxiliary anvil dies with said movable mount for shifting of said auxiliary anvil dies relative thereto, and cooperable elements on the pairs of spaced portions of said auxiliary anvil dies and on said pairs of members and having an engaged condition adapted to cause shifting of said auxiliary anvil dies for locating said fulcrum edges at a given distance from said main anvil dies.

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