Aug. 10, 1948. L. B. GREEN 2,446,824

METAL BENDING MACHINE WITH HOLD-DOWN MEANS TO PREVENT DIE DEFLECTION

Filed June 21, 1945 2 Sheets-Sheet 1

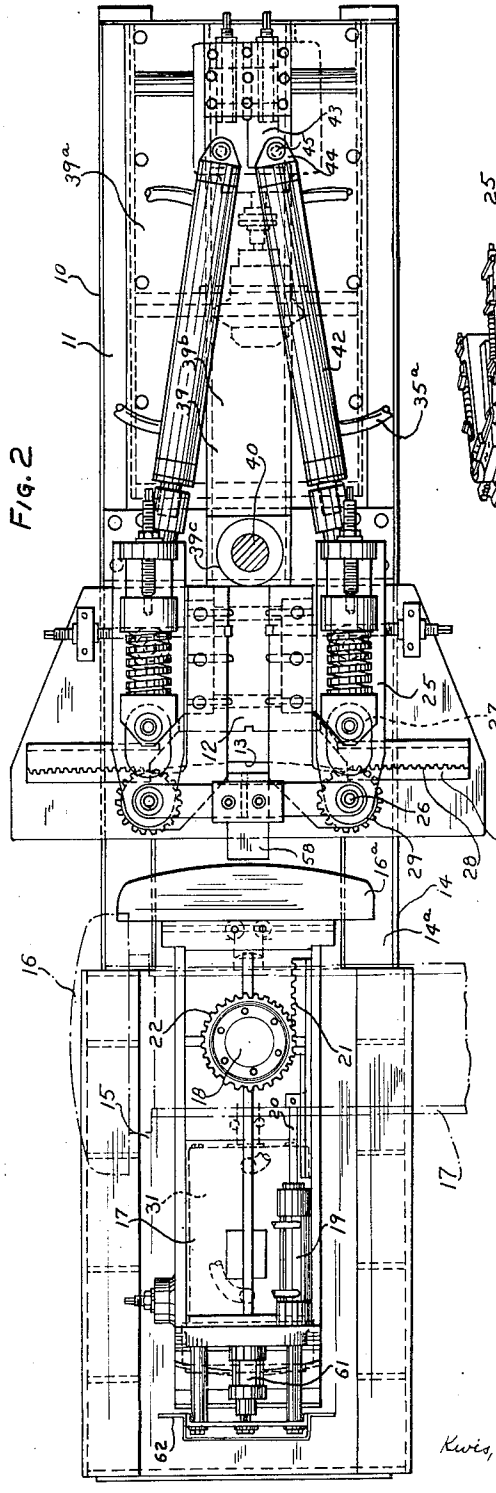


FIG. 2

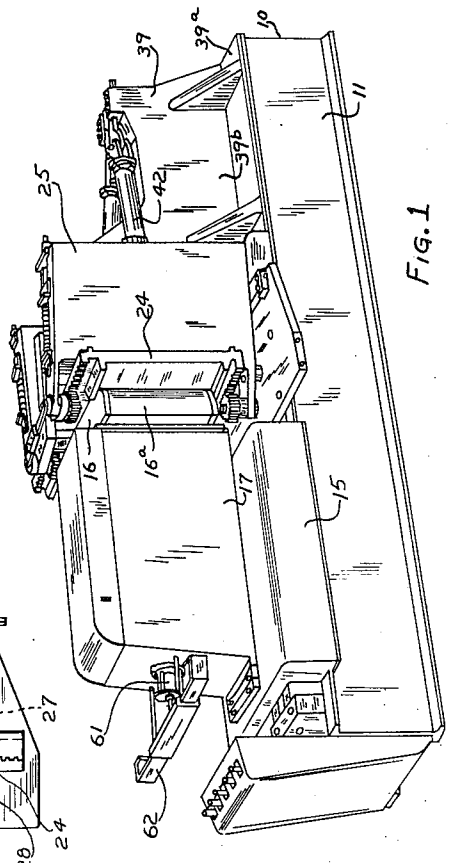


FIG. 1

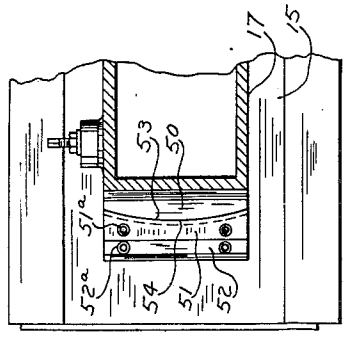


FIG. 4

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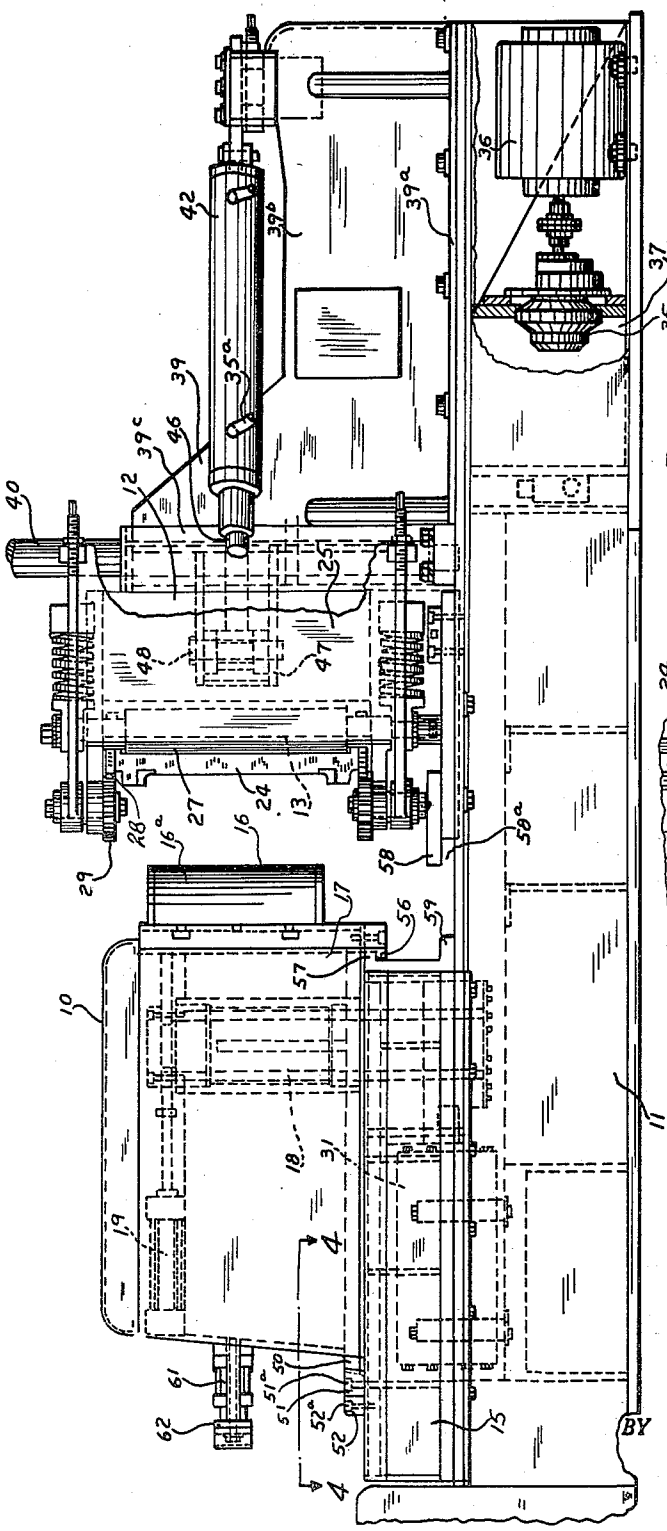


FIG. 3

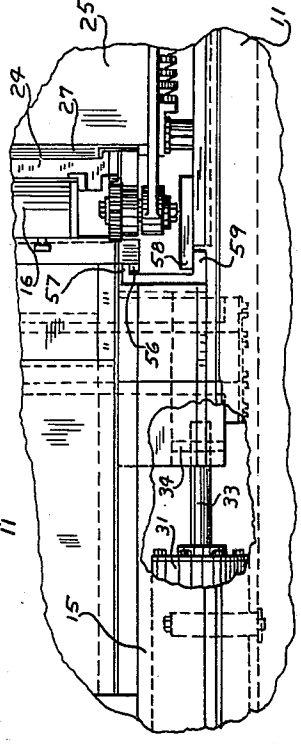


FIG. 5

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METAL-BENDING MACHINE WITH HOLD-DOWN MEANS TO PREVENT DIE DEFLECTION

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Application June 21, 1945, Serial No. 600,765

11 Claims. (Cl. 153—33)

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This invention relates to metal working machines and, more particularly, to a machine for carrying out forming and bending operations and which is an improvement over the machine disclosed in my earlier Patent No. 2,287,933 granted June 30, 1942.

As one of its objects, the present invention provides a forming and bending machine generally similar to that of my earlier patent but which is more compact and embodies several improvement features which enable it to carry out the intended operations in a more accurate and satisfactory manner.

Another object of this invention is to provide an improved machine of this character, in which novel hold-down means is employed for rendering the operations more accurate and satisfactory by substantially eliminating the effects of deflection in the machine and accumulated lost motion between the various moving parts of the machine.

A further object of the invention is to provide an improved machine of the character mentioned, having a pivoted carriage for the movable clamping and forming die and wherein novel holding means for the carriage protects the pivot mounting thereof from harmful stresses.

Still another object is to provide an improved machine of this character, in which a thrust absorbing backing is employed for the stationary die mount for preventing shifting or deflection thereof.

This invention also provides for a more positive and direct actuation of the bending dies by the use of pivoted individual power cylinders for swinging the wings which carry the bending dies.

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 perspective view showing a metal working machine embodying the improvement features of the present invention.

Fig. 2 is a plan view of the machine.

Fig. 3 is a side elevation of the machine with portions thereof broken away.

Fig. 4 is a partial sectional plan view taken on line 4—4 of Fig. 3, and

Fig. 5 is a partial side elevation corresponding with Fig. 3 but showing the slide in the position corresponding with the closed condition of the main dies.

The drawings show a metal working machine 10 which is generally similar to the machine

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shown in said earlier patent but which embodies important improvement features which will be described hereinafter. The improved machine is provided with an elongated generally horizontally extending rigid hollow frame 11 having thereon a stationary die mount 12 which is connected with the frame at a point intermediate its ends and extends a substantial distance thereabove. The mount 12 forms a support for one of the main dies of the machine, in this instance, the female die 13. On one side of the die mount 12 the frame 11 is provided with spaced ways 14a forming a guideway 14 on which a slide 15 is reciprocably movable toward and away from the mount 12.

A second main die, in this instance, a male die 16, is carried by the slide 15 and movable thereby into and out of working cooperation with the female die 13. The male die 16 is not carried directly by the slide 15 but by a carriage 17 which is mounted on the slide for swinging about the axis of an upright pivot post 18 carried by the slide.

The carriage 17 is shown in the drawings in full lines in its working position in which it is disposed in substantial alignment with the path of reciprocating movement of the slide 15 but is adapted to be swung laterally to the broken line position of Fig. 2 in which the carriage extends in angular relation to such path of reciprocating movement so as to facilitate the removal of a work piece from the male die 16. The swinging of the carriage can be effected by means of a hydraulic power cylinder 19 fixed thereon and whose piston rod 20 carries a rack 21 which cooperates with a gear 22 fixedly mounted on the pivot post 18 of the slide 15.

The female die 13 may be of any desired shape or contour, depending upon the operation to be performed thereby and in this instance is a substantially quadrangular member having a shallow concave contour in its front or working face similar to the female die shown in said earlier patent and serves as a combined forming and clamping die for the work piece. The male die 16 likewise may be of any desired shape or contour and in this instance is of a convexly rounded contour and cooperates with the female die 13 for the accomplishment of a combined forming and clamping operation. The sides of the male die form rounded anvil portions 16a with which the bending dies cooperate as explained hereinafter.

The metal working machine 10 can be used for various purposes, for example, it can be used in carrying out a simple forming or stamping oper-

ation on sheet metal work pieces,. or it can be used for various bending operations to be performed on plain or flanged sheet metal work pieces or structural forms while the latter are clampingly held by the main dies 13 and 16, or it can be used for carrying out a combined forming and bending operation. The particular dies 13 and 16 shown in this instance are intended for such a combined forming and bending operation and can be used for producing refrigerator cabinets or the like from flanged sheet metal work pieces as illustrated and described in said earlier patent.

The bending operation performed by the machine 10 is carried out by the use of a pair of bending dies 24 in cooperation with the main dies 13 and 16. The bending dies 24 are substantially identical with the bending dies disclosed in said earlier patent and are plate-like members mounted for similar rocking movement. The bending dies 24 cooperate with and are rockable around the above mentioned anvil portions 16a of the male die 16 when the latter is in its closed position. These bending dies are carried by pivotally mounted wings 25 which swing about pivot axes 26 for causing such rocking of the bending dies around the anvil portions 16a while the work piece is being clampingly held against the female die 13 by the male die 16.

During such rocking of the bending dies 24 pressure is applied to the backs thereof by the spring pressed rollers 27 of the wings 25 and slippage of the bending dies relative to the anvil portions 16a is prevented by the racks 28 of the bending dies meshing with the fixed gears 29. During this bending operation, laterally extending portions of the work piece are bent around the anvil portions 16a of the male die to thereby shape the work piece to the desired form such as the substantially U-shaped refrigerator cabinet shown in said earlier patent.

As thus far described, the machine 10 is substantially the same as the forming and bending machine disclosed in said earlier patent. The improvement features embodied in the present machine render the same more compact and provide for a more accurate and satisfactory performance of the forming and bending operations. These improvement features will be described next.

One of these improvement features provides for a more direct actuation of the slide 15 by the use of a hydraulic power cylinder 31 which is located in the hollow frame 11 and is fixed thereto. This power cylinder is provided with a reciprocable piston and a piston rod 33 which projects from the cylinder and has its outer end attached to the slide 15 as by means of the anchor screw 34.

The cylinder 31 is a double acting cylinder and supplies the power and motion required for moving the slide 15 toward and away from the stationary die mount 12 and for causing the male die 16 to cooperate with the stationary female die 13 for performing the desired work clamping and forming operation. Oil or other suitable liquid under pressure is supplied to the cylinder 31 by means of a suitable pump 35 driven by an electric motor 36. A reservoir 37 containing a supply of such liquid is located in the hollow frame 11 of the machine and in this instance the pump 35 is located in an opening of the wall of the reservoir as shown in Fig. 3.

In a machine of this kind very heavy pressures are exerted by the male die 16 against the work piece and the female die 13. It is important to the accuracy of the operations being performed that the female die 13 be securely held against longitudinal shifting by such pressure and also that movement of the female die as the result of deflection in the die mount 12 or in the frame 11 be minimized or substantially prevented. Such shifting or deflection can be substantially prevented as far as the female die 13 and its associated portion of the frame 11 are concerned, by providing a backing member or thrust block 39 on the frame and located at the rear of the die mount 12, that is to say, on the side thereof opposite the guideway 14.

The thrust block 39 can be formed as an integral part of the frame 11, or preferably as here shown, is a rigid structure attached to the frame and which reinforces the latter. This thrust block has a base portion 39a securely attached to the top of the frame 11 and an upright longitudinal portion 39b. The inner end of the upright portion 39b is in the form of an upright hollow post or section 39c which is engaged by the die mount 12 and has a vertical height above the frame 11 equal to or nearly equal to the height of the die mount. The thrust block 39 provides the frame 11 with a rigid thrust absorbing and reinforcing member which backs up the die mount 12 and prevents or minimizes shifting or deflection of the die mount which might result in inaccuracy in the work or in an imperfect performance of the machine. The upright section 39c of the thrust block 39 also serves as a means for mounting an upright post or column 40 which forms a part of an overhead crane or work handling device (not shown).

In the present machine 10 the pivotally mounted wings 25 which carry and manipulate the bending dies 24 are actuated by individual power cylinders 42. These power cylinders are double acting hydraulic cylinders to which liquid under pressure can be supplied from the pump 35 through the flexible conduits 35a. The cylinders 42 are disposed in a relatively inclined or divergent relation as shown in Figs. 1 and 2 with their outer or adjacent ends pivotally mounted on the outer end of the thrust block 39. These outer ends of the cylinders 42 are preferably not attached directly to the thrust block 39 but are attached to anchor members 43 by means of the yokes and pivot pins 44 and 45 and the members 43 are, in turn, adjustably connected with the outer end of the thrust block 39.

The cylinders 42 have reciprocable pistons therein and piston rods 46 connected with such pistons project from the cylinders and have their outer ends pivotally attached to the wings 25 by means of the yokes 47 and pivot pins 48. By controlling the supply of liquid under pressure to the cylinders 42 and the discharge of liquid therefrom the wings 25 can be swung about their pivot axes 26 to thereby cause the bending dies 24 to rock about the anvil portions 16a of the male die 16 and bend the work piece around the latter.

Since the cylinders 42 are pivotally mounted and are able to swing about their pivotal connections 45 during the swinging of the wings 25, it will be seen that these cylinders will act more directly and effectively to produce the desired swinging of the wings than if the actuation of the wings were accomplished through a linkage such as that shown in said earlier patent. It will be seen also that the use of these pivoted individual cylinders for actuating the wings and bending dies permits the machine to be consid-

erably shortened in length and otherwise rendered more compact and satisfactory.

As already explained above the male die 16 can be used in cooperation with the female die 13 so as to accomplish a forming operation on the work piece or for clamping the work piece when the latter is to be also subjected to a bending operation by the bending dies 24. When the die 16 is used for forming operations only it is usually not necessary to swing the carriage 17 because this kind of operation can ordinarily be carried out by a relative rapid closing and opening of the main dies 16 and 13 by reciprocating the slide 15. In view of the heavy pressures which are applied to the work by the male die 16 and the fact that the die 16 is located some distance above the guideway 14, it is important to prevent the actuating thrust for the die 16 from being transmitted through the pivot post 18.

This can be accomplished for both simple stamping operations and bending operations of the machine by providing a holding means for the carriage 17, preferably in the form of cooperating thrust elements 50, 51 and 52 located at the outer or rear end of the carriage. The thrust element 50 is a flange or projection provided on the carriage 17 and the elements 51 and 52 are bars or abutment members extending transversely of the slide 15 and attached thereto by means of the clamping screws 51*a* and 52*a*. As shown in Fig. 4 the cooperating faces of the elements 50 and 51 are curved faces 53 and 54 whose center of curvature lies on the axis of the pivot post 18. These cooperating curved faces 53 and 54 of the elements 50 and 51 are preferably beveled as well as curved, as shown in the drawings, so that when the element 51 is drawn down by the clamping screws 51*a* a wedging action can be obtained which will provide for some adjustment of the element 51 and will cause a tight engagement between the three thrust elements 50, 51 and 52.

When the male die 16 is to be used for the above mentioned simple forming or stamping operations and is merely reciprocated by the slide 15, the thrust element 51 is usually drawn down tightly by the screws 51*a* so that the thrust or reaction from the engagement of the male die 16 with the work and the female die 13 will be transmitted directly to the slide through the thrust elements 50, 51 and 52 and deflection of the pivot post 18 or shifting of the carriage relative to the slide will be substantially prevented. When the dies are to be used in carrying out a bending operation or a combined forming and bending operation on the work such that swinging of the carriage 17 relative to the slide 15 is desirable, the clamping screws 51*a* of the thrust element 51 are preferably loosened somewhat so that the desired swinging of the carriage can take place without undue binding by the curved faces 53 and 54 of the thrust elements 50 and 51.

During this swinging of the carriage 17 the curved face 53 of the thrust element 50 slides relative to the curved face 54 of the stationary thrust element 51. The radius of curvature provided for the faces 53 and 54 permits the carriage 17 to swing to its work-discharging position and to be returned to its working position and when the carriage has been thus returned the thrust elements 50 and 51 will be in cooperating engagement to receive the thrust when the main dies 16 and 13 are again closed by forward movement of the slide 15. It will be understood of course, that the clamping screws 51*a* are

loosened only enough to permit the desired relative sliding between the curved faces 53 and 54 which is necessary to accommodate the swinging of the carriage. In other words, the thrust element 51 is always maintained in a position to effectively absorb the thrust and prevent deflection of the pivot post 18.

Another important feature of the present machine is the provision of hold-down means for the carriage 17 and for the slide 15 so as to prevent a relative lifting of the male die 16 as the result of the heavy thrust applied thereto when the dies are being closed. The hold-down means for the carriage 17 comprises cooperating elements 56 and 57 provided respectively on the carriage and slide, and the hold-down means for the slide 15 comprises cooperating elements 58 and 59 provided respectively on the frame and slide. The hold-down element 57 is in the form of a bar or flange on the forward or inner end of the slide 15 and the hold-down element 56 comprises a lug or hook member mounted on the carriage 17 and engaging under the element 57 so as to prevent lifting or separation of the carriage relative to the slide. The cooperation of the elements 56 and 57 is such as to permit the carriage to be swung to its work discharging position and such that the element 56 will always re-engage under the element 57 when the carriage is returned to its working position as shown in the drawings.

The hold-down means for the slide 15 becomes effective only during the final closing movement of the male die 16 at which time the forwardly projecting element 59 of the slide engages in a recess 58*a* located under or in the hold-down element 58 of the frame. When the element 59 engages in the recess 58*a* it effectively prevents lifting or separation of the slide 15 relative to the frame and resists or prevents relative lifting of the male die 16 which might otherwise occur as the result of deflection or accumulated lost motion between the various parts of the machine.

In the embodiment of the machine here shown the carriage 17 is provided with an ejector cylinder 61 to which liquid can be supplied from the pump 35 for actuating an ejector or kicker 62. The ejector 62 engages the ends of the bent work piece to discharge the same from the male die 16 when the carriage 17 has been swung to its work-discharging position.

From the foregoing description and the accompanying drawings, it will now be readily understood that the present invention provides an improved forming and bending machine in which metal work pieces can be subjected to forming and/or bending operations in a more satisfactory manner than has heretofore been possible.

While the improved metal working machine of the present invention has been illustrated and described herein in considerable detail, it will be understood, of course, that the invention is intended to include all changes and modifications coming within the spirit of the invention and the scope of the claims hereof.

Having thus described my invention, I claim:

1. In a metal working machine of the character described, a frame having a fixed die mount thereon, a stationary die on said mount, a slide movable on said frame toward and away from said mount, a carriage, pivot means extending in projecting relation to the slide and mounting said carriage on said slide for swinging relative thereto, a die on said carriage and movable therewith for cooperation with said stationary

die in subjecting a work piece to clamping and forming pressure therebetween, means for reciprocating said slide for causing closing and opening of the dies and the application of said pressure to the work piece, and cooperating thrust elements on said slide and carriage and located to receive the major portion of the working thrust during the closing of the dies and prevent such thrust from being applied to said pivot means.

2. In a metal bending machine of the character described, a frame having a fixed die mount thereon, a stationary female die on said mount, a slide movable on said frame toward and away from said mount, a carriage, pivot means extending in projecting relation to the slide and mounting said carriage on said slide for swinging relative thereto, a male die on said carriage for cooperation with said stationary die in subjecting a work piece to clamping and forming pressure therebetween, means for reciprocating said slide for causing closing and opening of the dies and the application of said pressure to the work piece, said male die having curved anvil portions thereon, bending die means adapted for rocking cooperation with said anvil portions for bending portions of the work piece therearound while said pressure is being maintained, means for actuating said bending die means, and cooperating thrust elements on said slide and carriage and located to receive the major portion of the working thrust during the closing of the dies and prevent such thrust from being applied to said pivot means.

3. In a metal bending machine of the character described, a frame having a die mount fixed thereon, a stationary female die on said mount, a slide movable on said frame toward and away from said mount, a carriage, pivot means extending in projecting relation to the slide and mounting said carriage on said slide for swinging relative thereto, a male die on said carriage and movable therewith for cooperation with said stationary die in subjecting a work piece to clamping and forming pressure therebetween, means for reciprocating said slide for causing closing and opening of the dies and the application of said pressure to the work piece, said male die having curved anvil portions thereon, bending die means adapted for rocking cooperation with said anvil portions for bending portions of the work piece therearound while said pressure is being maintained, means for actuating said bending die means, and cooperating relatively fixed and movable thrust elements on said slide and carriage and having cooperating thrust faces which are curved to a radius which permits swinging of said carriage on said pivot means.

4. In a metal bending machine of the character described, a frame having a die mount fixed thereon, a stationary female die on said mount, a slide movable on said frame toward and away from said mount, a carriage, a male die on said carriage and movable therewith and having a clamping portion for cooperation with the stationary die in applying clamping pressure to an intermediate portion of an elongated work piece so that end portions of the work piece project outwardly from the clamped portion, said male die having anvil portions on opposite sides of said clamping portion, bending die means adapted to cooperate with said anvil portions for bending the projecting portions of the work piece therearound, means for actuating said bending die means, pivot means projecting from said slide and mounting said carriage on said slide for swinging relative thereto from a working position in substantial alignment with the path of movement of the slide to a work-discharging position in angular relation to said path of movement, power means for reciprocating said slide, and hold-down means for said carriage adapted to become effective when said carriage is swung to said working position.

5. In a metal bending machine of the character described, a frame having a die mount fixed thereon, a stationary female die on said mount, a slide movable on said frame toward and away from said mount, a carriage, a male die on said carriage and movable therewith and having a clamping portion for cooperation with the stationary die in applying clamping pressure to an intermediate portion of an elongated work piece so that end portions of the work piece project outwardly from the clamped portion, said male die having anvil portions on opposite sides of said clamping portion, bending die means adapted to cooperate with said anvil portions for bending the projecting portions of the work piece therearound, means for actuating said bending die means, pivot means projecting from said slide and mounting said carriage on said slide for swinging relative thereto from a working position in substantial alignment with the path of movement of the slide to a work-discharging position in angular relation to said path of movement, power means for reciprocating said slide, and hold-down means for said carriage comprising a holding portion on said slide and means on the carriage engageable under said holding portion when said carriage is swung to said working position, said hold-down means being effective for substantially preventing relative lifting of the carriage during the cooperation of said dies.

6. In a metal bending machine of the character described, an elongated horizontally extending rigid frame having a die mount fixed thereon, a stationary female die on said mount, a slide movable on said frame toward and away from said mount, a carriage, a male die on said carriage and movable therewith and having a clamping portion for cooperation with the stationary die in applying clamping pressure to an intermediate portion of an elongated work piece so that end portions of the work piece project outwardly from the clamped portion, said male die having anvil portions on opposite sides of said clamping portion, bending die means adapted to cooperate with said anvil portions for bending the projecting portions of the work piece therearound, means for actuating said bending die means, pivot means projecting from said slide and mounting said carriage on said slide for swinging relative thereto from a working position in substantial alignment with the path of movement of the slide to a work-discharging position in angular relation to said path of movement, hold-down means for said slide adapted to become effective on the end of the slide nearest said die mount during the final portion of the relative closing movement of the die for substantially preventing lifting of the slide relative to the frame, and other hold-down means adapted to become effective when said carriage is swung to said working position for preventing lifting of the carriage relative to said slide.

7. In metal bending apparatus of the character described, a frame having a die mount fixed thereon, a stationary die on said mount, a slide

reciprocable on said frame for movement toward and from said mount, a movable die carried by said slide for cooperation with said stationary die in clamping an intermediate portion of a work piece therebetween so that other portions of the work piece project outwardly from the clamped portion, said movable die having curved anvil portions at the sides thereof, a pair of bending dies for bending portions of the work piece around said anvil portions, a pair of pivotally mounted members located on opposite sides of said die mount and adapted to apply pressure to said bending dies and cause rocking of the latter relative to said anvil portions during the bending operation, means for reciprocating said slide, and a pair of pivoted power cylinders having their outer ends operatively connected with said frame rearwardly of said die mount and their inner ends connected with said pivotally mounted members for actuating the same, said power cylinders extending in diverging relation so that their inner ends straddle said die mount.

8. In metal working apparatus of the character described, an elongated substantially horizontal frame having a die mount thereon at an intermediate point and extending thereabove, a stationary die on said mount, means extending along the frame and providing a guideway thereon on one side of said mount, a slide reciprocable on said guideway for movement toward and away from said mount, a movable die carried by said slide for cooperation with said stationary die in clamping a work piece therebetween, means for reciprocating said slide, said movable die having curved anvil portions at the sides thereof, a pair of bending dies for bending portions of the work piece around said anvil portions, a pair of pivotally mounted members adapted to apply pressure to said bending dies and cause rocking of the latter relative to said anvil portions during the bending operation, means on said frame and projecting thereabove and forming a thrust block engaged by said die mount and extending along the frame and away from the die mount on the side of the latter opposite to said guideway, and a pair of power cylinders having pivotal connection with said thrust block and said pivotally mounted members for imparting swinging movement to the latter.

9. In a metal working machine of the character described, an elongated frame having a first die mount fixed thereon and laterally elongated guide means extending away from said die mount, a slide movable on the guide means of said frame toward and away from said die mount, a carriage pivoted on said slide and having a second die mount located thereon at a point spaced above said guide means, a first die member carried by the first die mount and spaced above said guide means, a second die member carried by said second die mount and adapted for closing cooperation with the first die member in applying pressure to a work piece received therebetween, said second die member having anvil portions thereon at the sides thereof, pivotally mounted bending die members adapted to cooperate with said anvil portions for bending portions of the work piece therearound, power means for actuating said slide to cause relative closing and opening of said first and second die members, power means for actuating said bending die members, and hold-down means for said slide located in the space between said guide means and die mounts and adapted to become effective on the end of the slide nearest said first die mount during the final portion of the relative closing movement of said first and second die members.

10. A metal working machine as defined in claim 9 in which said hold-down means comprises recessed stationary means on said frame adjacent said first die mount and a projection on said slide engageable in said recessed means.

11. In a metal bending machine of the character described, an elongated substantially horizontal frame having a die mount fixed thereon and extending thereabove, means on said frame providing a guideway extending therealong, a stationary die member carried by said mount and located above the level of said guideway, a slide reciprocable on said guideway for movement toward and from said mount, a movable die member carried by said slide in upwardly offset relation to said guideway and having a clamping portion for cooperation with the stationary die member in applying clamping pressure to an intermediate portion of an elongated work piece so that end portions of the work piece project outwardly from the clamped portion, said movable die member having anvil portions on opposite sides of said clamping portion, bending die members adapted to cooperate with said anvil portions for bending the projecting portions of the work piece therearound, power means for reciprocating said slide, fixed means on said frame and extending upwardly therefrom and forming a thrust block engaged by said die mount and located on the side of the die mount opposite to said guideway, said thrust block having a relatively high portion adjacent said die mount and a relatively low portion more remote from said die mount, and a pair of divergent power cylinders for actuating said bending die members, said cylinders having their widely spaced ends straddling the relatively high portion of said thrust block and operably connected with said bending die members and their closely spaced ends extending over and operably connected with said relatively low portion of said thrust block.

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