

March 29, 1949.

C. J. BATH

2,465,705

CONTOUR FORMING MACHINE

Filed Sept. 28, 1946

4 Sheets-Sheet 1

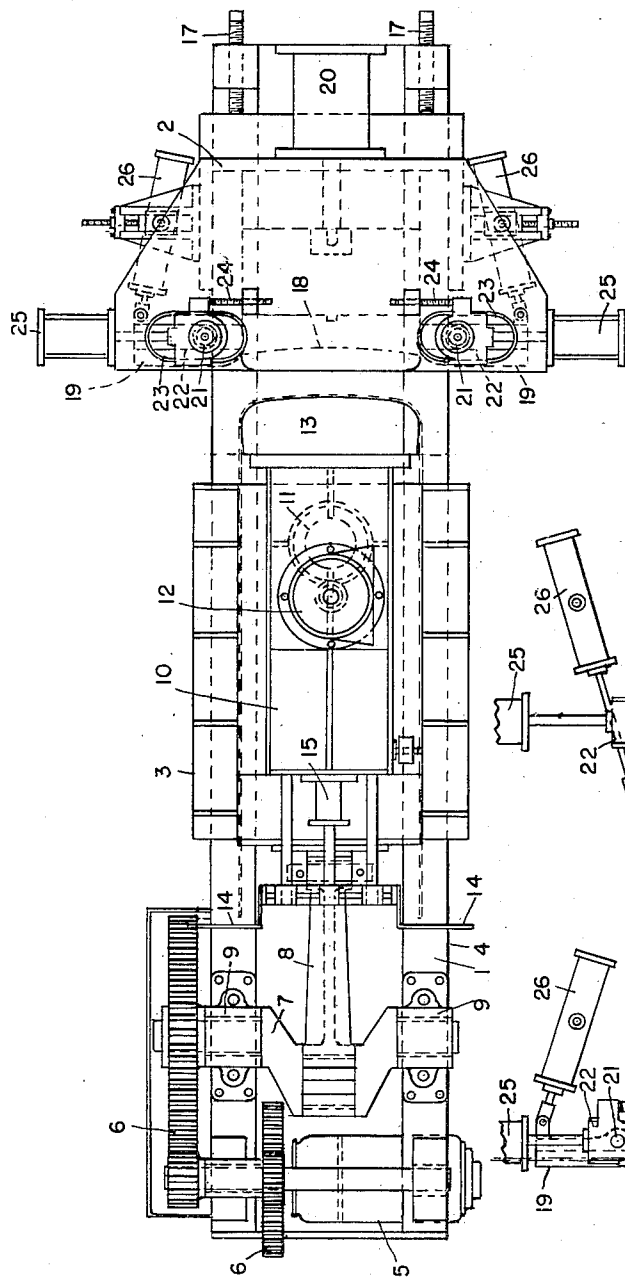


Fig. 1

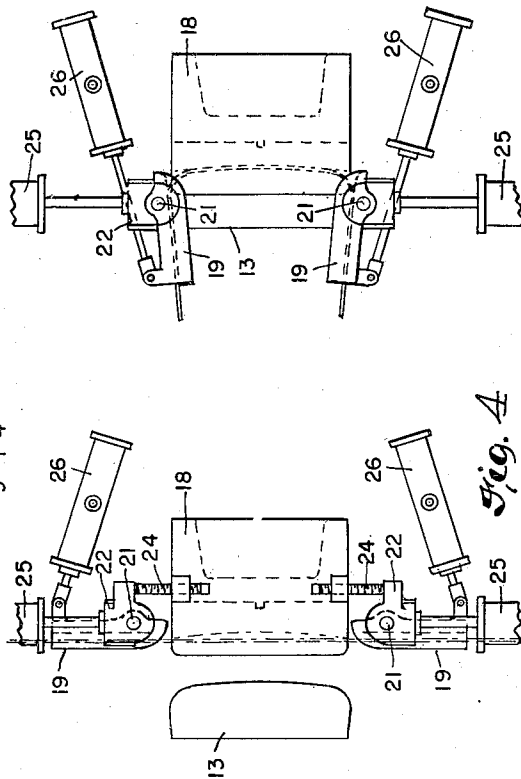


Fig. 5

Fig. 4

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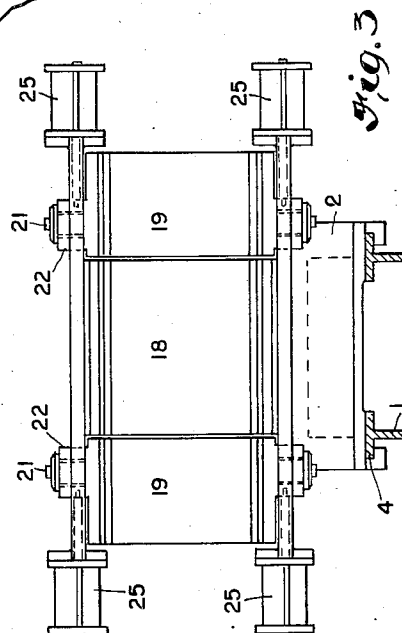
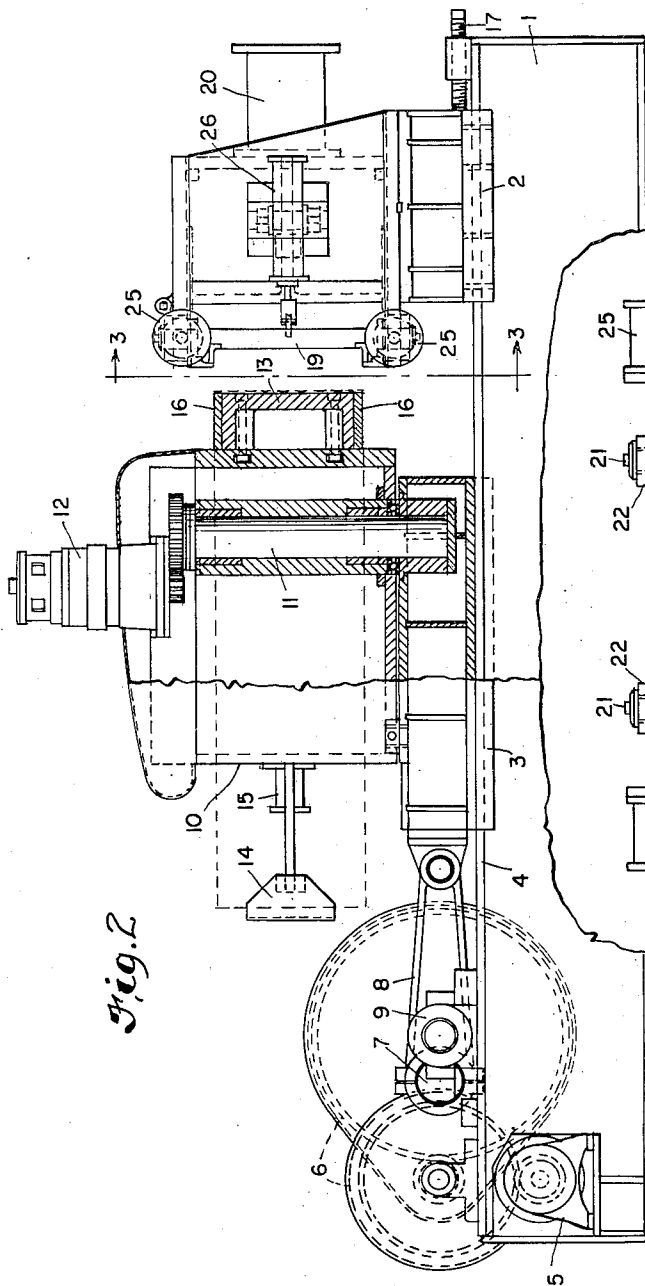
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

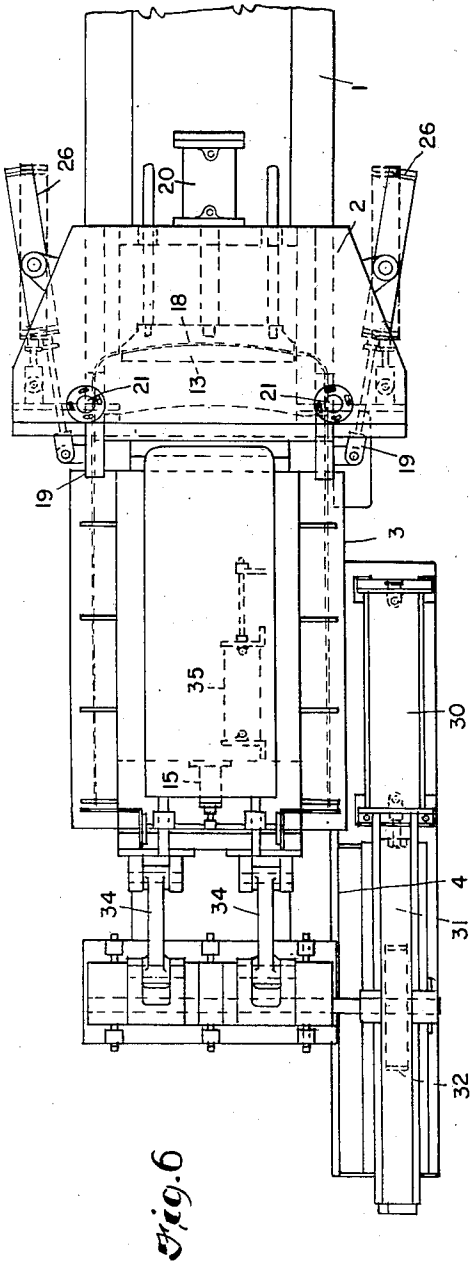


Fig. 6

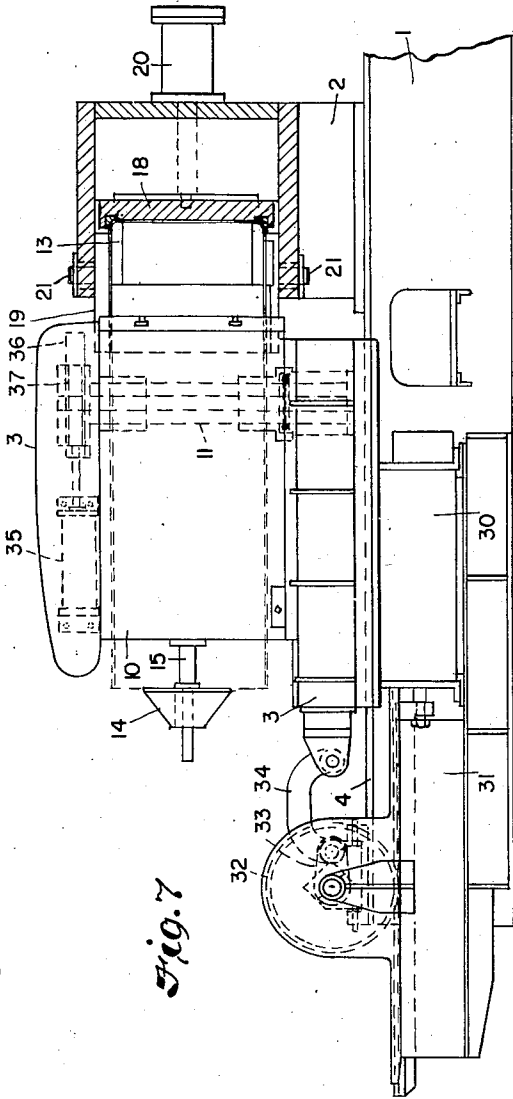


Fig. 7

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4 Sheets-Sheet 4

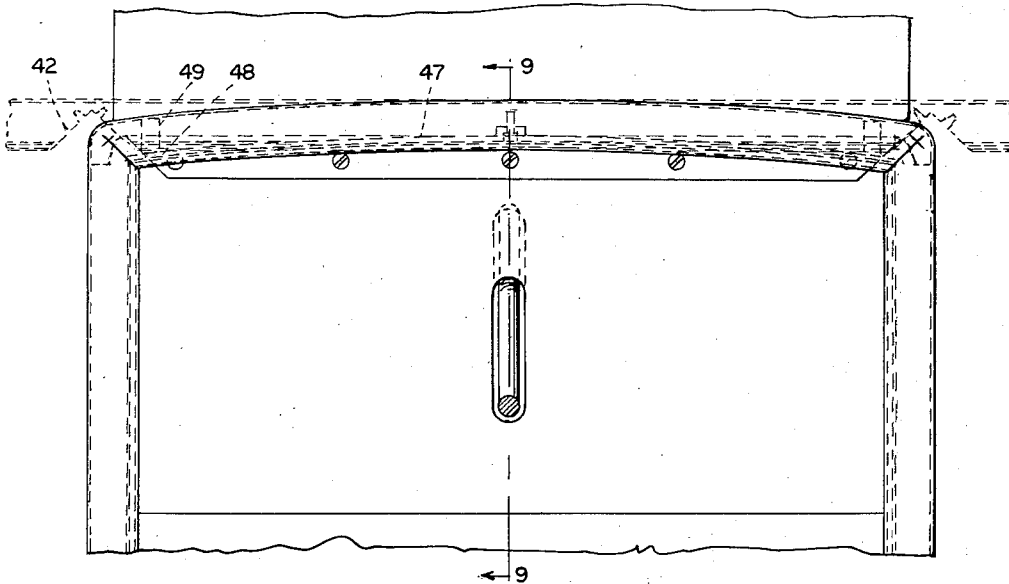


Fig. 8

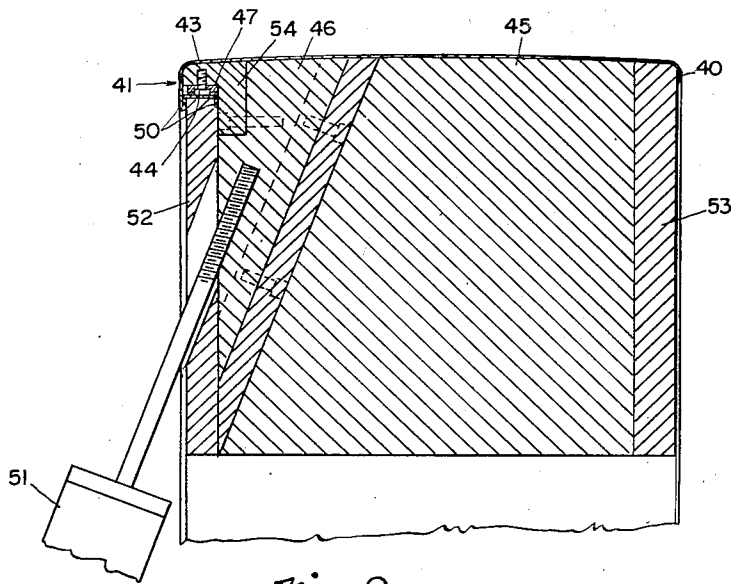


Fig. 9

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UNITED STATES PATENT OFFICE

2,465,705

CONTOUR FORMING MACHINE

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Application September 28, 1946, Serial No. 699,975

9 Claims. (Cl. 153—33)

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The present invention relating as indicated to contour forming machines has more particular regard to certain improvements in so-called tangent benders of the type capable of bending or forming flanged members to selected curved contour without causing the objectionable wrinkling or buckling of the flanges experienced prior to the advent of such benders. As illustrating the character of work piece which the present improvements are designed to produce, such metal structures as the curved bumpers on motor vehicles, frame members or carlings, cabinet sections and the like which are characterized by having portions thereof bent or formed to a desired shape and also have a flange or flanges extending along such bent or formed portions either for stiffening purposes or as a part of the structure.

The successful bending of flanged members in such machines is of course attributable to the continuous support of the flanges against buckling at and immediately adjacent the point of bending. However, machines now in general use while capable of satisfactorily bending flanged members are inherently slow multi-movement machines. Such slowness in addition to retarding production of members which can be formed while cold, makes such machines undesirable for forming members while hot because of the cooling of the members in the interim between clamping the same in the machine and the making of the last bend therein. Furthermore, such machines are suitable for forming only circular arcs and require a different set of gears in mesh with the rack on the bending shoe for each different radius to be bent.

Typical examples of so-called tangent benders are disclosed in Lee B. Green Patent No. 2,287,833 issued June 30, 1942 and it can be readily seen therefrom that the bending or forming of the cabinet section illustrated comprises four principal movements of the machine viz:

1. Clamping the work piece between the relatively movable male and female dies.

2. Actuating the rockers associated with the female die in one direction to displace the projecting ends of the work piece into engagement with the male die.

3. Actuating the rockers in an opposite direction, and

4. Unclamping the work piece.

Accordingly, it is one principal object of this invention to provide a machine which is capable of forming the work piece with one or more bends therein in one continuous movement of one of the dies and yet retaining the feature of being

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able to form contours in flanged members without the objectionable buckling or wrinkling of the flanges thereon.

It is another object of this invention to provide a machine wherein the work piece is formed to desired contour not only by the tangential bending action as in the prior art machines, but in addition by a drawing or wiping and an ironing action which still further minimizes the possibility of wrinkling or buckling of the flanges.

It is another object of this invention to provide a machine in which there are novel means for causing the rockers associated with the female die to follow any desired contour on the male die without requiring specially formed interlocking means between them.

It is another object of this invention to provide a machine in which there is a novel die structure for forming channel shaped stock to desired contour in a direction transverse to the flanges thereof.

It is another object of this invention to provide a machine having a novel die structure for forming desired contour stock having a generally transverse flange along one edge and a channel along its other edge opening toward such flange.

It is another object of this invention to provide a novel method of forming work pieces to desired contour.

Other objects will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

Fig. 1 is a plan view of a preferred form of machine;

Fig. 2 is a front elevational view partly in vertical cross-section of the machine illustrated in Fig. 1;

Fig. 3 is a view of the female die as viewed from line 3—3 of Fig. 2;

Fig. 4 is a top plan view of the die mechanism showing the same in a position ready for forming a work piece;

Fig. 5 is a view similar to Fig. 4, except showing the die mechanism in a position completing the last bend in the work piece;

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Fig. 6 is a top plan view of a modified form of machine;

Fig. 7 is a front elevational view of the machine illustrated in Fig. 6;

Fig. 8 is a top plan view of a die mechanism for forming stock having a transverse flange along one edge and a channel opening toward such flange along its other edge; and

Fig. 9 is a central vertical cross-section view taken along a line 9—9 Fig. 8.

Referring now to the drawing and first to Figs. 1 to 5, the machine illustrated therein comprises a bed or frame 1 on which is mounted an upright longitudinally adjustable member 2 and an upright reciprocable member 3. The bed 1 has suitable guideways 4 thereon on which said upright members are slidable.

The mechanism for reciprocating member 3 comprises a motor 5, a gear train 6, a crankshaft 7 rotatably supported in bearing boxes 9, and a connecting rod 8 pivotally connected to the crankshaft and to one end of the member 3. All of said elements are interconnected as clearly shown in the drawings so that one full revolution of the crankshaft 7 will effect reciprocation of member 3 toward and away from member 2.

Mounted on member 3 is an intermediate member 10 which is rotatable 90° from the position shown in Fig. 1 to a position transverse of the bed 1. Such rotation is effected through a shaft 11 connected to member 10 and rotatably supported in member 3, such shaft 11 being rotated by means of a motor 12. Member 3 is provided with suitable stops not shown for limiting rotation of member 10 between the aforesaid positions.

Secured to one end of member 10 is a male die 13 which has a face of contour to which it is desired to form the stock. The stock herein illustrated is a straight piece having along its respective edges generally transverse flanges. Such stock is to be curved transversely to form a cabinet section for a domestic refrigerator; the flanges in the finished cabinet serving as means for securing a door and a rear panel thereto. The male die 13 is adapted to engage the inner face of the stock and to lie closely adjacent the inner faces of the flanges.

At the other end of member 10 is a knock-out plate 14 which is reciprocable relative to member 10 by means of a pneumatic cylinder 15 or the like and adapted when member 10 is rotated to a position transverse of the bed to engage the ends of the completed work piece and to displace the same from the male die 13 to thus facilitate removal of the finished work piece. The die 13 preferably includes hardened inserts 16 at its upper and lower edges to thus provide hard wear-resisting surfaces in engagement with the flanges of the work piece.

Upright member 2 as previously indicated is longitudinally adjustable along the bed 1, such adjustment being effected by rotating a screw 17 having threaded engagement with bed 1. The female die which cooperates with male die 13 to form a straight work piece into desired contour is carried by member 2 and comprises three parts; namely, an intermediate part 18 and two adjacent rockers 19; the latter forming continuations of part 18 and all three parts being engageable with the outer face of the work piece and lying closely adjacent the outer surface of the flanges thereof. The intermediate die part 18 is of transverse width less than that of the male die 13 and is formed with a work piece en-

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gaging surface similar to the corresponding portion of the male die 13. In the present case, the male die 13 and the intermediate die part 18 are provided with slightly curved complementary surfaces to form a curved crown in the work piece when the same is initially clamped between die 13 and part 18.

The intermediate die part 18 is reciprocable in member 2 and is yieldably held in the position shown in Figs. 1 and 2 preferably by an air cylinder 20 although a coil spring or the like may be used if desired. When an air cylinder is used, the pressure therein is sufficient when the male die 13 is moved toward the intermediate die part 18 to clamp a work piece therebetween and to form the crown in the work piece and to continuously engage the work piece during the forming of the laterally projecting ends thereof around the relatively short radius curves at each lateral end of the male die 13.

The rockers 19 are respectively disposed adjacent the lateral ends of the intermediate die part 18 and are rotatably carried in member 2. The trunnions 21 on the rockers are rotatable in bearing members 22 which are reciprocally mounted in laterally extending slots 23 in member 2. In order to yieldably urge the rockers 19 to a position adjacent the ends of die part 18 air cylinders 25 fixed to member 2 are employed, member 2 having threaded thereinto a stop screw 24, the end of which is engageable with sleeve 22 to thus prevent engagement of the edge of the rockers 19 with the edges of die part 18.

Yieldably holding the rockers 19 in line with one another and with part 18 are air cylinders 26 having the rod portions thereof pivotally connected to rockers 19 at points eccentric of the trunnions 21. Cylinders 26 are pivotally connected to member 2 and suitable means such as those shown are provided for laterally adjusting the pivot axes thereof.

It can now be seen that when the parts of the machine are in the position shown in Figs. 1, 2, 3 and 4 a work piece may be placed across the female die. The successive steps in one complete cycle of the machine will be described without regard to any particular piping and wiring diagrams for coordinating such steps, it being within the skill of any electrical and hydraulic engineer to provide for such coordination upon disclosure of the desired steps and their sequence. With a work piece properly positioned across the female die, the motor 5 can be started to rotate crankshaft 7 and to thus move the member 3 toward the member 2. Such movement clamps the work piece between the male die 13 and the intermediate die part 18 and thus forms the crown therein. Continued movement of member 3 subsequent to clamping of the work piece effects movement of the intermediate die part 18 in unison with male die 13; thereby constantly clamping the work piece under regulated pressure as determined by the pressure in cylinder 20. During the movement of male die 13 and intermediate die part 18 and the work piece the laterally projecting ends of the work piece engage the rockers 19. Such engagement of the work piece with the rockers causes the rockers to yieldably rotate and to yieldably press against the projecting ends of the work piece. Such rotation resisting and laterally outward movement resisting action is effected by the cylinders 25 and 26. Such dual action causes the work piece engaging faces of the rockers 19 to follow and to be parallel to the tangent lines of the curves

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at the lateral ends of the male die 13 whether they be circular arcs, elliptical arcs or any other curved surface. When the ends of the finished work piece are to be parallel it is preferred that they be over-bent slightly to compensate for spring back thereof. To accomplish the over-bending in the particular example shown, the air pressure in cylinder 26 is reversed whereupon the rockers 19 are forcefully rotated to the position shown in Fig. 5 wherein the work piece engaging faces thereof are rotated to positions beyond lines which are parallel to the direction of movement of member 3. At this point of the cycle, the crank 7 has rotated through 180° whereupon continued rotation thereof will move member 3 toward the left as viewed in Figs. 1 and 2 away from member 2. At the same time the pressure may be reversed in the cylinders 20, 25 and 26 to permit ready separation of the male die 13 and the work piece from the female die. After the crank 7 has rotated 360° the motor 5 can be shut off and the intermediate member 10 rotated 90° to a position where the crown portion of the cabinet section so formed is transverse of the bed 1. The knock-out plate 14 can then be actuated so as to engage the ends of the work piece and to thus free the same from die 13. The work piece is then removed and the intermediate member 10 rotated 90° in opposite direction ready for forming another work piece.

From the above it can be seen that a work piece is completely formed by one continuous movement of one of the dies, first in one direction and then in the opposite direction. Furthermore, no intermeshing gears and racks are required between the male die and the rockers 19 in order to insure that the work piece engaging faces of the rockers will be tangent to the work piece as it is being formed. Likewise, the rockers 19 will follow any curved contour of the male die 13.

A further feature growing out of the present invention is that the work piece is formed by a drawing or a wiping action by reason of the resistance offered by the rockers 19 to rotation. Thus as the male die 13, the intermediate die part 18 and the work piece move toward the right as viewed in Figs. 1, 2 and 5, there is a sliding or wiping and an ironing action of the rockers 19 against the work piece. The magnitude of such wiping and ironing action is of course controlled by the amount of air pressure in the cylinders 25 and 26.

Insofar as the machine illustrated in Figs. 6 and 7 is the same as that illustrated in Figs. 1 to 5, like reference numerals have been used to designate like parts. In Figs. 6 and 7 the upright reciprocable member 3 is reciprocated by means of an air cylinder 30 the piston rod 31 of which has a rack thereon in mesh with a gear 32, which gear in turn rotates a crank 33. A pair of curved links 34 have their respective ends pivotally connected to the crank 33 and to the member 3. In this form of the invention the crank 33 is rotated 180° in opposite directions during one complete cycle of the machine. Also, the intermediate member 10 is herein shown as being rotated by means of a cylinder 35 through a rack and gear 36 and 37. One primary difference between the form illustrated in Figs. 6 and 7 and that illustrated in Figs. 1 to 5 is that in the former, the rockers 19 are rotatable about a fixed axis thereby limiting the width of die 13 which can be used; but there is yet included in this modified form the wiping and ironing action on the work

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piece as the male die and the intermediate die part 18 move in unison relative to the rockers 19. Such wiping and ironing is effected by the resistance to rotation of the rockers 19 by the cylinders 26. Inasmuch as the general operation of the machine illustrated in Figs. 6 and 7 is the same as that of the machine illustrated in Figs. 1 to 5, such operation will not now be repeated.

While the above described machines have particular utility in the forming of flanged members such as the cabinet sections illustrated because the forming dies closely embrace the flanges at and immediately adjacent the point of bending to prevent buckling or wrinkling of the flanges and also because of the stretching of the work piece due to the drawing or wiping action during bending, it is to be understood that flat sheet stock, angle bars, T-bars, I-beams and etc. may be formed with equal facility.

Referring now to Figs. 8 and 9 there is shown therein a novel die arrangement for making cabinet sections, for example, from stock which is formed along its respective edges with a generally transverse flange 40 and a channel 41 open toward such flange. Where such stock is to be formed as shown, there is preferably a notch 42 in each corner of the channel 41 to provide for a sharp inner corner and an outer corner of relatively small radius when the stock is bent. To my knowledge, no one has heretofore been able to transversely form such stock with any degree of success because of the attempt to engage the forming faces of the dies with only the outer faces of the parallel flanges 43 and 44 of the channel 41. Therefore that portion of the die structure described below which relates to the formation of the parallel flanges 43 and 44 to a desired curvature is applicable as well for forming the flanges of channel shaped stock which consists only of a channel 41 without a flange 40. In the illustrated cabinet section, the crown is curved both in vertical and horizontal planes.

In this novel die structure, the female die is formed in three parts as is the female die in Figs. 1 to 7. The male die is, however, made in two parts, one part 45 being engageable with a portion of the inner face of the stock and the outer face of the channel flange 44 and the inner face of flange 40 and the other part 46 being in the nature of a supplemental die interposed within channel 41 and having a face thereof engageable with the remainder of the inner face of the stock and also the inner face of the channel flanges 43 and 44. All of the faces of both parts are curved to conform to the desired final form of the stock except that face which is engageable with the inner face of the channel flange 44; such face being normally straight as shown. Such face is part of a flexible element 47 which is secured at its middle to part 45. The ends 48 of the flexible element 47 are free to be displaced transversely relative to the middle thereof to, in effect, wrap the channel flange 44 onto the curved face of part 45 which engages the outer face of the channel 44. The ends 49 are displaced by means of pins 49 secured thereto and projected through the part 46 into engagement with the inner face of the channel flange 43.

It can now be seen that when the male and female dies are brought together to clamp and form the crown in the stock, the engagement of the female concavely curved die with the outer face of the channel flange 43 will be at points opposite the ends of pins 49 and thus the forming of the channel flange 43 automatically displaces the

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ends 48 of the flexible element 47 to displace the channel flange 44 toward the curved face of part 45 opposite the outer face of the channel flange 44. During such displacement the middle of the convex face of part 45 will be in engagement with the outer face of the channel flange 44 at a point corresponding with the middle of the flexible element 47 and at the same time the middle of the convex face of part 46 will engage the inner face of the channel flange 43 at a point also corresponding with the middle of the flexible element 47 whereby both channel flanges will be simultaneously formed. Having thus formed the crown of the cabinet section, the projecting ends of the stock are drawn or wrapped around the remaining portion of the male die in the manner described above in relation to Figs. 1 to 7. As previously mentioned, this much of the die structure may be used for forming channel shaped stock formed, for example, with just a plain channel 41 including the spaced flanges 43 and 44.

In order to remove the completely formed stock the parts 45 and 46 must be displaced relative to one another out of alignment to disengage the flange 40 from part 45 to thus permit the finished work piece to be displaced or lifted upwardly from part 46. Such relative displacement of parts 45 and 46 in the case of a cabinet section such as illustrated is preferably along an inclined plane so that the flanges 40 on that portion of the cabinet section which forms the side walls can be moved upwardly relative to part 45. Suitable means such as the air cylinder 51 may be employed to actuate the part 46 relative to the part 45. Transverse displacement of parts 45 and 46 relative to one another is also desirable in order to disengage the curved face of part 45 from the transverse flanges 50 on the channel 44.

As soon as the completed cabinet section is removed the flexible element 47 flexes or springs back to its normal straight form and the pins 49 accordingly "pop" out with the ends thereof in line with the middle of the convex face of part 46 ready for slipping on of another straight piece of stock onto the male die.

Part 45 is preferably formed with a T-slot in which part 46 is slidably guided so as to partake only of inclined movement relative to part 45. Also, as shown, the parts 45 and 46 are respectively fitted with wear-resisting stock engaging pieces 52 and 53, and 54 and 47.

Other modes of applying the principle of the invention may be employed, changes being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A die for forming channel-shaped stock in a direction transverse of the flanges thereof, comprising a pair of dies movable toward and away from one another and having forming faces engageable with the outer faces of such flanges respectively and shaped to conform to the desired finished form of the stock, a supplemental die interposed between said dies and adapted to lie between such flanges and having one face conforming to the finished shape of the inner face of one flange, a flexible element on said supplemental die adapted to be flexed to the finished shape of the inner face of the other flange and normally being differently shaped therefrom, and means for so flexing said element in re-

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sponse to movement of said dies toward one another.

2. A die for forming channel-shaped stock in a direction transverse of the flanges thereof, comprising a pair of dies movable toward and away from one another and having forming faces engageable with the outer faces of such flanges respectively and shaped to conform to the desired finished form of the stock, a supplemental die interposed between said dies and adapted to lie between such flanges and having one face conforming to the finished shape of the inner face of one flange, a flexible element on said supplemental die adapted to be flexed to the finished shape of the inner face of the other flange and normally being differently shaped therefrom, and means interposed between said element and the inner face of the first-named flange and movable in response to movement of said dies toward one another to so flex said element.

3. A die for transversely forming a piece of stock having at its respective edges a flange extending generally transversely of the stock body and a channel open toward such flange, comprising a pair of dies movable toward and away from one another and having forming faces engageable respectively with the inner and outer faces of the stock body, and said die which is engageable with such inner face having a portion thereof movable relative to the remaining portion thereof to a position in line and out of line therewith, such portions having forming faces engageable respectively with the inner and outer faces of that portion of the channel which is spaced from and opposite the stock body.

4. A die for transversely forming a piece of stock having at its respective edges a flange extending generally transversely of the stock body and a channel open toward such flange, comprising a pair of dies movable toward and away from one another and having forming faces engageable respectively with the inner and outer faces of the stock body, and said die which is engageable with such inner face having a portion thereof movable relative to the remaining portion thereof to a position in line and out of line therewith, such portions having forming faces engageable respectively with the inner and outer faces of that portion of the channel which is spaced from and opposite the stock body, and being arranged so that when moved to a position out of line with one another wherewith the remaining portion is disengaged from the surface of the flange which faces toward the channel, the stock may be fitted onto or removed from the portion thereof which fits into such channel.

5. In a contour forming machine, the combination of main and wing dies movable relative to one another along a predetermined path, said main die being formed with a convexly curved surface, clamping means operative to clamp a workpiece to said main die in a laterally extending position with respect to such path and with a portion of the workpiece projecting laterally beyond such curved surface, said wing die being formed with a surface engageable with such projecting portion of the workpiece, pivot means supporting said wing die for swinging movement around such curved surface of said main die by such projecting portion of the workpiece in response to relative movement of said dies, means supporting said pivot means for movement laterally of the path of said dies, means yieldably urging the pivot means toward

such path, and reversible power means selectively operable for yieldably imposing a resultant turning moment on said wing die in opposition to but less than that effected by the projecting portion of the workpiece as aforesaid, and for yieldably imposing a resultant turning moment on said wing die supplementing that effected by the projecting portion of the workpiece as aforesaid.

6. In a contour forming machine, the combination of a pair of main dies movable relative to one another along a portion of a predetermined path to clamp a workpiece therebetween with a portion of the workpiece projecting laterally beyond said dies and movable together with such workpiece along another portion of such path, a wing die engaged by the projecting portion of the workpiece, means supporting said wing die for swinging movement by the workpiece laterally toward said main dies about an axis transverse to the length of such path, means supporting the pivot means for movement laterally of such path, means yieldably urging said pivot means laterally toward such path, and reversible power means selectively operable to yieldably urge said wing die to swing about said pivot means away from such path with sufficient force to impose a resultant turning moment on said wing die of sufficient magnitude to effect forming of the projecting portion of the workpiece by wiping action to conform with one of the main dies between which it is clamped and beyond which a portion thereof initially projected and to yieldably urge said wing die to swing about said pivot means toward such path with sufficient force to impose a resultant turning moment on said wing die of sufficient magnitude to effect overforming of the projecting portion of the workpiece to compensate for spring back therein.

7. In a contour forming machine, the combination of a pair of relatively movable members, one of said members being formed with a surface of contour to which it is desired that a workpiece conforms when finished, means for clamping a workpiece to said one of said members with a portion of the workpiece projecting laterally therebeyond, a wing die rotatably carried by the other of said members adapted to be engaged by and rotated by the projecting portion of the workpiece to thus progressively force the workpiece into engagement with said one of said members in response to relative movement of said members toward each other, and reversible power means connected to said wing die and selectively operable for yieldably resisting rotation of said wing die during such relative movement to thereby effect forming of the workpiece by a wiping action, and for forcefully rotating said die at least during the latter part of such relative movement to overform the workpiece and thereby compensate for spring-back thereof.

8. A contour forming machine comprising a main die having a convexly curved corner surface at one lateral margin and being movable along a predetermined path, clamping means operative to clamp a workpiece to said main die in laterally extending position with respect to said path with a portion of the workpiece projecting laterally across the path of said curved corner surface, a wing die having a curved surface which is convex toward said main die, pivot means supporting said wing die for swinging movement about an axis generally parallel to the axis of said curved corner surface of the main die, supporting means supporting said pivot means for movement generally laterally of said path, yieldable means yieldably urging said pivot means toward said path, to dispose the curved surface of the wing die in the path of said corner surface, said pivot means, supporting means, and yieldable means being arranged and cooperative concurrently normally to maintain the curved surface of the wing die in yielding pressure engagement with such projecting portion of the workpiece so that the curved surface of the wing die can roll the workpiece about said curved corner surface of the main die with resultant swinging of the wing die in one direction about its pivot, upon movement of the main die along a portion of its said path on its forming stroke, and yieldable restraining means in addition to said yieldable means operatively connected to the wing die and opposing the swinging movement thereof in said direction with sufficient restraining force to partially overcome the said rolling action of the wing die curved surface and to cause said curved surface of the wing die to partially slide on the workpiece around said corner surface under sufficient pressure to tension the workpiece while the curved surface partially rolls thereabout.

9. The contour forming machine according to claim 8 characterized in that said yieldable restraining means is a fluid pressure operated piston and cylinder assemblage.

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