

March 2, 1948.

A. M. GREENE, JR., ET AL

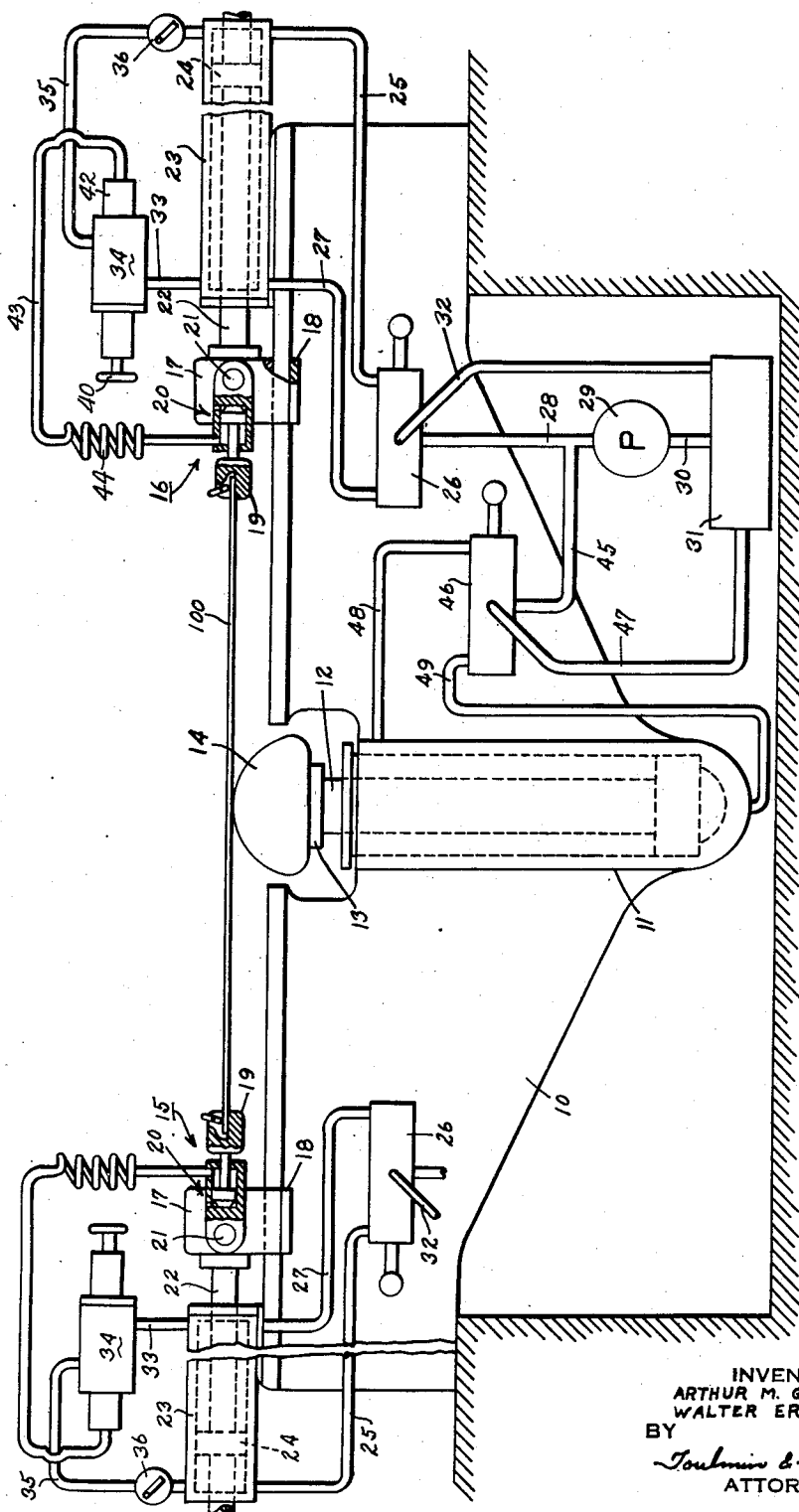
2,437,092

METAL STRETCHING PRESS

Filed Sept. 22, 1944

3 Sheets-Sheet 1

FIG. 1.



INVENTORS
ARTHUR M. GREENE JR.
WALTER ERNST
BY
Toulmin & Toulmin
ATTORNEYS

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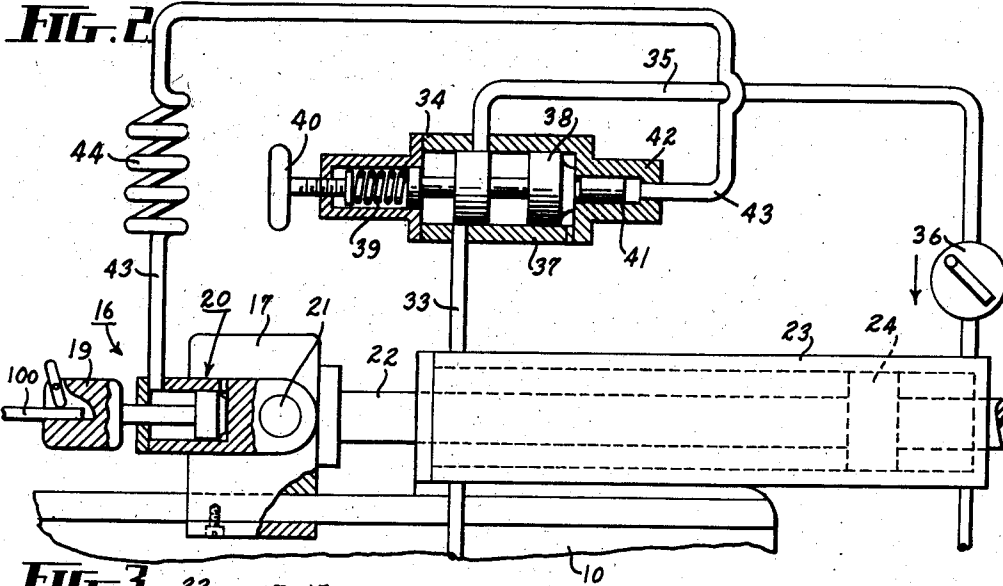
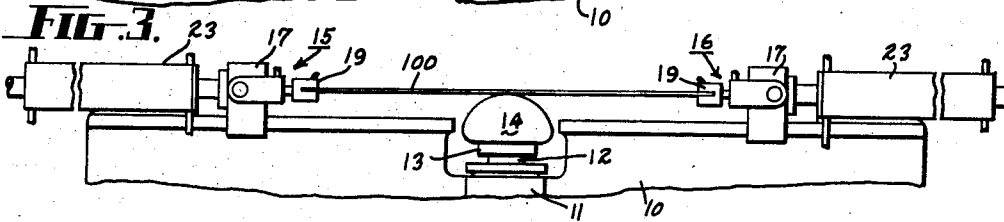
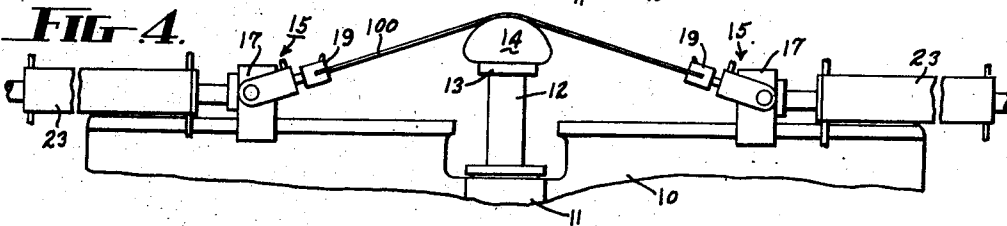
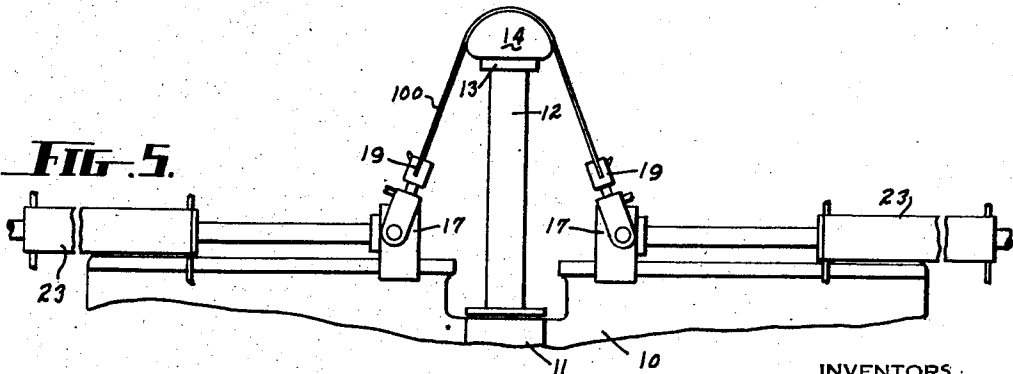
A. M. GREENE, JR., ET AL

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3 Sheets-Sheet 2



INVENTORS
ARTHUR M. GREENE JR.
WALTER ERNST
BY
Toulmin & Toulmin
ATTORNEYS

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3 Sheets-Sheet 3

FIG. 6.

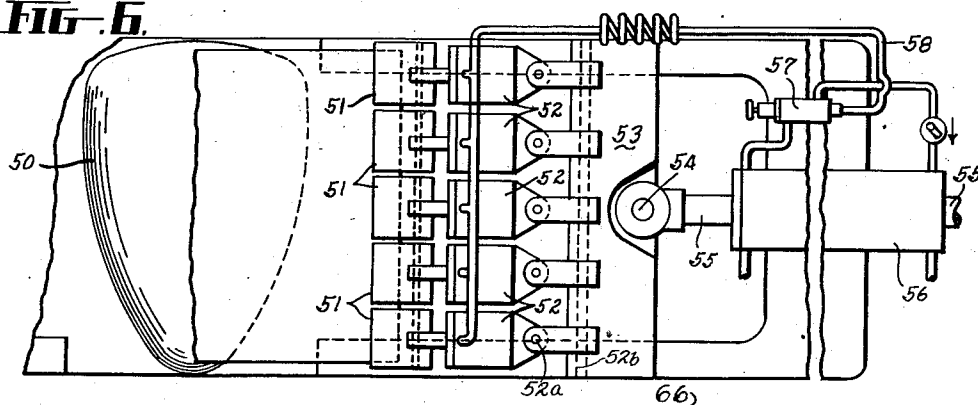


FIG. 7.

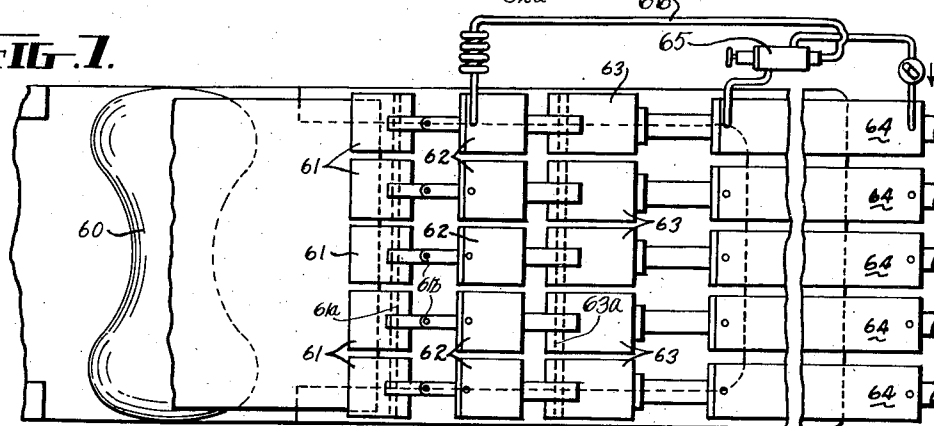
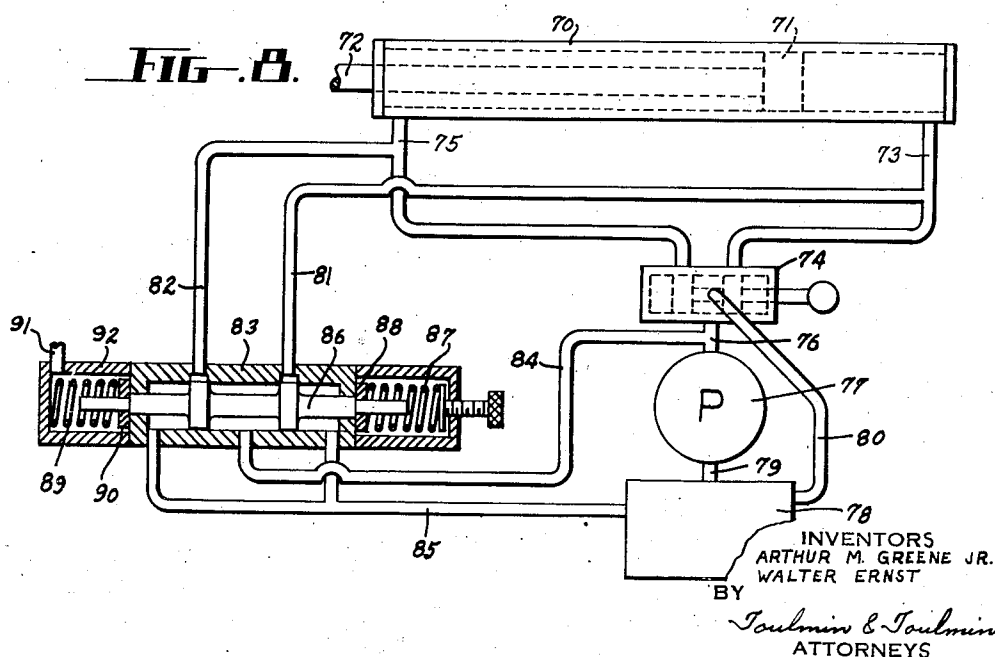


FIG. 8.



INVENTORS
ARTHUR M. GREENE JR.
WALTER ERNST
BY
Toulmin & Toulmin
ATTORNEYS

UNITED STATES PATENT OFFICE

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METAL-STRETCHING PRESS

Arthur M. Greene, Jr., Princeton, N. J., and
Walter Ernst, Mount Gilead, Ohio, assignors to
H-P-M Development Corporation, Wilmington,
Del., a corporation of Delaware

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11 Claims. (Cl. 153—48)

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This invention relates to method and apparatus for stretching sheets of material into predetermined configurations.

In the art of metal stretching it is customary to grip a sheet of metal along the edge thereof and to advance a single die or forming member into the said sheet so as to stretch the material into the desired configuration. Ordinarily, the gripping jaws are manually manipulated to be moved closer to the stretching member as the operation progresses so that the sheet does not rupture or so that the sheet may be more completely formed around the punch or die member.

It will be apparent that the manual manipulation of the gripping members requires a highly skilled operator and, at best, can only approach the most desirable conditions for a stretching operation.

It is a primary object of the present invention to provide a stretching press which will produce superior workpieces.

It is another object to provide a stretching press in which the tension in the sheet being stretched is automatically controlled.

It is another object of the present invention to provide automatic means for moving the gripping members during the stretching operation.

It is another object to provide a stretching press in which any predetermined tension may be maintained on the sheet, or in any portion thereof during the stretching operation.

It is another object to provide a method and apparatus for stretching sheets into more or less complex configurations.

These and other objects and advantages will become more apparent upon reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a metal stretching press constructed according to this invention;

Figure 2 is an enlargement of a portion of Figure 1 showing in greater detail the swivelled jaws and the valve arrangement associated with the jaw reciprocating motor;

Figures 3, 4 and 5 are diagrammatic views showing different stages of a stretching cycle;

Figure 6 is a modification showing a plurality of gripping members attached to a crosshead and a single jaw reciprocating motor;

Figure 7 is a view showing a plurality of jaws and jaw reciprocating motors in association with a pressing member of irregular shape; and

Figure 8 is a view of a modified arrangement for the jaw and slide reciprocating motor showing power means for moving the same.

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General arrangement

In general, a stretching press constructed according to this invention comprises a frame having suitably mounted therein, in any desirable manner, a die carrying reciprocable platen. Motor means, preferably fluid operable, are provided for reciprocating the platen thereby to advance the die or punch into the work. The workpiece is adapted to be gripped by a pair of gripping members mounted on the press frame on either side of the said platen. According to this invention, the jaws are swivelled to crossheads which latter are automatically reciprocated during the stretching operation. The movement of the crossheads or jaw carrying slides is automatically controlled so that a predetermined and substantially constant tension is maintained in the sheet throughout the stretching operation. The jaws and slides to which they are attached are preferably reciprocated by a fluid motor which has associated therewith suitable valving means for initially positioning the said jaws and for thereafter effecting the aforementioned automatic control.

The valve which automatically controls the motor connected with the slide comprises a pilot operated valve which is hydraulically connected with a plunger associated with the gripping jaws. In response to a predetermined tension on the sheet, a predetermined pressure is developed by the said plunger and is transmitted to the pilot operated valve. The pilot operated valve is adapted to respond to a predetermined pressure to permit the exhaust of fluid from one side of the slide motor thereby permitting the latter to move.

According to one modification the pilot operated valve is connected with a source of fluid pressure so that the slide is positively moved by fluid pressure rather than by the tension in the sheet.

According to another modification a plurality of gripping means are provided on either side of the platen and the tension in the sheet may be varied from place to place as required by the shape of the pressing member.

According to still another modification a plurality of jaws is provided on either side of the press platen, the jaws being separately swivelled to the slide or crosshead and the latter being swivelled to the crosshead reciprocating motor so that the crosshead and the jaws may automatically shift during the pressing operation in the event that the workpiece is wider at one end than the other.

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Detailed description

Referring to Figure 1, the press according to this invention comprises a frame 10 having mounted therein, or integral therewith, a main cylinder 11 within which is reciprocable the ram 12 which carries a platen 13. A die or punch 14 is attached to the platen 13 in any suitable manner.

Arranged on either side of the platen 13 are the gripping or jaw structures 15 and 16. Each of the jaw structures comprises a slide or cross-head 17 which is slidably mounted on the press frame 10 such as by the way and gib arrangement indicated at 18. Swivelly attached to the slide member 17 are jaw units comprising a gripping member 19 and a piston and cylinder arrangement 20. The piston-cylinder arrangement is connected by the trunnion 21 to the slide member 17. Since the jaw structures at each side of the platen are identical, a description of the one at the right of the platen, as seen in Figure 1, will suffice for both.

Affixed to the side of the slide member 17 opposite the platen 15 is a plunger 22 which extends into a cylinder 23 mounted on the bed 10. The plunger 22 extends completely through the said cylinder and has a piston 24 thereon within the cylinder so as to form a fluid operable motor having advancing and retracting areas which are equal.

Connected with the right end of the cylinder 23 is a conduit 25 which leads to a four-way valve 26. Connected to the left end of the cylinder 23 is a conduit 27 also leading to the valve 26. The valve 26 is supplied with pressure fluid by a conduit 28 from the pump 29 which is connected by a conduit 30 with a reservoir 31. The valve 26 also has connected thereto an exhaust conduit 32 which leads directly to the reservoir 31. The valve 26 is movable into a first end position to interconnect the conduits 28 and 35 while simultaneously connecting the conduits 27 and 32 and, into a second end position to interconnect the conduits 27 and 28 and the conduits 25 and 32. The valve 26 is also movable into an intermediate position wherein the fluid communication between the said conduits is interrupted.

Also connected with the left end of the cylinder 23 is a conduit 33 which leads to a valve 34, the valve also being connected by the conduit 35 with the right end of the cylinder 23. The conduit 35 comprises the check valve 36 which permits the fluid flow from the valve to the cylinder but not vice-versa.

The valve 34, more clearly shown in Figure 2, comprises a valve casing 37 within which is reciprocable a valve member 38. The valve member 38 is urged into its right hand end position by a spring 39, the thrust of which may be varied by adjusting the hand wheel and screw arrangement at 40. In its right hand position, the valve member 38 interrupts fluid communication between the conduits 33 and 35. Opposite the spring 39 is a plunger 41 which is reciprocable in the cylinder 42. The plunger 41 is operable, when pressure fluid is supplied to the cylinder 42 from the conduit 43, to move the valve member 38 leftwardly so as to interconnect the conduits 33 and 35.

The conduit 43 is connected with the piston-cylinder arrangement at 20 associated with the jaw 19. Preferably the conduit 43 comprises a flexible portion 44 which permits the free movement of the slide 17 relative to the valve 34. The conduit 43 is connected into the left end of the

piston-cylinder-arrangement at 20 so that movement to the left by the jaw 19 is effective to create a pressure which, when conducted to the cylinder 42, actuates the plunger 41 and the valve member 38.

Connected with the discharge side of the pump 29 by means of the conduit 45 is a distributing valve 46 which also has connected therewith the exhaust conduit 47, the conduit 48 which leads to the upper end of the cylinder 11 and, the conduit 49 which leads to the lower end of the cylinder 11. The valve 46 is movable into position to interconnect the conduits 48 and 45 and the conduits 49 and 47 or into position to connect the conduits 48 and 47 and the conduits 49 and 45.

Referring now to Figure 6, a modification is shown wherein the pressing member 50 is of an irregular shape, being larger at the one end than at the other. The press shown in Figure 6 comprises a plurality of jaw members 51 which are connected with a plurality of piston-cylinder arrangements at 52 the latter being universally connected with a crosshead or slide 53 by the pivotal connections 52a and 52b. The slide 53 is pivoted as at 54 to a plunger 55 of the motor 56. As in the case of the motor 23, the motor 56 has equal advancing and retracting areas.

A valve 57 similar to the valve 34 is connected with the opposite ends of the motor 56 and is piloted by fluid conducted thereto to the conduit 58. The conduit 58 is connected with the several piston-cylinders 52 so that the average pressure in the said piston-cylinder arrangement is conducted to the valve 57. It will be apparent that the arrangement in Figure 6 is such that a predetermined tension may be maintained across a sheet which is being drawn by an irregularly shaped pressing member.

Referring to Figure 7, there is shown a modified arrangement of this invention wherein the pressing member 60 is of relatively complex configuration. A plurality of jaws 61 grip the workpiece along the margin thereof, each of the jaws 61 having associated therewith a piston-cylinder arrangement 62. Each of the piston-cylinder arrangements 62 is pivotally connected with an individual slide 63 at 63a, and each of the latter has associated therewith the motor 64.

Each of the motors 64 has connected thereto a valve 65 similar to the valves 34 and 57 and each valve is actuated by fluid pressure conducted thereto from the associated piston-cylinder 62 by a conduit 66.

It will be apparent that any desired tension may be maintained in any portion of the sheet merely by adjusting the individual valves 65. Accordingly, it is possible to form a workpiece of relatively complex configuration without over-stressing or rupturing or underforming any of the various portions thereof. It will be noted that the jaws 61 are pivoted at two points so that they may follow the outline of the work-piece as it is being formed.

Referring now to Figure 8, there is shown a modified arrangement wherein the jaw and slide reciprocating motor is positively moved during the stretching operation. In this figure the jaw and slide reciprocating motor 70 has therein the double acting piston 71 to which is attached the plunger 72 which is, in turn, connected with the slide member of the jaw structure.

Connected with the right end of the cylinder 70 is a conduit 73 which connects with the valve 74 and, connected with the left end of the cylinder 70 is a conduit 75 also leading to the valve 74.

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The valve 74 is supplied with pressure fluid by a conduit 76 which connects with the discharge side of the pump 77. The pump 77 and the valve 74 are also connected with a reservoir 78 by the conduits 79 and 80, respectively.

The valve 74 is movable into position to direct pressure fluid either to the right or to the left end of the cylinder 70 while simultaneously exhausting the other end or, into an intermediate position for interrupting said fluid connections.

Connected with the conduits 73 and 75 are a pair of conduits 81 and 82 which lead to a valve 83. The valve 83 also has connected therewith the conduit 84 which is connected with the discharge side of the pump 77 and a conduit 85 which is connected with the reservoir 78. The valve 83 comprises a valve member 86 which is normally positioned to interrupt fluid communication between the various valve conduits. An adjustable spring 87 at the right end of the valve urges the valve member 86 leftwardly until the collar 88 engages the end of the valve casing.

A spring 89 at the left end of the valve urges the valve member 86 rightwardly until the collar 90 engages the end of the valve casing. A conduit 91 is connected into the spring casing 92 and is also connected with the piston-cylinder arrangement associated with the jaw and slide structure attached to the plunger 72.

It will be apparent that a predetermined pressure within the spring chamber 92 conducted thereto by the conduit 91 is effective to move the valve member 86 rightwardly thus establishing fluid communication between the pump 77 and the right end of the cylinder 70 while simultaneously connecting the left end of the cylinder 70 with exhaust. The plunger 72 is thus positively moved toward the platen of the press.

Operation

In operation, the jaws 19 are initially positioned so as to grip the edges of the work sheet 100 by manipulation of the valves 26. After the sheet 100 has been properly gripped by the jaws 19, the valves 26 are moved into their central position so that the fluid in the opposite ends of the motors 23 is trapped.

The operator then shifts the valve 46 to move the plunger 12 and the punch or die member 14 upwardly. The condition prior to the stretching operation is shown in Figures 1 and 3.

After the die has moved upwardly a short distance, the conditions existing are illustrated in Figure 4. In this figure the movement of the die member has created a predetermined tension in the portion of the sheet between the die and the jaw members on either side thereof. The tension in the sheet creates a predetermined pressure in the piston-cylinder arrangement 20 which, when conducted through the conduit 43 to the cylinder 42 actuates the plunger 41 to move the valve member 38 leftwardly against the thrust of the spring 39 thus interconnecting the conduits 33 and 35. After the valve member 38 has been shifted to interconnect the opposite ends of the motor 23, the tension on the sheet is effective to move the slide 17 and plunger 22 leftwardly until the valve 34 again closes.

In this manner the piston-cylinder arrangement 20 acts as a "signal" cylinder for the main cylinder 23 which thus pays out the slide 17 in response to the tension in the workpiece. Thus it is not just the piston of the piston-cylinder arrangement 20 which moves in response to the tension created in the work piece, but it is the

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whole slide 17, with gripping member 19 and signal cylinder 20 carried by it, which moves in response to said tension. It is to be further noted that the pivot points of the pivotal connections at 21 of the gripping arrangements 20 are moved automatically in response to a predetermined tension in the sheet in a direction at right angles to the upward movement of the pressing member.

As the stretching cycle continues the parts move from their Figure 4 position into the position indicated in Figure 5 where the workpiece is substantially completed. It will be apparent that throughout the stretching operation a substantially constant and predetermined tension has been maintained in the portions of the sheet between the pressing and the edges thereof which are gripped by the jaws.

It should be noted that as the work piece is formed, as shown in Figures 3, 4, and 5, the gripped edges of the sheet material have moved towards the forming member substantially at right angles to it, subject only to a slight angular deflection caused by the tilting of the member 20 about the pivot 21. Thus, said gripped edges are automatically paid out towards said forming member in a substantially right angular relation to it, said paying out of said edges being in response to a predetermined tension in said sheet material.

Should it be desired to move the jaws even closer to the platen than their Figure 5 position, the operator may shift the valves 26 while permitting the die 14 to continue its advancing movement.

The operation of the embodiment shown in Figure 6 is similar to the operation of the embodiment of Figure 1 except that the slide 53 is free to assume an angular position relative to the press frame thus permitting a workpiece to be stretched which is substantially wider at one end than the other. It will be apparent that the modification of Figure 6 also provides for a substantially constant and predetermined tension to be maintained in the sheet at all times.

The modification illustrated in Figure 7 operates in a manner substantially identical with the modification of Figure 1 except that each gripping member or jaw is separately moved so that a workpiece of complex configuration may be formed. It will be noted that the pressure which is maintained on the portion of the sheet associated with each jaw is individually adjustable so that one portion of the sheet may be stretched a great deal more than another portion without in any way detracting from the quality of the finished workpiece.

The modification shown in Figure 8 provides power means for moving the jaws and thereby eliminates the possibility that the inward movement of the jaws may be halted before the forming operation is completed. In fact, with the arrangement shown in Figure 8, the margins of the workpiece may be formed even beyond the limits of the die member thus providing means for eliminating spring-back should it be desired to form a piece having substantially parallel side portions thereon.

It will be apparent that various modifications may be made in the structure of this invention without in any way departing from the spirit thereof. For example, the motors 23 could be contained within the bed 20 if so desired thereby providing for a somewhat more compact arrangement. Also, the jaws 19 could be replaced

with any other suitable jaw mechanism without affecting the operation of the control system according to this invention.

It will be obvious that the piston-cylinder arrangements at 20 provide means for directly measuring the tension in the sheet 100 thus insuring that the valve 34 will be actuated at the proper time. Also, it will be obvious that the valve 34 will, in most instances, operate to throttle the flow of fluid from the left end of the motor 23 rather than intermittently exhausting the same.

It will also be apparent, upon reference to Figures 6 and 7, that the work sheets could be slit between the jaw members in order to facilitate the shaping of complex workpieces if so desired.

It will be understood that we desire to comprehend within our invention such modifications as may come within the scope of the invention and the claims.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. A method of forming workpieces from ductile sheet material with a single forming member which comprises, rigidly gripping the said sheet at a plurality of points on either side of said forming member and, advancing said forming member into said sheet while automatically positively paying out said sheet rigidly gripped points substantially at right angles to said forming member in response to a substantially constant and predetermined unit stress in said material between each of said gripped points and said forming member.

2. A method of forming workpieces from ductile sheet material which comprises, rigidly gripping a pair of opposite edges of said sheet by a plurality of movable gripping members, advancing a substantially rigid forming member into said sheet, and automatically positively moving said gripping members substantially at right angles relative to said forming member, during the advancing movement of the latter, in response to a predetermined unit stress in said sheet between each of said gripping members and said forming member.

3. A press for shaping metal sheets comprising a frame, a reciprocable pressing member carried thereby, a pair of gripping means slidably mounted on said frame on opposite sides of said pressing member, each of said gripping means including jaw members swivelled thereto, fluid operable motor means for reciprocating said pressing member relative to said gripping means, fluid operable motor means for initially positioning said gripping means relative to said pressing member, and fluid pressure control means for said gripping means automatically operable in response to a predetermined tension in said sheet to cause said second mentioned motor means to move said gripping means toward each other in a plane which is substantially at right angles to said pressing member.

4. A press for shaping metal sheets comprising a frame, a press platen reciprocable relative to said frame and adapted to mount a die member, slide means arranged on said frame on either side of said press platen and movable relative thereto, each of said slide means including a jaw member having associated therewith a piston-cylinder arrangement pivotally secured to said slide means, first motor means for reciprocating said press platen relative to a sheet gripped by

said jaw members, second motor means for reciprocating said slide means relative to said platen, a fluid source for supplying actuating fluid to said motor means for reciprocating said platen and said slide means, valve means connected with said fluid source and said second motor means and movable into a position to interrupt fluid communication between said motor means and said fluid source for maintaining said slide means in any predetermined position, and fluid control means associated with said second motor means responsive to a predetermined pressure in said piston-cylinder arrangement to by-pass fluid around said valve means to cause said slide means to move relative to said platen.

5. A press for shaping metal sheets comprising a frame, a platen adapted to mount a die member reciprocable relative to said frame, slide means slidable on said frame on either side of said platen, jaw means associated with each of said slide means and including a piston-cylinder arrangement pivotally connected with said slide means, reciprocable fluid operable motor means connected with said slide means for reciprocating the same, valve means operable to connect said motor means with a source of fluid pressure or to disconnect said motor means from said fluid source and from exhaust, other valve means operable to simultaneously connect said motor means with said source of fluid pressure and with exhaust, and fluid pressure actuated means responsive to a predetermined pressure in said piston-cylinder arrangement for operating said other valve means.

6. A press for shaping ductile sheet material into workpieces comprising a frame, a vertically reciprocable press platen carried by said frame, a pair of transversely slidable crossheads slidably carried on said frame on either side of said platen, each of said crossheads having pivoted thereto cylinder means, each of said cylinder means having a piston therein and each of said pistons having connected therewith a jaw member adapted to grip a marginal portion of said sheet, fluid operable motor means mounted on said frame having plungers reciprocable therein and connected with said crossheads, said plungers having equal opposed areas thereon, a fluid source for supplying actuating fluid to said areas, valve means movable to connect one or the other of said areas with said source, said valve also being movable to interrupt fluid communication between said areas and said source, other valve means interconnecting said areas and normally positioned to prevent fluid flow therebetween, and fluid pressure responsive control means for said other valve operable in response to a predetermined fluid pressure in said cylinder means to cause said other valve to move into position to hydraulically interconnect said areas, and means for adjusting the pressure at which said control means is responsive to maintain any desired predetermined constant tension in said sheet during reciprocation of said platen.

7. A press for shaping ductile sheet material into workpieces comprising a frame, a die carrying platen reciprocable relative to said frame, a crosshead slidably mounted on said frame on either side of said platen, said crossheads and said frame having cooperating guiding means to cause said crossheads to move transversely of said frame and also to swing in said frame, each of said crossheads having pivotally secured thereto a plurality of gripping members each of which has associated therewith a piston-cylinder arrange-

ment, fluid operable motor means pivotally secured to said crossheads for initially positioning the latter relative to said press platen, means for actuating said motor means for accomplishing said initial positioning and for thereafter trapping the fluid in said motor means, valve means connected with said motor means for bypassing the same to allow yielding movement of said crosshead, and fluid pressure responsive hydraulic control means interconnected with said valve means and with said piston-cylinder arrangement operable by pressure variations in said piston cylinder arrangement to cause said valve means to regulate the yielding movement of said crosshead in response to a predetermined average tension in said sheet.

8. The combination in a metal stretching press having a frame and a pressing member reciprocable relative thereto, of means slidably mounted on said frame on either side of said pressing member for gripping opposite marginal portions of said sheet, each of said gripping means comprising a jaw member universally pivoted to a plunger, a cylinder within which said plunger is reciprocable, a slide to which said cylinder is pivotally connected, and motor means connected with said slide for reciprocating the same so as to initially position said jaw members; and fluid control means operable by pressure created in said cylinder by the pull of said jaw member on said plunger to cause said motor means to move said jaw member toward said pressing member as the latter advances into said sheet.

9. A press for shaping ductile sheet material comprising a frame; a pressing member reciprocable relative to said frame; workpiece gripping means slidably mounted on said frame on either side of said pressing member, said workpiece gripping means comprising a jaw member, a piston-cylinder arrangement, a slide member and a fluid operable motor, said jaw member being pivotally connected to said piston-cylinder arrangement and said piston-cylinder arrangement being pivotally connected to said slide member; means connecting said slide member with said fluid operable motor; valve means operable to entrap fluid in said fluid operable motor; and fluid pressure control means for said valve means interconnected between said fluid operable motor and said piston-cylinder arrangement, said fluid pressure control means being responsive to a predetermined pressure in said piston-cylinder arrangement so as to release said entrapped fluid by controlling said valve means.

10. A method of forming workpieces from sheet material which comprises, rigidly gripping a sheet of material along at least two edges thereof, effecting relative movement between said sheet and a forming member so as to form the work-

piece, and automatically maintaining a positively controlled tension in said sheet at a substantially predetermined constant amount throughout the whole of said relative movement and the entire formation of said workpiece by automatically positively paying out said rigidly gripped edges of said sheet at substantially right angles to the plane of said forming member in response to said tension.

11. The combination in a metal stretching press having a frame and a die carrying platen reciprocable relative to said frame, of workpiece gripping means slidably mounted on said frame on either side of said platen, said workpiece gripping means comprising slide means, jaw members pivotally connected with said slide means, and motor means selectively operable for reciprocating said slide means to initially position said jaw members; and control means connected with said motor means so that said motor means may cause further automatic movement of said slide means and the pivot points of said pivotal connections, said control means being automatically operable in response to a predetermined tension applied to oppose the pull of said jaw members in the workpiece to thus cause said motor means to move said slides and said pivot points relative to each other in timed relationship with the reciprocation of said platen, said relative movement of said slides and said pivot points being at right angles to the reciprocation of said platen.

WALTER ERNST.

ARTHUR M. GREENE, JR.

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