May 15, 1951 L. S. HUBBERT 2,553,092

APPARATUS FOR STRETCH-BENDING WORK IN DIFFERENT DIRECTIONS UNDER A PREDETERMINED TENSION

Filed Nov. 21, 1945 5 Sheets-Sheet 1

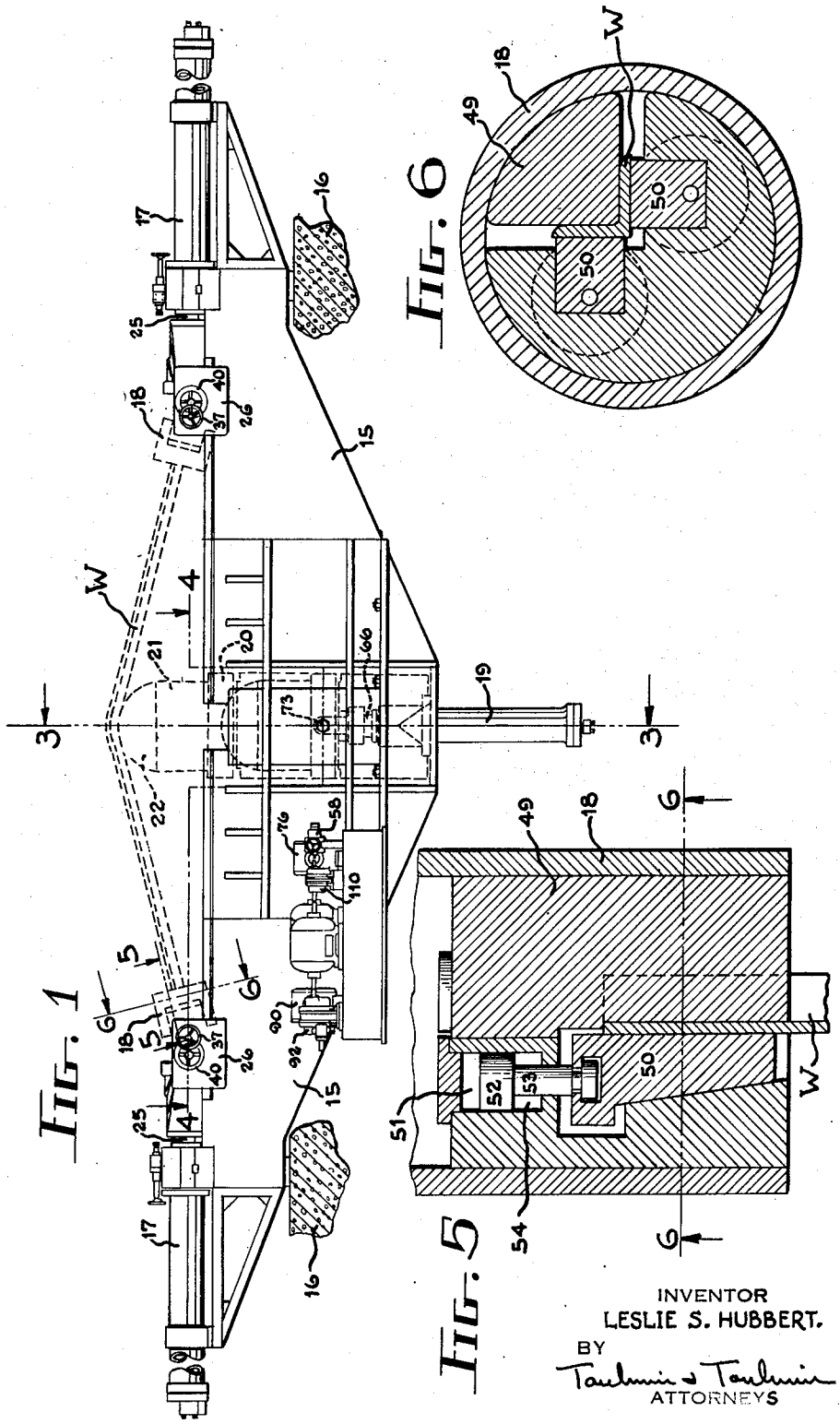

FIG. 1

FIG. 6

FIG. 5

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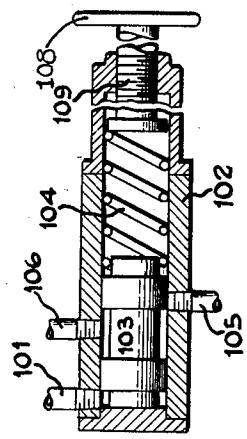

FIG. 10

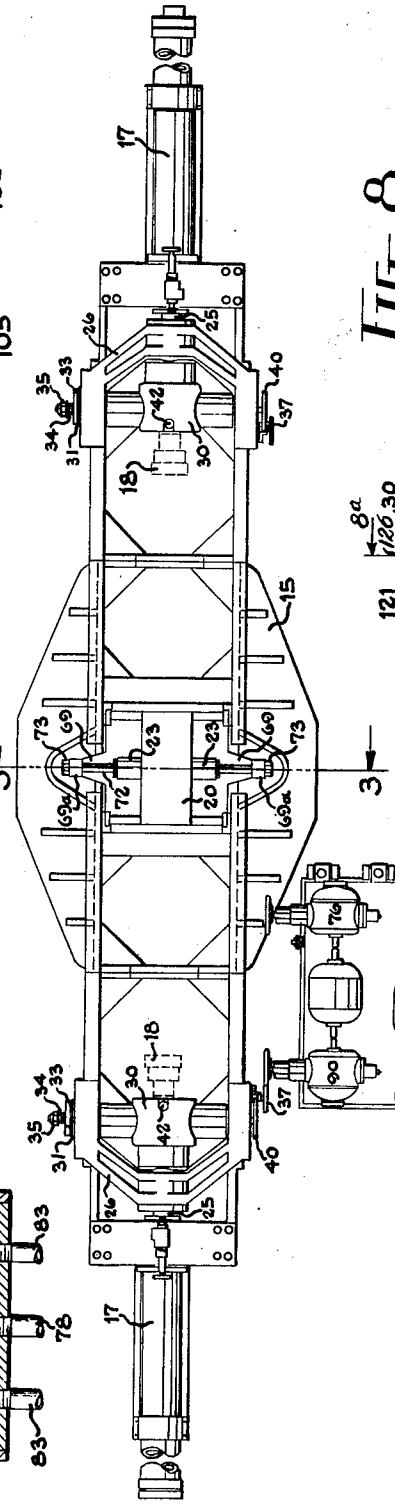

FIG. 2

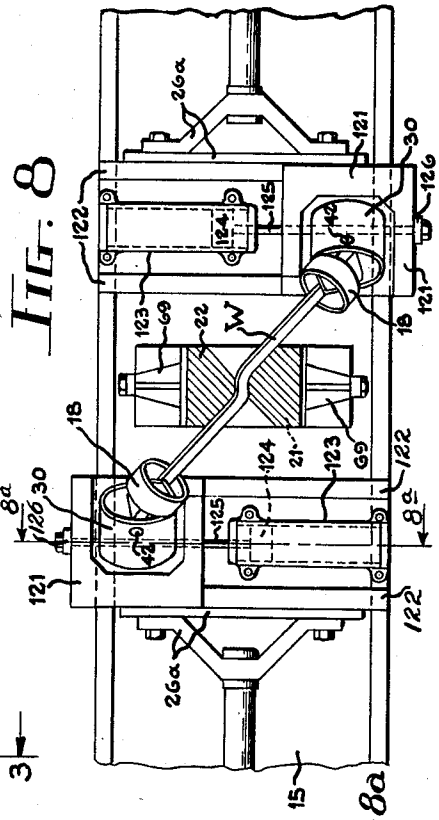

FIG. 8

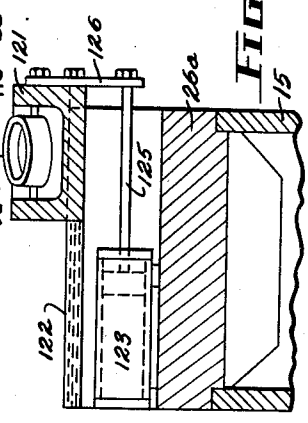

FIG. 8a

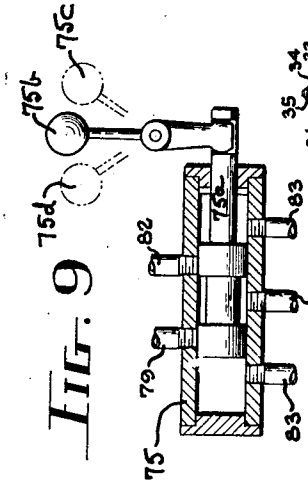

FIG. 9

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FIG. 3

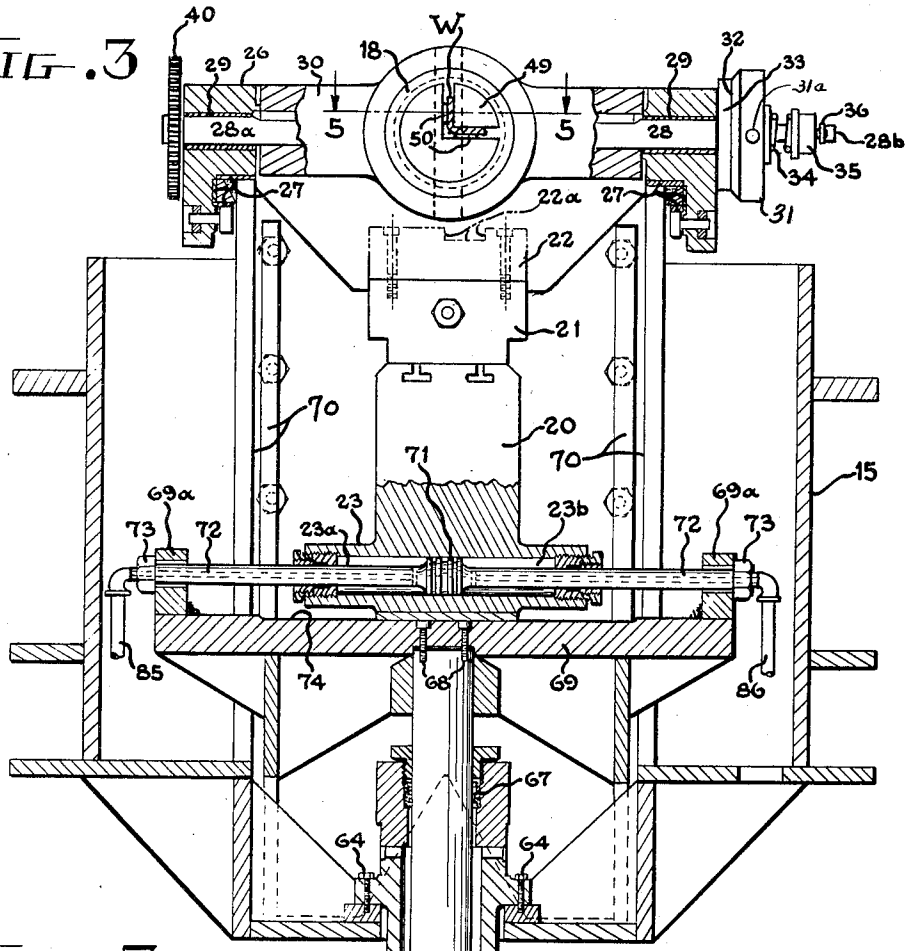
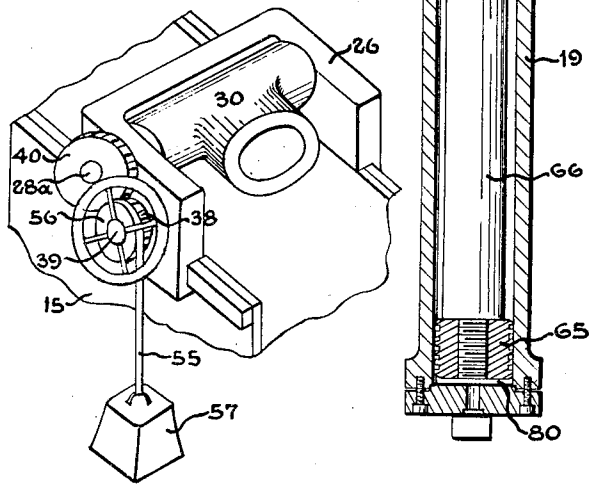


FIG. 7



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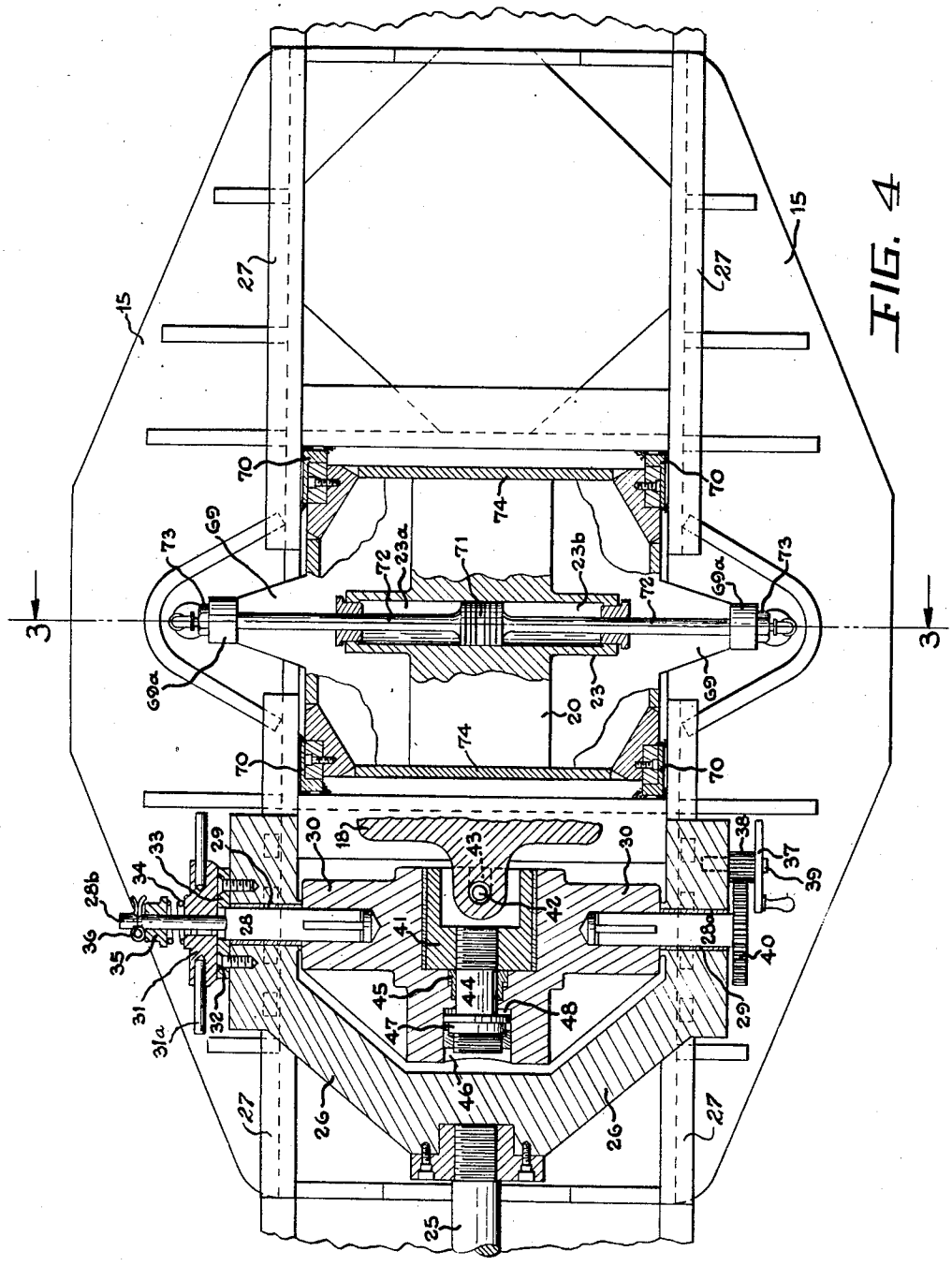

FIG. 4

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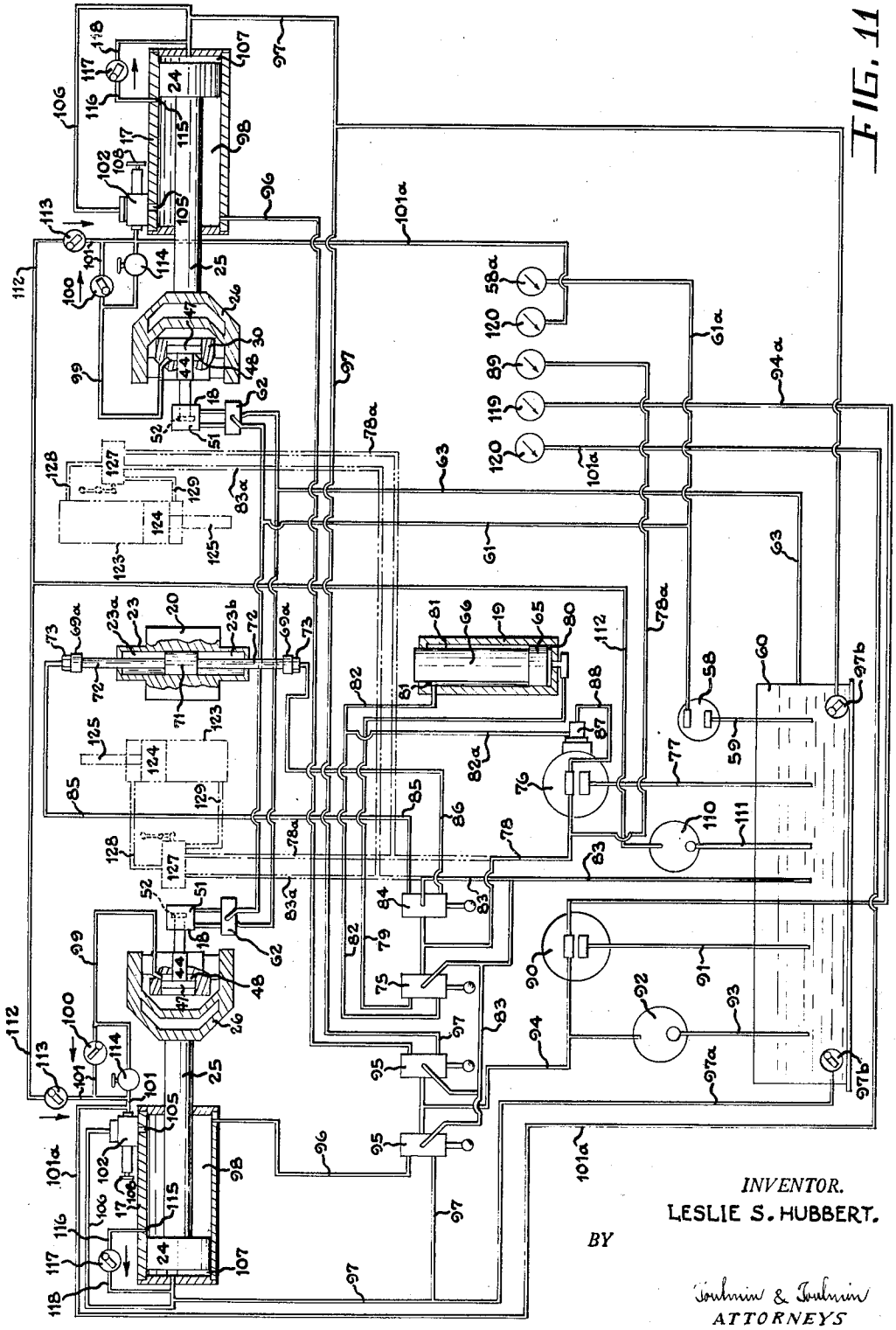
FIG. 11



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UNITED STATES PATENT OFFICE

2,553,092

APPARATUS FOR STRETCH-BENDING WORK IN DIFFERENT DIRECTIONS UNDER A PREDETERMINED TENSION

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Application November 21, 1945, Serial No. 630,090

2 Claims. (Cl. 153—48)

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This invention pertains to an improved method and apparatus for metal stretching and bending.

It is a primary object of this invention to provide a metal stretching and bending press of highly universal application for producing ccomplex metal shapes with precision and speed.

Another object is to provide a metal stretching and bending press capable of forming a work piece by bending in a plurality of different directions while automatically maintaining a desired tension in the work piece.

Still another object of this invention is to provide a method of bending a work piece in a plurality of different directions and controlling the tension in the work piece automatically during said bending operation.

A further object is to provide a method of bending metallic work pieces by gripping the ends of the work piece and maintaining it automatically under a predetermined tension while subjecting the intermediate portion of the work to bending forces acting in a plurality of different directions.

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

Figure 1 is a side elevation of a metal stretching and bending press incorporating the features of this invention.

Figure 2 is a plan view of the press shown in Figure 1.

Figure 3 is a vertical transverse view on the line 3—3 of Figures 1, 2, and 4.

Figure 4 is an enlarged fragmentary plan view partly in section on the line 4—4 of Figure 1.

Figure 5 is a fragmentary enlarged section through a work gripping jaw on the line 5—5 of Figures 1 and 3.

Figure 6 is a fragmentary enlarged section on the line 6—6 of Figures 1 and 5.

Figure 7 is a fragmentary perspective view showing a counterweight arrangement for a work gripping jaw.

Figure 8 is an enlarged fragmentary plan view partly in section showing a modification of the transverse movement arrangement in Figure 2.

Figure 8*a* is a section on the line 8*a*—8*a* of Figure 8.

Figure 9 is an enlarged sectional view through a manual control valve for the hydraulic operating system.

Figure 10 is an enlarged sectional view through an automatic work tension control valve.

Figure 11 is a diagram of the hydraulic operating and control circuit.

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As an exemplary embodiment of this invention, there is illustrated a stretching and bending press comprising a frame 15 mounted on a suitable foundation 16. On each end of this frame is fixed the hydraulic tensioning motors or cylinders 17 which control the movement of the work gripping jaws indicated generally at 18. Also mounted on this frame 15 is the main platen hydraulic motor or cylinder 19 upon which is mounted an auxiliary transversely movable platen or cross slide 20 to which is fixed the die block 21, Figure 3, and the work engaging die 22 so that this die may be moved vertically into the work intermediate the gripping jaws, and also moved transversely while in engagement with the work W by the hydraulic motor or cylinder 23.

With a work piece W held in the gripping jaws 18, the application of fluid pressure to the tensioning cylinder 17 is arranged to automatically maintain a predetermined tension in the workpiece as the die 22 is fed into it. Each of these cylinders 17 and their control mechanism is identical so that a description of one of them will suffice for both. Taking for example the tensioning cylinder 17 on the left-hand side of the machine, there is provided a piston 24 operable in the cylinder 17 and having a piston rod 25 connected to it, Figure 11. The piston rod 25 is connected to a cross head 26, Figure 4, which is slidably mounted on suitable guide ways 27 formed on the frame 15 of the machine so that application of fluid pressure in the cylinders 17 may control the horizontal reciprocation of the cross heads 26 on the machine frame.

Pivotally mounted on suitable trunnion pins 28 and 28*a* in bearings 29 carried in the cross head 26 is the swivel block 30. On an extension 28*b* of the trunnion pin 28 is mounted a friction disc 31 and secured to the side of the cross head 26 is a friction plate 33 having a face 32 in engagement with the disc 31. A spring 34 acts between the washer 35 and the disc 31 to urge the latter against the friction plate 33. The washer is retained in place by a suitable cotter pin 36 and the entire assembly is operable frictionally to restrain tilting movement of the block 30. The disc 31 may include arm or bars 31*a* by which the block 30 may be manually rocked in the bearings 29 to any desired position to facilitate gripping the work.

For fine adjustment in setting the swivel block 30 relative to the work to be gripped, there is also provided a hand wheel 37 having an integrally formed gear 38 journaled on a suitable shaft 39 mounted on the cross head 26. The

gear 38 in turn engages a larger gear 40 fixed to the trunnion shaft 28a so that upon rotation of the hand wheel 37, the swivel block 30 may be nicely adjusted to any desired position.

The work gripping jaw 18 is attached to an axially slidable sleeve member 41 through a pivot pin 42 which permits the jaw 18 to swivel about the axis of the pin 42 which is located normal to the axis of the trunnions of the swivel block 30 but which pin extends radially outwardly and is confined in a slot 43 formed in the swivel block 30 so as to prevent rotation of the gripping jaw 18 and the sleeve 41 relative to the swivel block. The sleeve 41 has fixed to it a piston rod 44 extending through a suitable packing 45 into a cylinder bore 46 in which operates a piston 47 fixed to the piston rod 44. Normally fluid pressure is maintained in the fluid pressure chamber 48 formed by the cylinder bore 46 and the piston 47 as shown in Figure 4 so that the pressure in this chamber 48 will oppose the pull of the work on the work gripping jaws during the forming operation.

The work gripping device is arranged for gripping the end portions, in this instance, of an angle iron work piece W, and comprises an anvil block 49, Figures 5 and 6, which is engaged by the V of the angle iron W when a pair of clamping wedges 50 are moved into clamping position by applying fluid pressure in the clamping cylinder chamber 51 behind the clamping piston 52 and the piston rod 53 connected to the wedges 50. The work may be released from the work gripping jaws 18 by appropriately applying fluid pressure in the chamber 54 behind the clamping piston 52.

As an alternate method of counter-balancing the jaws, the swivel block 30 is provided with a counterweight arrangement comprising a cable 55, Figure 7, operating over a cylinder 56 formed integral with the gear 38 and upon the end of which is hung a weight 57, which may be varied in amount to suit the variation in the weight of the various different types of gripping jaws 18 and associated clamping wedges necessitated by different types of work pieces to be gripped in the machine. In this way, the machine is readily adapted for easy adjustment in presenting the gripping jaws in alignment with the work when initially placed in the machine so as to effect a rapid gripping and clamping of the work with a minimum of skill and effort required on the part of the operator.

With the cross heads 26 moved to retracted position, a work piece or angle iron W (which at this time is usually a straight linear member) is positioned in the machine, and the swivel blocks 30 rotated to proper aligned position by the hand wheels 31 or 37. The tensioning cylinders 17 are then actuated by fluid pressure so as to move the gripping jaws 18 over the ends of the work to the position shown in Figure 5. A fluid pressure pump 58, Figure 11, receives a supply of fluid through a suction line 59 from the fluid reservoir 60 and transmits it through a pressure line 61 connected to the clamping control valves 62 which may be manipulated to direct fluid pressure to the chambers 51 behind the clamping pistons 52, Figure 5. At the same time, these valves 62 connect fluid discharged from the chambers 54 behind the clamping pistons 52 to a drain line 63 for return of the discharge fluid to the reservoir 60. An appropriate pressure gauge 58a connected through an appropriate line 61a to the pressure line 61 at all times indicates to the operator whether or not the work is properly gripped in the work gripping jaws during the forming operation. The work W is then ready for the compound bending operation which may be effected in this machine.

The die 22, Figure 3, carried on the die block 21, has a notched portion 22a which engages the work piece W so that it may be moved upwardly to deflect the work in a vertical direction and may also be moved transversely in a horizontal direction to bend the work in still another transverse direction. The main platen cylinder 19, Figure 3, is fixed by appropriate screws 64 to the machine frame 15 and has operating therein a piston 65 attached to a piston rod 66 which projects upwardly through a suitable packing gland 67 and is connected by the screws 68 to the platen 69. This platen 69 is guided in vertical movement on suitable guide ways 70 formed in the frame 15 so as to adequately resist all transverse movements of the platen in the machine frame while at the same time providing freedom of vertical reciprocatory movement of the platen by the application of fluid pressure in the cylinder 19. On the platen 69 is mounted the auxiliary transversely movable platen 20 including the integral cylinder 23 in which is carried a piston 71 having integral piston rods 72 rigidly fixed at their outer ends by suitable nuts 73 to the lugs 69a of the platen 69 so that the application of fluid pressure in the cylinder 23 on either side of the piston 71 effects relative movement of the auxiliary platen 20 along the transverse guide ways 74 formed on the platen 69.

After having gripped the ends of the work piece W in the gripping jaws 18 by appropriately manipulating the control valve 62, Figure 11, as described, the main platen actuating cylinder 19 is rendered operative to move the die 22 upwardly into the work W by appropriately manipulating a four-way control valve 75 so that fluid pressure from the fluid pressure pump 76, which derives fluid through a suction line 77 from the reservoir 60 and transmits the fluid under pressure through a pressure supply line 78 connected to the valve 75, Figure 9. At this time, the valve plunger 75a is moved by positioning the control lever 75b in position 75c, connecting pressure line 78 to line 79 so that fluid pressure is transmitted through the line 79 to the bottom chamber 80 in the cylinder 19. Discharge at this time from the upper chamber 81 of the cylinder 19 into the line 82 is connected by the valve 75 to the drain line 83 for return of fluid to the reservoir 60. In this way the piston 65 moves upwardly to cause the die 22 to engage and bend the work in one direction, in vertical plane in this particular instance. When the lever 75b is moved to position 75d, the flow in lines 79 and 82 is reversed by connecting pressure from line 78 to line 82 while connecting line 79 to drain line 83 to withdraw the die downwardly from the work. When the lever is in neutral or stop position 75b as shown in Figure 9, flow in lines 79 and 82 is blocked off so as to arrest movement of the platen 69 in any desired position.

The die 22 may be moved transversely or perpendicular to the vertical movement effected by the cylinder 19 by appropriately manipulating the four-way control valve 84, Figure 11, which is of similar design to the valve 75. The valve 84 is connected to the pressure line 78 and may at one time be operated to transmit fluid pressure through the line 85 to the chamber 23a and the transverse actuating cylinder 23 while connect-

ing its chamber 23*b* through the line 86 to the drain line 83 for transverse movement of the die in one direction. By manipulating the valve in the other direction, pressure may be applied through the line 86 to the chamber 23*b* while exhausted from the chamber 23*a* through the line 85 into the drain line 83 for transverse movement of the die 22 in the opposite direction.

It is to be noted that the control valves 75 and 84 may be readily operated simultaneously or independently so as to effect the compound bending motions in a plurality of different directions either simultaneously or independently so as to produce the most efficient compound bending action in the work piece W.

Both of the control valves 75 and 84 may be moved to central or stop position so as to cut off flow to or from their respective cylinders 19 and 23 to arrest their motion in any desired position. After the bending operation has been completed, the transverse slide may be moved again to an appropriate initial starting position, such as shown in Figure 3, and stopped in that position by moving the control valve 84 into neutral so that the die 22 will have its slot 22*a* in proper position to again engage a new work piece.

When the piston 65 reaches the end of its stroke, pressure builds up in the line 82 and is transmitted through a line 82*a* connected to the control mechanism 87 of the pump 76 to automatically shift it into neutral and unload fluid pressure from its driving mechanism in a conventional manner. There is also provided a control line 88 connected to the control mechanism 87 on the pump and responsive to excess pressure in the line 78 which may develop during the forward or upward movement of the platen piston 65 or excessive resistance being encountered by the transverse movement of the auxiliary platen when actuated by the cylinder 23 so as to prevent damage to the pump and excess strain being developed in the machine mechanism. An appropriate gauge 89 connected through a line 78*a* to the line 78 gives the operator a direct indication of the forces being applied by both the vertical and transverse movements of the platen and auxiliary platen in forming the work to the desired compound bent condition.

As the work piece W is being operated upon by the vertical and transverse movement of the die 22, the tensioning cylinders 17 are so controlled as to automatically maintain a predetermined tension in the work piece at all times while the compound bending operations are being performed on it. These cylinders 17 are operated from a source of fluid pressure comprising the high volume, low pressure pump 90, Figure 11, which derives its source of fluid from the reservoir 60 through the suction line 91, and a high pressure, low volume pump 92 which derives its source of fluid from the reservoir 60 through the suction line 93. Both of these pumps 90 and 92 are connected to discharge into the pressure line 94 which is connected to the control valves 95, each connected to one of the tensioning cylinders 17 through the lines 96 and 97. The valves 95 are four-way control valves of similar design to the valve shown in Figure 9, and positioned in a neutral or shut-off position so as to close off lines 96 and 97 when in neutral position to prevent fluid from escaping through the lines from the cylinder 17. With the work W held in the gripping jaws as described, and the die moved into the work to begin the bending operation, the pull on the gripping jaws by the work will tend to move

the pistons 24 toward the platen so as to develop pressure in the piston rod chamber 98 in the cylinder 17. As this pressure develops, tending to resist movement of the piston rod 25 in the cross head towards the platen, pressure in the pressure chamber 48 behind the piston 47 in the cylinder 46 of the swivel block 30 also builds up and is transmitted out through the line 99 and through the check valve 100 and the line 101 which is connected to the tensioning control valve 102 shown in detail in Figure 10. The pressure thus developed in the line 101 moves the plunger 103 of this valve in opposition to the compression spring 104 so as to interconnect the line 105 connected to the cylinder chamber 98 with a line 106 which is connected to the other cylinder chamber 107 behind the head end of the piston 24. Thus, as the tension in the work reaches a certain predetermined value, and which value may be readily adjusted by manipulating the hand wheel 108 and operating screw 109 of the valve 102, Figure 10, fluid will be allowed to escape from the chamber 98 through the valve 102 and the line 106 into the chamber 107 so as to allow the piston 24 and cross heads 26 to yieldably move toward the platen during the forming operation. As the pistons 24 move toward the platen, fluid is drawn in through lines 97 and 97*a* and the check valves 97*b* from the reservoir 60 to keep the piston head chambers 107 properly filled with fluid at all times.

The tension control chamber 48 in the swivel block 30 is kept properly charged with fluid at all times by pressure from a pump 110 which derives its source of fluid from the reservoir 60 through the suction line 111 and transmits its pressure through the line 112 which is connected through the check valves 113 to the line 101 and thence through a choke 114 to the line 99. The pressure developed by this pump 110 is of a value below that required to shift the plunger 103 of the valve 102 against the pressure setting of the spring 104. As pressure develops in the chamber 48 during the bending operation, pressure may readily pass through the check valve 100 from the line 99 to the line 101 to actuate the plunger 103 while the check valve 113 closes to prevent escape of this pressure (which is greater than the pressure from the pump 110) from the line 101 into the line 112. Also, the check valve 100 closes when pressure is suddenly released from the chamber 48 by the completion of the working stroke of the press and return of the platen while the choke permits a relatively slow small amount of fluid to pass from behind the plunger 103 of the valve 102 through the line 101 to the line 99 to retract the piston 47 and fill the chamber 48 preparatory to gripping the next piece of work to be formed. This also stabilizes the operation of the valve plunger 103 to prevent its too rapid closing and consequent jar to the machine if the pistons 24 of the cylinder 17 were suddenly arrested in their forward tensioning movement.

After the completion of the forming operation and the retraction of the platen and die and the work is released from the gripping jaws and removed from the machine, the valves 95 may be manipulated so as to now connect pressure from the line 94 to the piston rod chambers 98 of the cylinder 17 while at the same time connecting the line 97 from the piston head chambers 107 of these cylinders to the drain line 83 to thus cause the pistons 24 to retract and bring the cross heads and work gripping jaws back to ini-

tial starting position. As the pistons approach the end of their retraction stroke, a port 115 in each of the cylinders 17 is exposed by the passage of the piston beyond it to thus connect the fluid pressure in the chamber 98 through a line 116 and a check valve 117 into the line 118 which is connected to the line 97 to thus stop further movement of the piston 24 since the pressure now is connected under these conditions to the drain line 83 to the line 97 to thereby unload pressure from the pumps 90 and 92 while at the same time automatically stopping further retraction movement of the pistons 24 in the tensioning cylinders 17.

After having again placed a new piece of work to be bent in the machine and having adjusted the work gripping jaws by manipulating the hand wheels 37 to properly align them with the work to be gripped, the valves 95 are again manipulated to now connect pressure from the line 94 through the line 97 to the piston head chamber 107 of the cylinder 17 while connecting the chamber 98 through the line 96 to the drain line 83 so as to in this way move the cross heads toward the platen to initially position the work gripping jaws with the work. A suitable pressure gauge 119, connected to the line 94 through the line 94*a*, serves to indicate the operating condition in the pressure circuit served by pumps 90 and 92. A pressure gauge 120 connected through a line 101*a* indicates to the operator the behaviour of the tensioning pressure in the chambers 48 of the cylinders 46 in the swivel blocks 30 to assist in determining the proper manipulation of the platen and auxiliary transversely movable platen to effect the most satisfactory bending and forming operation on the work.

There has thus been provided a metal stretching machine in which a work piece W is gripped at each end and held at a predetermined tension as pressure is exerted intermediate its ends to deflect it in one direction and wherein force is exerted in a perpendicular direction to this last mentioned force at the same time so as to bend the work piece into a two-dimensional position while at all times maintaining a predetermined tension in the ends of the work piece during the forming operation.

Figure 8 shows a modification in which the transverse relative movement of the work and main platen is provided by mounting the work gripping jaws 18 carried in the swivel blocks 30 on cross slides 121 carried on suitable guide ways 122 formed on the cross head 26*a*. Appropriate hydraulic actuating motors or cylinders 123 are fixed on the cross heads 26*a* and have pistons 124 and piston rods 125 connected by suitable means 126 to the cross slides 121 so that application of fluid pressure in said cylinder 123 may be utilized to transversely reciprocate the slides and therefore the work gripping jaws 18. In this arrangement, the die block 21 and die 22 are rigidly fixed to the platen 69, there being no transversely movable auxiliary platen 20 required. The die is reciprocated in vertical movement by the piston 19.

The hydraulic actuating and control arrangement utilized in connection with this modification is shown in broken section line in Figure 11. In this arrangement, of course, the control valve 84, the associated lines 85 and 86, and the transverse auxiliary platen actuating cylinder 23 would be dispensed with. Each of the cross slide actuating cylinders 123 is provided with a control valve 127, of similar design to the valve shown in Figure 9, which receives a pressure supply through the lines 78*a* and is connected through drain lines 83*a* to the drain line 83. The pressure chambers in the cylinders 123 on each side of the pistons 124 are connected through suitable lines 128 and 129 with the valves 127 which are four-way control valves movable to a neutral position to trap the fluid in the cylinders 123 so as to hold the cross slides in any selected position during the movement of the platen and die 22. These valves 127 may be manipulated to effect any degree of cross slide movement in either direction for the cross slides 121.

In this modification, the end portions of the work may be moved transversely to any degree relative to the die 22 so that the end portions may each be bent to different degrees while the platen may be raised into the work to effect still other configurations of bending in the work. Thus this stretching and bending apparatus is adapted to bending work in a plurality of different directions to effect a multiplicity of bending operations on a work piece with a single gripping of the work piece in the machine and accomplishing these operations while at all times maintaining a predetermined tension in the work piece.

While the apparatus herein disclosed and described constitutes a preferred form of the invention, it is to be understood that the apparatus is capable of mechanical alteration without departing from the spirit of the invention and that such mechanical arrangements and commercial adaptations as fall within the scope of the claims are intended to be included herein.

Having thus fully set forth and described this invention, what is claimed as new and desired to be secured by United States Letters Patent is:

1. In a stretch-bending press; the combination of a frame; a pair of work-gripping members carried in longitudinally spaced order on said frame and mounted for limited longitudinal sliding movement on said frame; fluid-pressure-responsive means connected with each of said work-gripping members for controlling the movement thereof with respect to said frame; a pressing head carried in said frame between said gripping members for engagement with an intermediate portion of a workpiece carried between said gripping members, said pressing head being mounted in said frame for movement in a plurality of angularly related planes; fluid-pressure-responsive means for moving said pressing head in each of said angularly related planes; and valve means connected with the fluid-pressure-responsive means associated with said work-gripping members and operable in response to bending forces applied to a workpiece carried between said gripping members by engagement with said pressing head to relieve fluid pressures within said first-named fluid-pressure-responsive means and thereby permit said gripping members to move inwardly of said frame and toward one another.

2. In a stretch-bending press; a frame; a pair of relatively spaced workpiece-gripping members carried longitudinally of said frame for limited sliding movement along the longitudinal axis of said frame; fluid-actuated means connected with each of said workpiece-gripping members and operable to impart limited sliding movement to the latter; a pressing head carried in said frame for movement in a plurality of angularly related planes, said pressing head being engageable with a workpiece carried between said gripping mem-

bers; a plurality of fluid-pressure-responsive means connected with said pressing head for moving the latter in said plurality of angularly related planes; and means connected with said fluid-actuated means and responsive to a predetermined bending stress within a workpiece carried between said gripping members to relieve fluid pressures within said fluid-actuated means to thereby maintain a constant tension within a workpiece carried between said gripping members throughout bending operations.

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