

[54] **CONTROL FOR FLUID PRESSURE ACTUATORS**

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[51] Int. Cl..... **B30b 15/16**

[58] Field of Search.. **100/229 R, 53, 269 R, 258 A, 100/257, 226; 91/177, 413; 72/453; 83/639**

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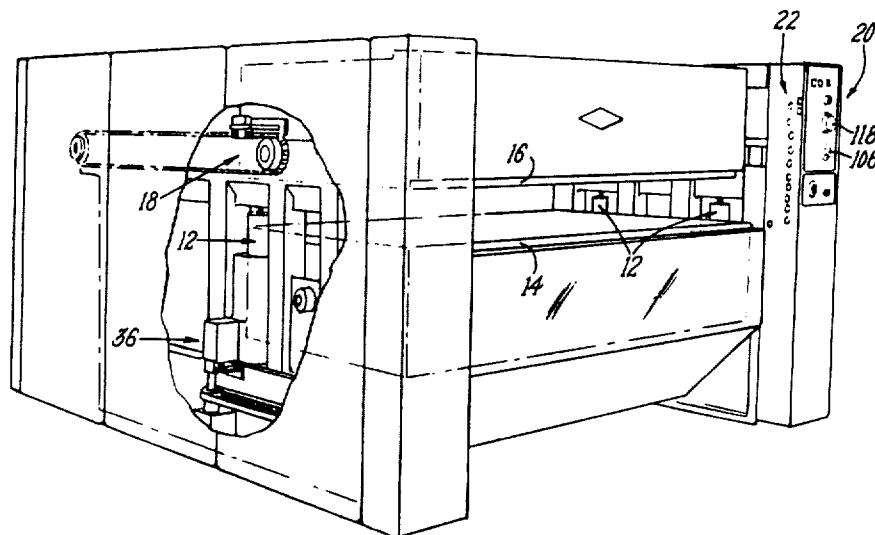
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[57] **ABSTRACT**

A control for hydraulic actuators preferably relatively moving platens of a press toward each other has means for coordinating the operation of the actuators. Preferably, the coordinating means comprise valves throttling fluid supply to each actuator and means for coordinating the operation of the valves. The control preferably also has a device for adjusting a preset function of the actuators, a device responsive to fluid pressure in the actuators for relieving excess pressure to the actuators and a device for preventing operation of the actuators during preparation for press operation.

3 Claims, 11 Drawing Figures



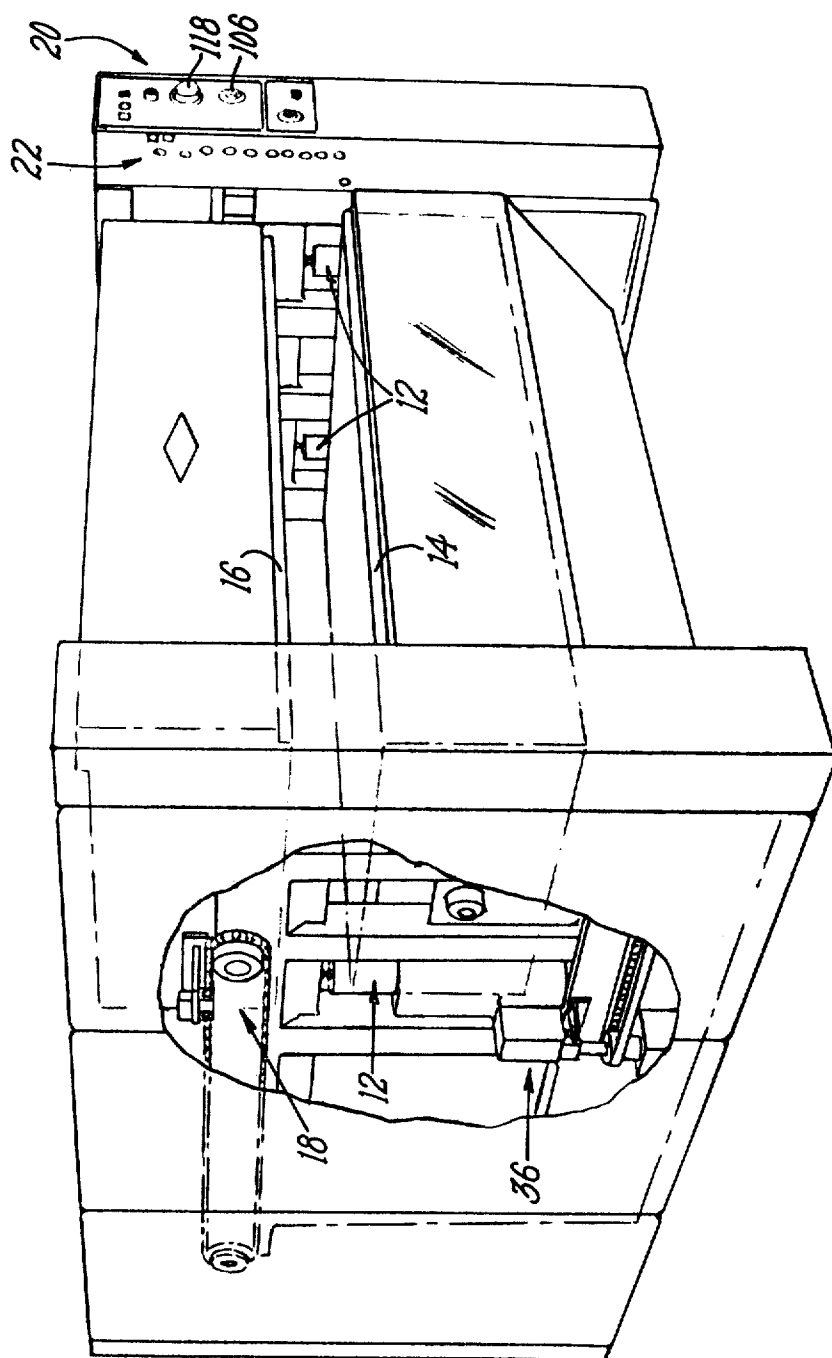


Fig. 1

Fig. 2

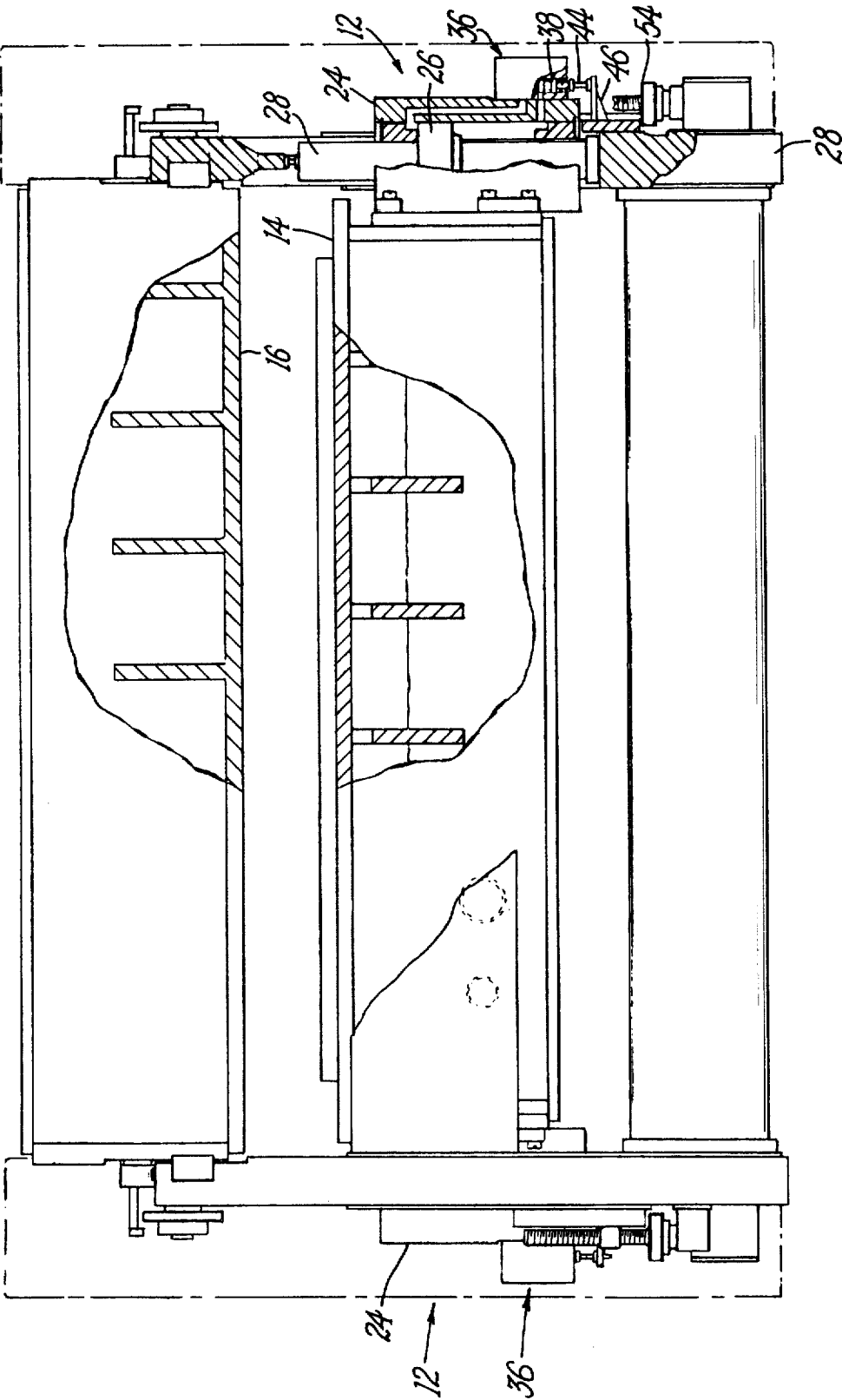


Fig. 3

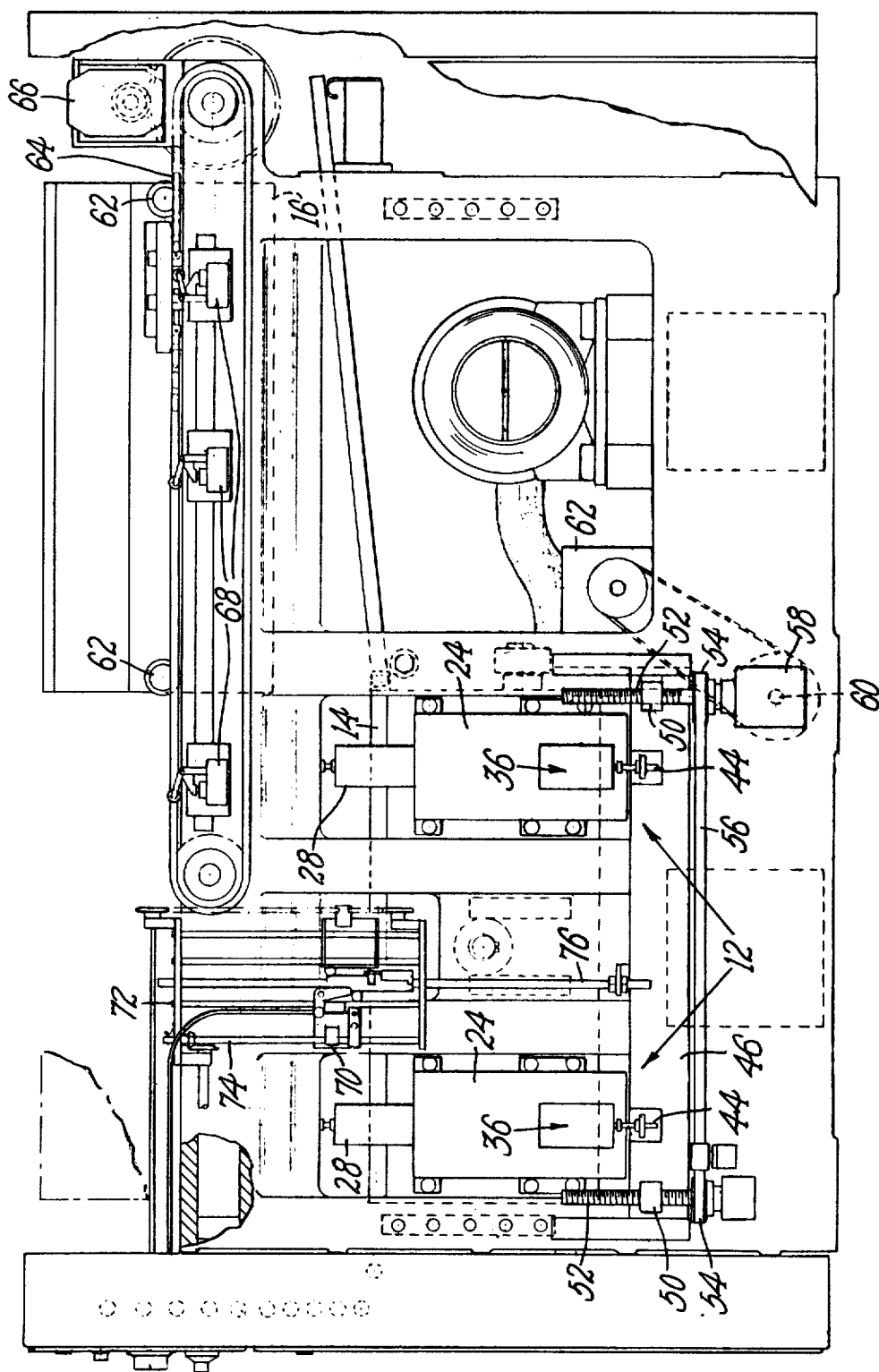
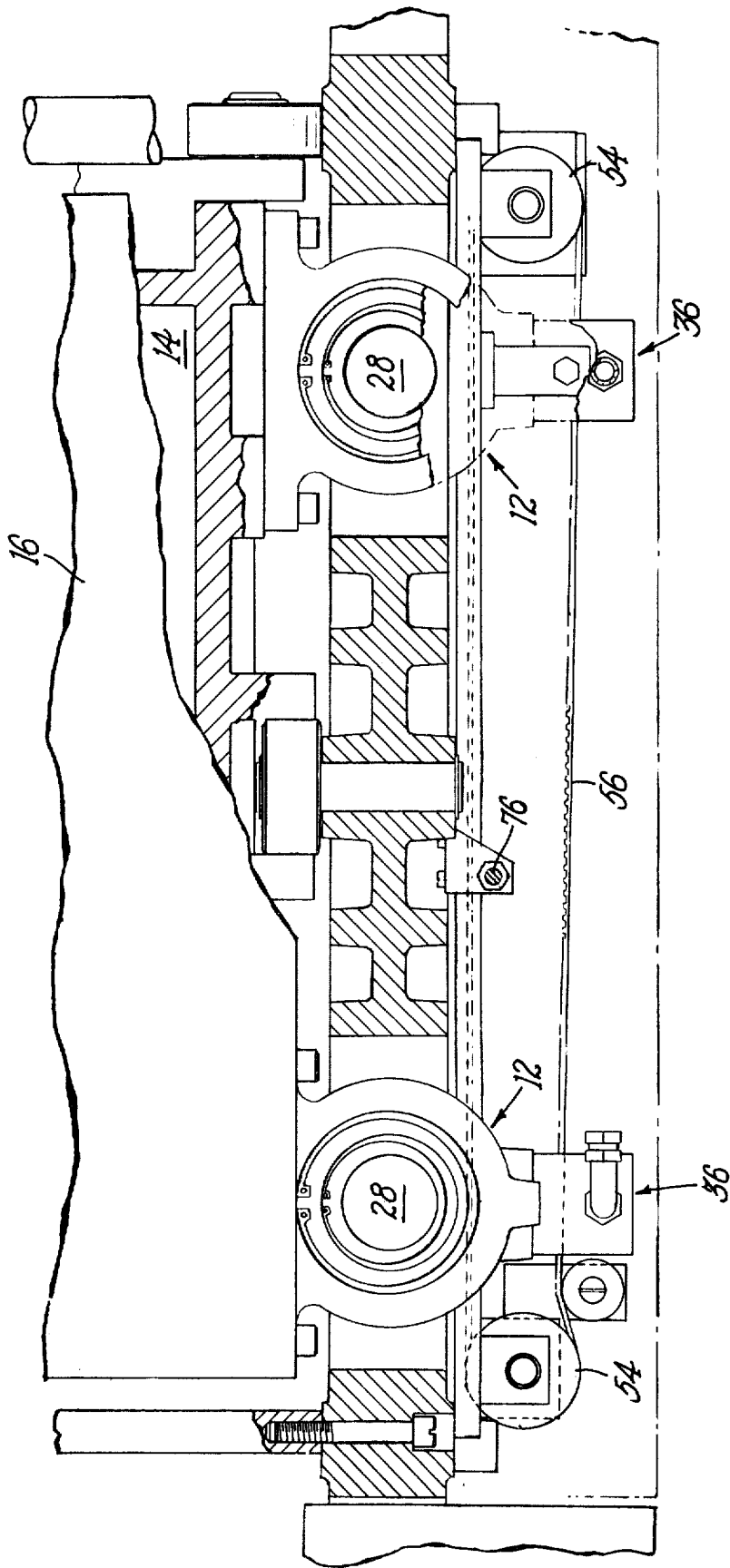


Fig. 4



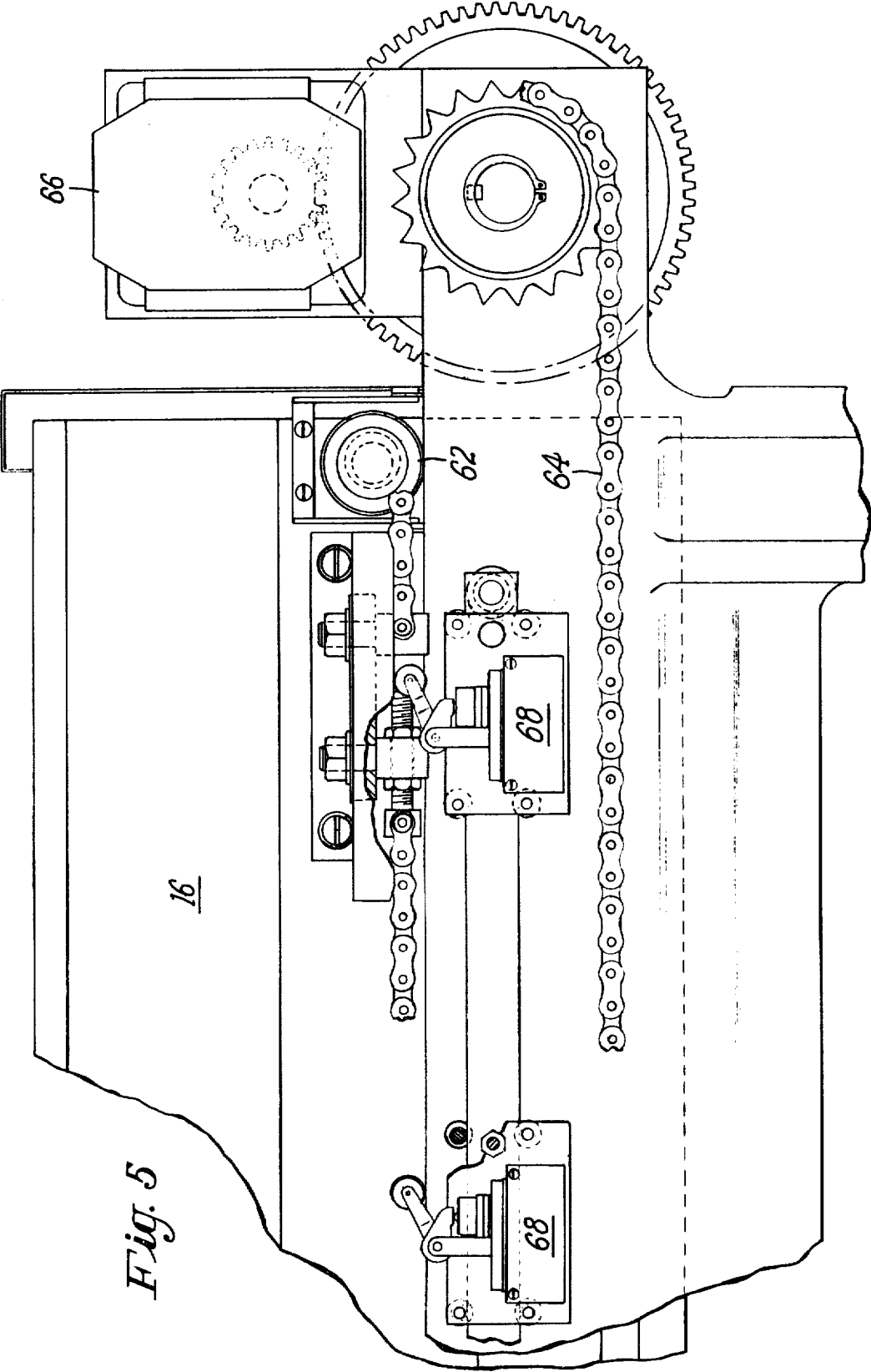


Fig. 5

Fig. 6

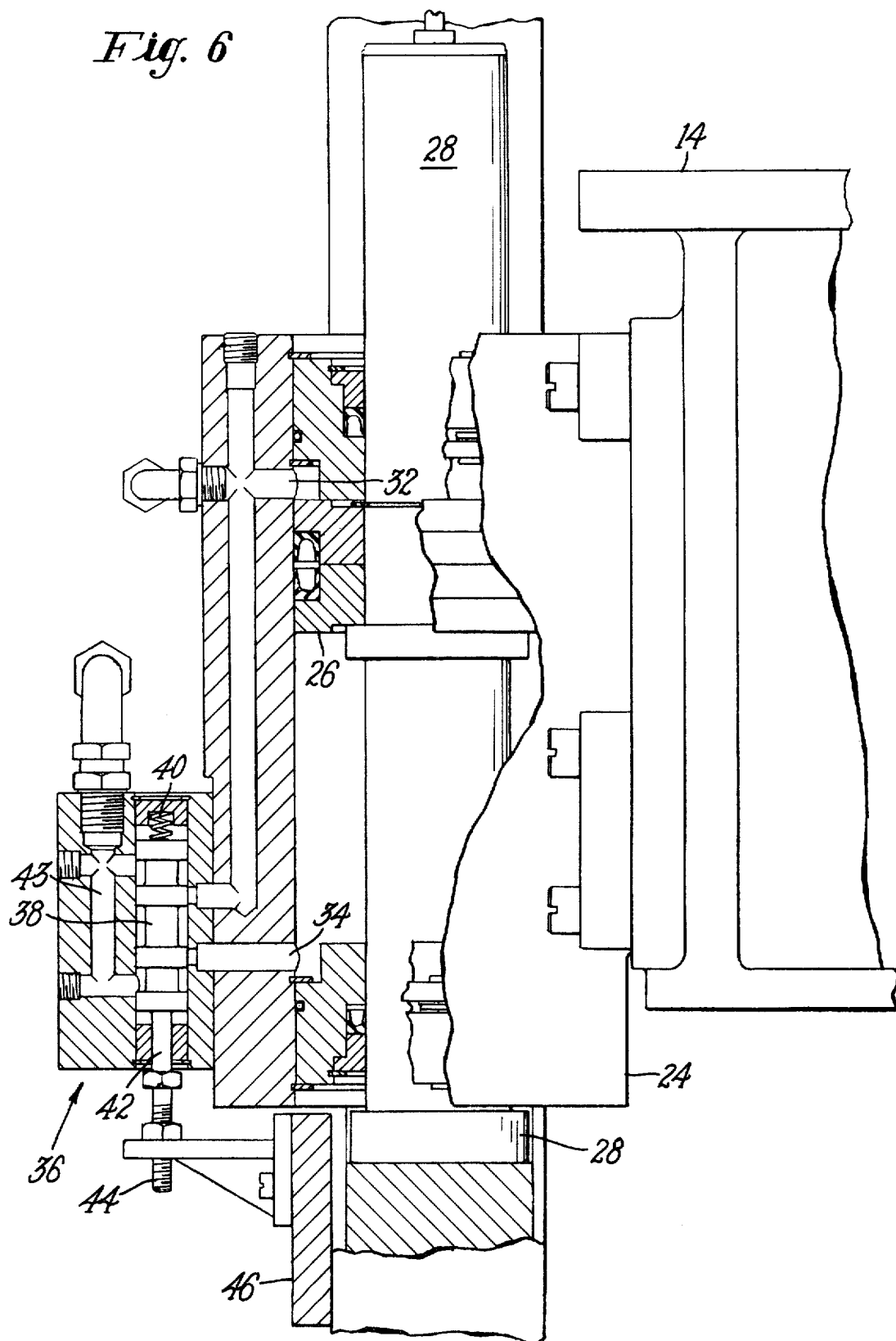


Fig. 7

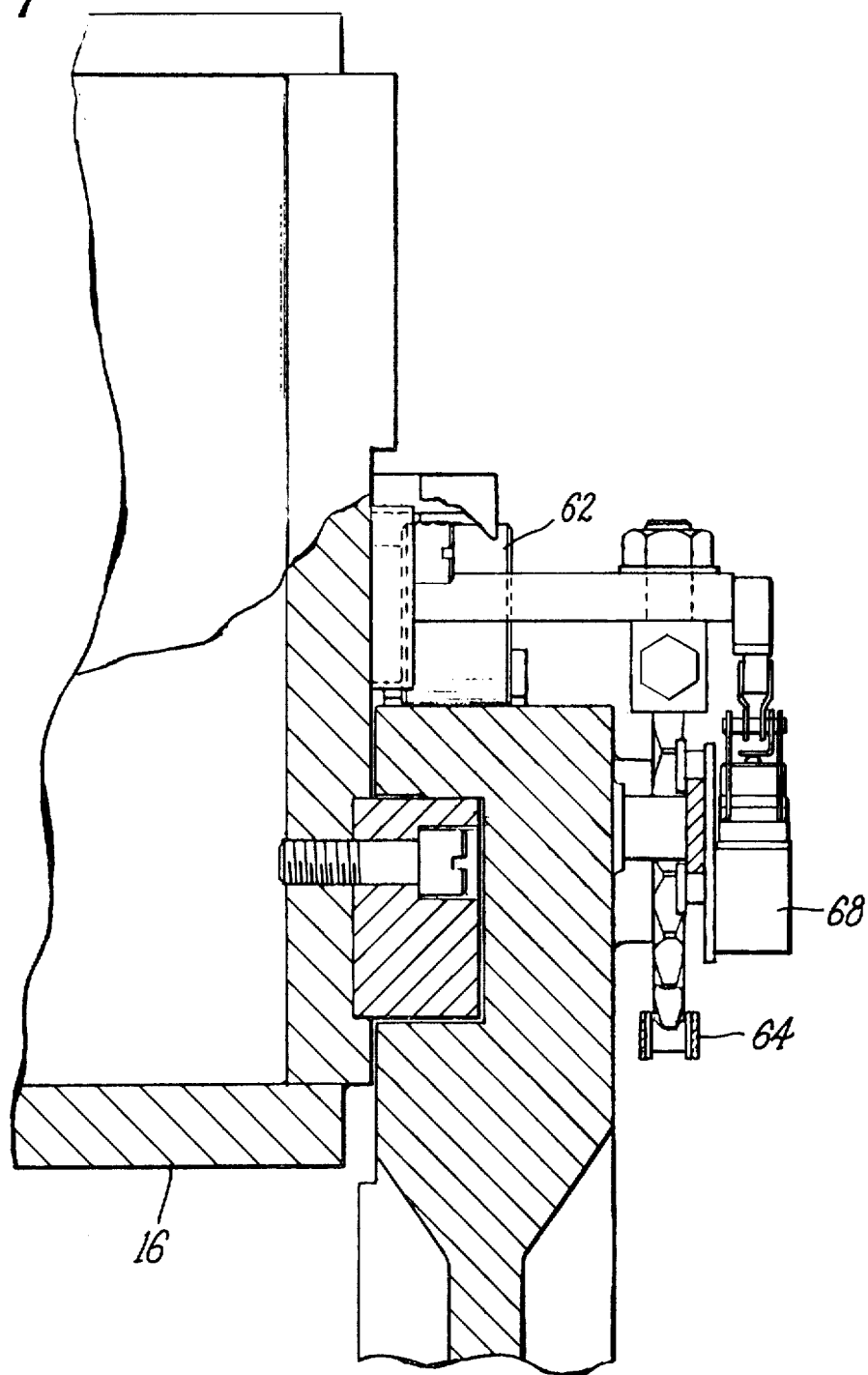


Fig. 8

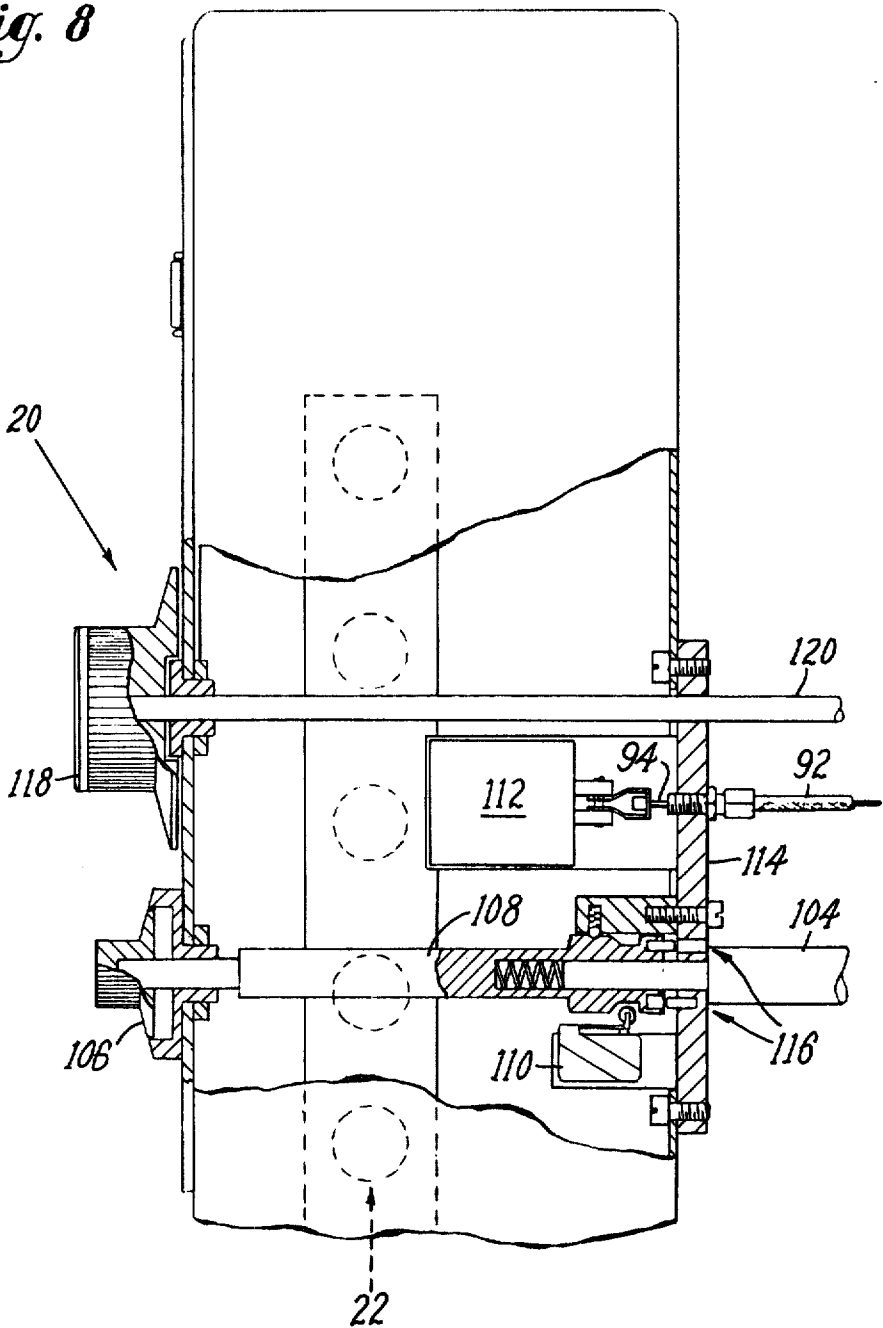


Fig. 9

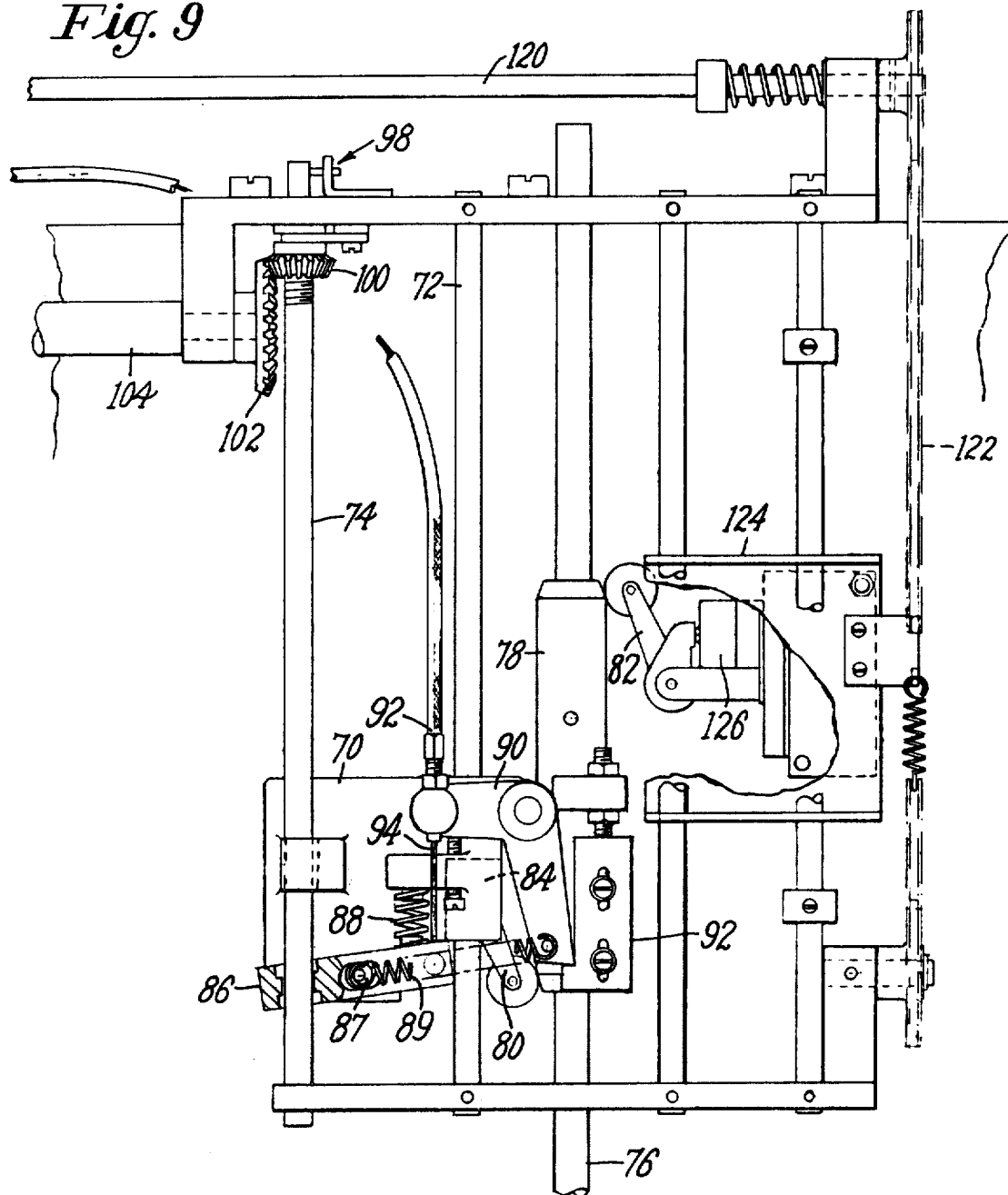


Fig. 10

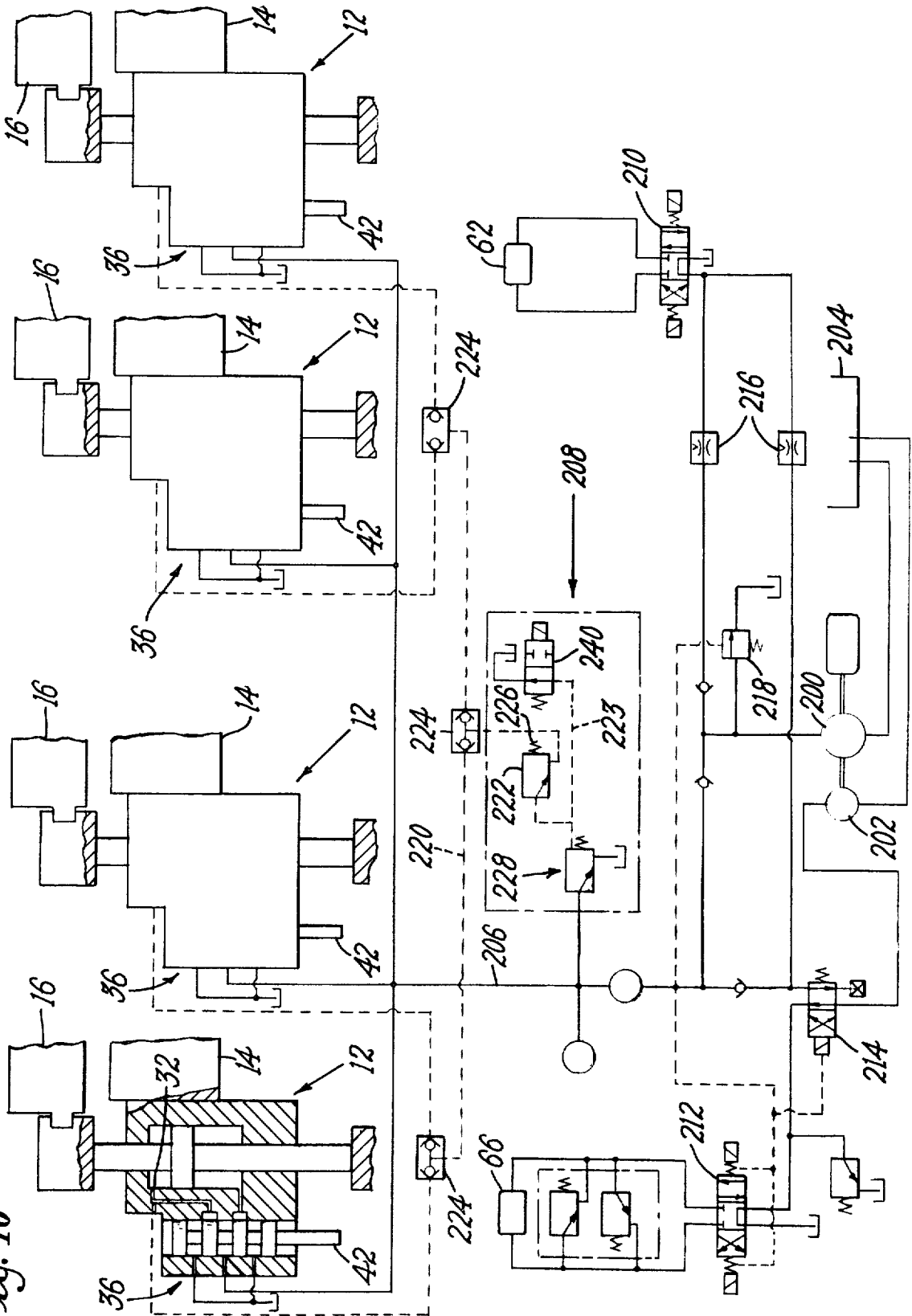
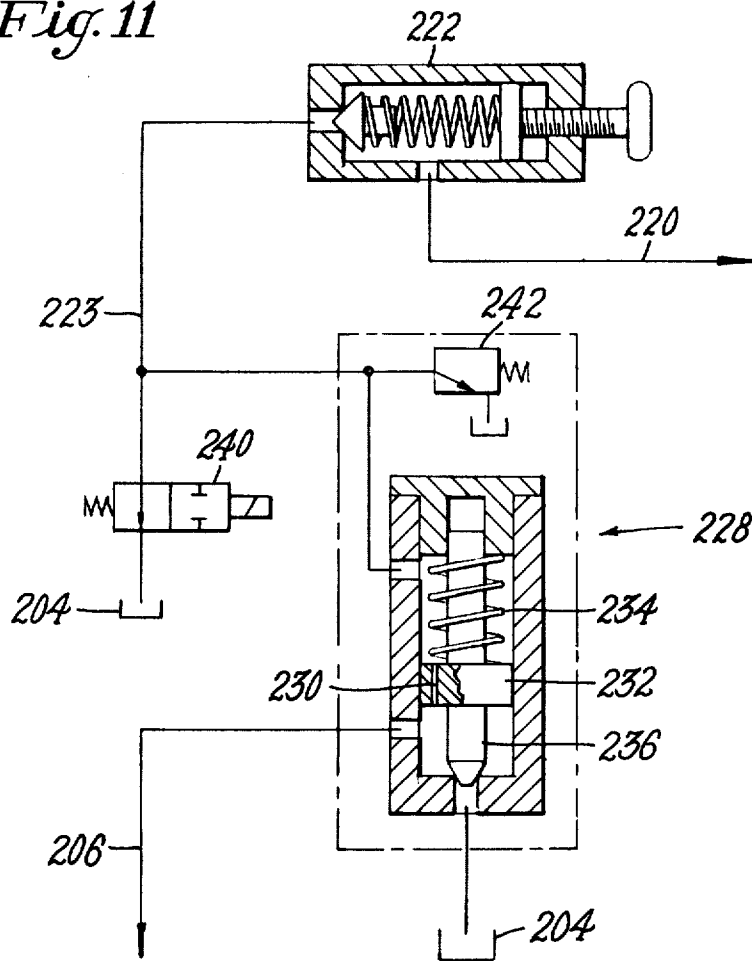


Fig. 11



CONTROL FOR FLUID PRESSURE ACTUATORS**BACKGROUND OF THE INVENTION**

A wide variety of fluid pressure actuators are used in wide variety of modern industrial machines. Fluid pressure actuators include both linear actuators such as fluid pressure operated piston and cylinder devices and rotary actuators such as fluid pressure operated motors. Machines using such actuators include presses, jacks, winches and robots. In some of these machines it is desirable to coordinate the operation of two or more fluid pressure actuators.

For example, structural support for a large platen movable relative to another platen of a press for applying pressure to articles between the platens conveniently requires two or more piston and cylinder devices for movably supporting the platen. In such a press it is often desirable to maintain exact parallelism between the platens of the press to provide a uniform pressure over the entire areas of the platens. Such parallelism can only be maintained if each actuator moving the platen operates coordinately with each other actuator moving the platen.

Platen parallelism is particularly difficult to maintain when the platens engage and press articles between them. Surfaces of these articles engaging the platens may substantially depart from parallelism with the platens as, for example, where an article is not co-extensive with the platen areas. Pressure applied to such articles then tends to tip the platens out of parallelism.

In addition, many fluid pressure actuators are responsive to both the pressure and volume and fluid supplied to the actuator. For example, a high pressure, low volume fluid supply to a piston and cylinder will provide a force corresponding to the high fluid pressure only at a rate corresponding to the low fluid volume. Conversely, a low pressure, high volume fluid supply can supply a small force rapidly. In many machines both high speed and high pressure are desirable. In a press, for example, it is desirable to move the platens rapidly into engagement with articles between the platens and to press the articles with a high pressure.

In many machines it is desirable to limit the movement of fluid pressure actuators; in an exemplary press, it is desirable to limit the approaching movement or stroke of fluid actuated platens. For this purpose, it is known to use limit switches positioned to disable a fluid actuator upon actuator movement of a machine element into tripping relationship with the switch. The limit switches heretofore have been positioned manually or automatically by operation of the machine through a set-up cycle preceding production operation of the machine. In the exemplary press for example, the platens are moved to their closest desired spacing during the set-up cycle of the press and the limit switches positioned according to this platen spacing. Such a system offers no possibility for adjustment of the set-up established limit switch position.

The low-to-high pressure requirements of many fluid actuated machines have imposed additional restrictions on the safe operation of the machines. As described above with reference to the exemplary press, only a low pressure is required to move the platens into engagement with an article between the platens while a much higher pressure may be required to press the article between the platens. For the safe operation of such a press, it is known to provide a pressure relief valve in

the fluid supply line for the press actuators. If such a pressure relief valve is set to relieve pressure in excess of that required to move the platen, it will relieve or dump the higher pressure required to press articles between the platens. The press is then inoperative. If, on the other hand, the pressure relief valve is set to dump only pressure in excess of the high fluid pressure required to press particles between the platens, it will require the build-up of this high pressure even before the platens engage an article. Damage to an element inadvertently between the platens during their approaching movement may result from this high pressure required to dump the otherwise low-pressure requirements of the exemplary press.

SUMMARY OF THE INVENTION

To this end, it is an object of the invention to provide a control for fluid pressure actuators which coordinates the operation of fluid pressure actuators, provides both high and low operating pressures for the actuators, permits adjustment of a preset actuator operating stroke, and has a pressure responsive device for relieving fluid pressure supplied to the actuator.

To this end, the invention provides means operative on the fluid supply for fluid pressure actuators for coordinating the operation of the actuators. Preferably, these coordinating means comprise valves throttling fluid supply to each actuator and means for coordinating the operation of the valves. The control also preferably has means for adjusting a preset stop for actuator movement and means responsive to the fluid pressure in each actuator for relieving excess pressure to the actuators.

DESCRIPTION OF THE DRAWINGS

A preferred embodiment which is intended to be illustrative of and not a limitation on the invention will now be described with reference to drawings of the embodiment in which:

- FIG. 1 is a perspective view of the embodiment;
- FIG. 2 is a front view of the embodiment with certain parts broken away;
- FIG. 3 is a right side view of the embodiment with covers removed to show construction detail;
- FIG. 4 is a fragmentary top view of parts shown in FIG. 3;
- FIG. 5 is a fragmentary side view of certain moving means shown in FIG. 3;
- FIG. 6 is a partly section view of a piston and cylinder type actuator and an associated valve shown in FIG. 3;
- FIG. 7 is a front view of the moving means shown in FIG. 5;
- FIG. 8 is a detail view of a stroke control of the embodiment;
- FIG. 9 is a view of further detail of the stroke control shown in FIG. 8;
- FIG. 10 is a schematic of fluid controls of the embodiment; and
- FIG. 11 is a detail view of a portion of schematic FIG. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the control will now be described with reference to an exemplary press generally illustrated in FIG. 1. Fluid actuators generally at 12 responsive to the control are piston and cylinder de-

vices. Four piston and cylinder devices (only three shown in FIG. 1) are connected to a lower platen 14 of the press to move the lower platen toward an upper platen 16 to press articles (not shown) between the platens. The upper platen 16 is mounted on the press for movement only normal to the approaching movement of the lower platen; such movement is generally called a receding head and is effected by a drive mechanism generally at 18. A housing generally at 20 for a portion of the control includes a plurality of photoelectric devices and light sources generally at 22 to form a light screen across the press. The control portion at 20 additionally includes means for adjusting a preset stroke or movement of the lower platen toward the upper platen in its illustrated position.

As best seen in FIGS. 2, 3 and 6, the lower platen 14 is connected to a cylinder 24 of each piston and cylinder device generally at 12. Each cylinder 24 has a piston 26 having piston rods 28 projecting from both ends of an interior chamber of the cylinder and secured at both ends to a frame of the press. Admission of pressure fluid to the cylinder above or below the piston from fluid flow passages 32 or 34, respectively, will then move the cylinder along the piston to move the platen 14 toward or away from the upper platen of the press.

A spool valve generally at 36 is mounted on the outside of each cylinder 24 to provide pressure fluid to the fluid passages 32 and 34. Each valve has a spool 38 urged by a spring 40 to a lower position in which a stem 42 of the spool extends from the valve. As best seen in FIG. 6, the spool has an illustrated, neutral position in which flanges of the spool block fluid flow to the passages 32 and 34, a raised position forming a fluid flow passage between flanges of the spool from a fluid supply passage 43 in the valve to the fluid supply passage 34 in the cylinder, and a lowered position forming a fluid flow passage between flanges of the spool from the passage 43 to the passage 32 in the cylinder.

The spool is moved between the raised and lowered positions by engagement of the stem 42 and abutment screw 44 connected to a portion of an actuator bar 46. One actuator bar 46 extends parallel to two sides of the platen 14 to support two abutment screws 44, one for each of the two piston and cylinder devices 12 on each side of the platen. The bar is slidably mounted on a frame of the press and has two threaded lugs 50 near its ends each in threaded engagement with a rotatable lead screw 52.

Rotation of the lead screws then slides the bar in engagement with the stems 42 of the spool valves to move the spools to provide fluid to fluid supply passages of the cylinders. Each lead screw 52 is held against translation. Each lead screw has a belt wheel 54; each pair of lead screws connected to one actuator bar 46 is connected by a belt 56 extending about the belt wheels. One lead screw of each belt connected pair is rotatably driven by a gear box 58 the gears of which are turned by a shaft 60 which is rotatably driven by a belt connected to an hydraulic motor 62. The gear ratio to each lead screw is the same so that each lead screw is coordinately rotated to coordinately advance each actuator bar into coordinate engagement with the stem of each spool valve 36.

FIG. 3 also shows the upper platen 16 drive means generally at 18. The platen 16 is supported on rollers 62 for the receding movement normal to the direction

of movement of the lower platen 14. The platen is connected to a chain 64 driven about cooperative sprockets by a drive motor 66. Limit switches 68 are positioned along the path of movement of the upper platen for selective control of the position of the upper platen.

FIG. 8 illustrates a portion of the control housing, generally at 20 showing devices for setting the stroke or extent of movement of the lower platen 14 toward and away from the upper platen. FIG. 9 illustrates further connected devices for this purpose. As seen in FIG. 9, a plate 70 has a pair of lugs slidably mounting the plate on vertically disposed rods 72 and 74. A parallel rod 76 is slidably mounted in a frame of the press and connected to one actuator bar 46 (see FIG. 3). The rod 76 has a cam member 78 fixed to it and cooperative at opposite ends with roller microswitch actuating members 80 and 82. The member 80 actuates a microswitch 84 mounted on the plate 70 which is effective to terminate movement of the lower platen toward the upper platen.

To determine the position of stroke termination of the lower platen toward the upper platen, the plate 70 is positioned along the rods 72 and 74 and held in position by a plate 86 having an oblique bore through which the rod 74 passes. The plate 86 is pivoted on the plate 70 at 87 and urged by spring 88 into a position (not shown) in which the bore binds or monkeys the plate 86 firmly to the rod 74. A spring 89 urges an arm of a bell crank 90, also pivoted to the plate 70, out of a position (not shown) to engage a lug 92 connected to the cam member 78. In this position (not shown) of the bell crank 90, the cam member 78 will move upwardly with the lower platen until the microswitch actuator member 80 passes off the lower end of the cam member 78 to actuate the microswitch 84 to terminate upward movement of the platen 14. The position of stroke termination is thus determined by the relative vertical positions of the plate 70 and cam member 78.

To adjust the relative position of the plate and cam member, a cable casing 92 is connected to another arm of bell crank 90 and a cable 94 coaxially slidable within the casing connected to the plate 86 on an opposite side of the plate 86 from the oblique bore. Pulling the plate 86 with the cable into the position illustrated in FIG. 9 positions the bore in parallel relationship with the rod 74. At the same time, the casing 92 pivots the bell crank 90 into a position to engage the stop 92. The bore in the plate 86 now being parallel to the rod 74 releases the bite of the plate 86 on the rod and the plate 70 falls under gravity until the bell crank 90 engages the stop 92 as shown. Movement of the cable 94 is also effective to disable the microswitch 84; the platen 14, without premature termination by the switch 84 connected cam member 78 and now engaged plate 70 may then be moved to a desired stroke termination position. Release of the cable 94 then permits the spring 88 to urge the plate 86 back into biting engagement with the rod 74 and the spring 89 to draw the bell crank 90 out of engagement with the stop member 92. The microswitch 84 is also again rendered effective to terminate platen movement at the position now determined by the cam member 78 and switch actuator member 80.

After thus setting the stroke termination position, fine adjustment of the position may be made by slidably positioning the rod 74 and thus the plate 70 monkeyed to the rod. For this purpose, rod 74 is held against rotation but permitted to slide vertically rela-

tive to a frame of the press by a pin and slot connection to the frame generally at 98. A bevel gear 100 is threadedly connected to the rod and rotationally driven by cooperative bevel gear 102, the latter being rotatable by rotation of a shaft 104. Rotation of the shaft 104 then turns the gears to slide the rod 74 vertically to adjust the position of plate 70 relative to the cam.

FIG. 8 illustrates devices for actuating the cable 94 and shaft 104. For this purpose a knob 106 is connected to a shaft 108 coupled to the shaft 104 for rotation but axially slidable relative to the shaft 104. Depressing the knob 106 then slides the shaft 108 to trip a microswitch 110 with a cam portion of the rod 108. The microswitch 110 actuates a solenoid 112 which pulls the cable 94 relative to the cable casing 92. As above described, the plate 70 then drops until the bell crank 90 engages the stop member 92. Moving the platen 14 then positions the plate 70 where it is retained by release of the knob 106 to relax the solenoid 112.

Rotation of the knob 106 rotates the shaft 108 and connected shaft 104 to vertically position the rod 74 for adjustment of the stroke termination position of the plate 70 preset as above described. To properly regulate such adjustment, it is desirable that the rod 74 be in a neutral or zero position when the platen and plate are first, presettingly positioned. For this purpose, the shaft 108 and a mounting plate 114 for the shaft have cooperative pins and holes which permit the knob and shaft 108 to be depressed for actuation of the solenoid 112 only when cooperative pins and bores in the shaft and plate, generally shown at 116, are aligned.

A lowermost position of the platen 14 may be set by a knob 118 connected to a rotatably mounted shaft 120. Returning to FIG. 9, a sprocket on the shaft 120 then drives a chain 122 connected to a slidably mounted plate 124 to position this plate. Rotation of the knob 118 then positions the plate 124 relative to the cam 78. A microswitch 126 is actuated by the roller actuator member 82 when an upper end of the cam member 78 is in a lowermost position; the switch 126 terminates downward movement of the platen 14.

FIG. 10 is a schematic of the fluid supply circuit for the press. Each of the piston and cylinder devices generally at 12 is shown with its associated spool valve generally at 36. Fluid for operating the piston and cylinders is supplied from both a low pressure, high volume pump 200 and a high pressure, low volume pump 202, each receiving fluid from a tank 204 conveniently formed by a bed for the lower platen 14. Fluid from the pump 200 flows to each piston and cylinder device through a line 206. With the spool valves generally at 36 in the illustrated neutral position, fluid flow to the piston and cylinders is blocked and line 206 vented by a pressure relief valve arrangement generally at 208. The line 206 is also vented to the tank by a valve 210. Pressure from the pump 202 is vented to the tank by a valve 212 similar to the valve 210.

Upon initiation of press operation, the valve 212 is first shifted as by a switch controlled solenoid to supply high-pressure, low volume fluid to the hydraulic motor 66 for advancing the upper platen 16 into opposed relationship with the lower platen 14. One of the microswitches 68, e.g. the left switch shown in FIG. 3, signals the arrival of the upper platen in this opposed position and returns the valve 212 to the position illustrated in FIG. 10; this switch 68 also moves a valve 214 to switch

fluid from the pump 202 into the line 206. At the same time, the valve 210 is shifted to supply pressure fluid to the hydraulic motor 62. As before described, this motor coordinately rotates lead screws to advance actuator bars into engagement with the stems 42 of the spool valves to trip these valves into supplying fluid to raise the cylinders on the pistons. A pair of restrictor valves 216 between each pump and the motor 62 are pressure compensated so that the ratio of fluid flow to the motor 62 and piston and cylinder devices 12 is substantially constant. The speed of the motor 62 is preferably less than the maximum speed at which the piston and cylinders 12 could drive the platen 14 if maximum fluid flow were allowed through the spool valves to avoid pushing the valves with the actuator bars.

As the platens begin to apply pressure to an article between the platens, pressure in the line 206 increases. At a preset pressure, a pressure relief valve 218 dumps fluid from the low-pressure pump 200 back to the tank. Continued movement of the piston and cylinder devices is then accomplished solely by the high-pressure pump 202. The lower platen then continues to move until the cam member 78 trips the microswitch 84 as described with reference to FIG. 9.

The microswitch 84 then switches the valve 210 to reverse fluid flow to the motor 62. The motor 62 then reverses to lower the actuator bars away from the spool valve stems 42. The spool valve springs then move the stems to reverse fluid flow to the pistons and cylinder devices 12 to lower the platen. At the same time valve 218 is again closed to permit lowering of the platen on the low pressure fluid from the pump 200. After a short delay just sufficient to permit separation of the platens from an article between them, movement of the valve 218 shifts connected valves 212 and 214 to provide fluid from the high-pressure pump 202 to the motor 66; however, fluid flow to the motor 66 is reversed from its earlier flow. The upper platen then recedes to its out-of-the-way position. Finally, one of the microswitches 68, e.g., one of the two right-hand switches shown in FIG. 3, returns the valve 212 to its illustrated position to terminate receding movement of the upper platen 16, and, when the platen 14 is sufficiently lowered, the microswitch 126 returns the valve 210 to its illustrated position. The piston and cylinder devices then move the spool valve stems into sufficient engagement with the actuator bars 46 to return the spool valves to their illustrated neutral positions.

During the operation of the press, the pressure relief device generally at 208 prevents excessive pressure in the line 206. To prevent such excessive pressure, the fluid supply line 32 in each piston and cylinder device (only one shown) for raising each cylinder is connected by a return line 220 to a pressure relief valve 222 of the device at 208. The line 220 has three shuttle valves 224 serving as an expanded OR gate to provide the highest pressure of any of the fluid supply passages 32 in each of the cylinders to the valve 222.

As shown in more detail in FIG. 11, the outlet side of valve 222 is connected by line 223 to a further pressure relief valve generally at 228. The valve at 228 is of the balanced piston type in which a passage 230 through a piston 232 of the valve permits fluid flow to balance the pressure on both sides of the piston. A spring 234 urges a stem 236 connected to the piston into a cooperative valve seat to prevent venting fluid pressure to the tank 204.

In idling condition, a further valve 240 remains in a spring urged condition connecting the line 223 to the tank. Pressure in the line 206 then passes fluid through the passage 230 into the line 223 and to the tank, the valve 222 being closed by its spring. Upon initiation of press operation, the valve 240 is shifted to open the connection between the line 223 and the tank. Pressure then builds in the line 206 from the throttling of the spool valves 36 and lifting the platen 14 to cause fluid flow through the passage 230 to the line 223 sufficient to open the valve 222. Fluid then flows through the line 220 toward the piston and cylinder devices 12. The resulting reduced pressure in the line 223 together with the restriction of the passage 230 creates an unbalanced pressure condition on the piston 232 such as to lift the piston against the spring 234 to throttle the line 206 to the tank. As pressure builds in the cylinders, it is supplied through the line 220, valve 222 and line 223 to the valve at 228 to increase the back pressure on the piston 232, thereby increasing the pressure necessary to unseat the stem 236. Thus, the pressure relieved by the valve at 228 is responsive to the pressure in the piston and cylinder devices at 12.

A further pressure relief valve 242 is provided in the line 223 merely as a safety. If the pressure in line 223 exceeds that necessary to urge the valve 242 against its spring to dump the line 223, the reduced or dumped pressure in the line 223 will unbalance the valve at 228 to raise its piston 232 to vent the line 206.

I claim:

1. In a press having a movable platen which is driven by fluid piston and cylinder means against a relatively fixed platen, a system for supplying and controlling fluid under pressure to the piston and cylinder means comprising:

- A. a first pump connected to supply pressurized fluid to the piston and cylinder means at low pressure and high volume;
- B. a second pump connected to supply pressurized fluid to the piston and cylinder means at high pressure and low volume;
- C. a conduit connected to receive the pressurized fluid from both pumps and for directing said fluid to the piston and cylinder means;
- D. first valve means connected to the first pump and the conduit to divert fluid from said pump away

from said conduit when the pressure in the conduit reaches a predetermined value, thereby allowing further movement of the movable platen to be caused solely by the pressurized fluid from the second pump;

- E. mechanically actuated second valve means associated with the piston and cylinder means to control the flow of pressurized fluid from the conduit to the piston and cylinder means;
- F. a mechanical assembly operatively associated with a lead screw for actuating the second valve means, said lead screw being driven by a first fluid motor; and
- G. third valve means connected to the first pump to cause said first pump to supply low pressure, high volume fluid to the first fluid motor in order to drive said lead screw, thereby actuating the second valve means.

2. In a press having a movable platen which is driven by fluid piston and cylinder means against a relatively fixed platen, a system for supplying and controlling fluid under pressure to the piston and cylinder means as described in claim 1 wherein the relatively fixed platen may be moved to and from an out-of-the-way position and said movement is caused by a system comprising:

- A. a second fluid motor operatively connected to the relatively fixed platen to move said platen into and out of its operative position; and

- B. fourth valve means connected to the second pump to cause said pump to supply high pressure low volume fluid to the second fluid motor in order to actuate movement of the relatively fixed platen.

3. In a press having a movable platen which is driven by fluid piston and cylinder means against a relatively fixed platen, a system for supplying and controlling fluid under pressure to the piston and cylinder means as described in claim 2, further comprising a switch actuated by movement of the relatively fixed platen into its operative position, said switch being connected to the fourth valve means to cause said valve to direct fluid from the second pump away from the second fluid motor to the conduit; and to the third valve means to cause said first pump to supply pressurized fluid to the first fluid motor.

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