Dec. 23, 1941. R. TYLER 2,267,380

HOLD-DOWN SYSTEM

Filed Nov. 16, 1938 3 Sheets-Sheet 1

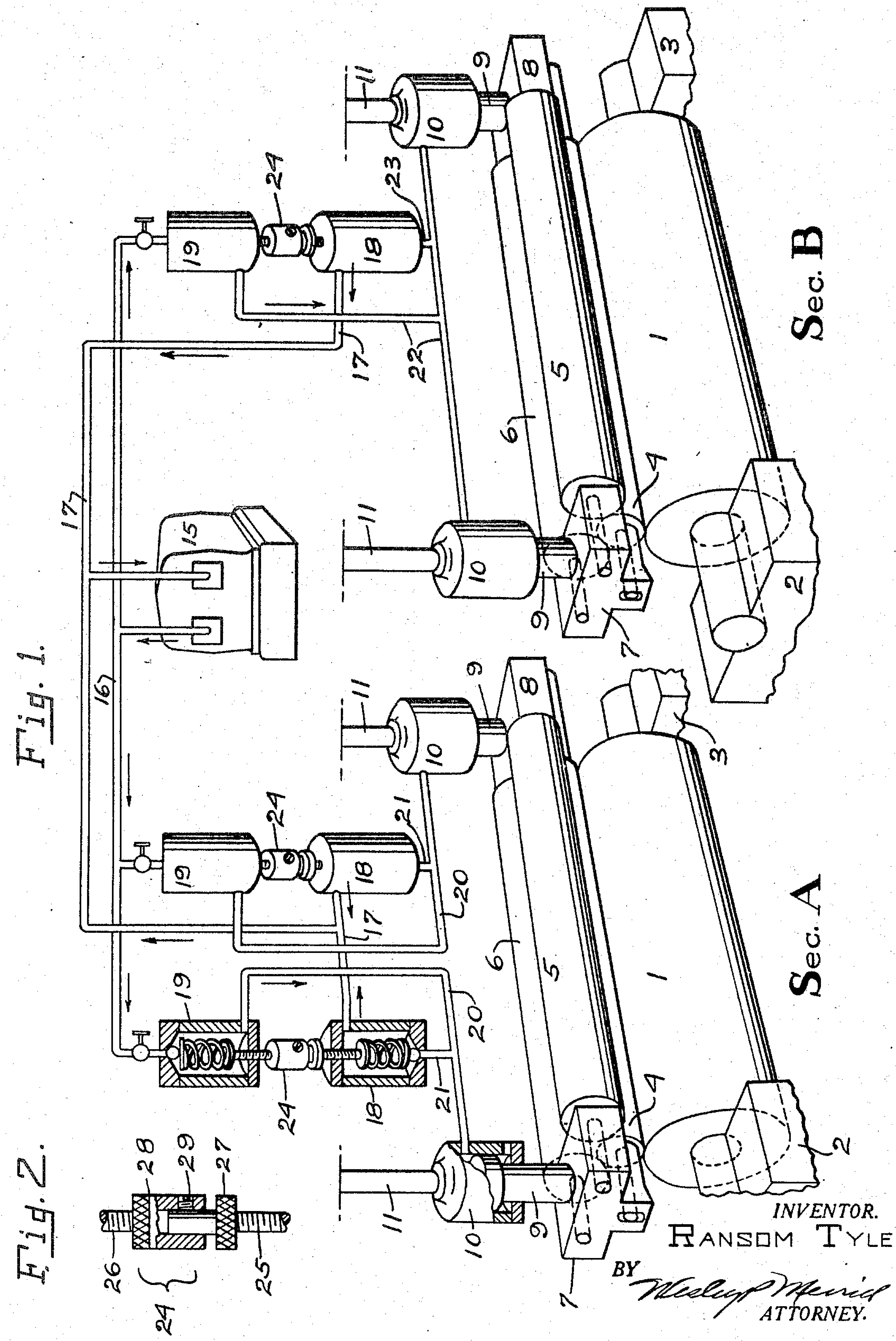

Fig. 1.

Fig. 2.

Sec. A

Sec. B

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Fig. 3.

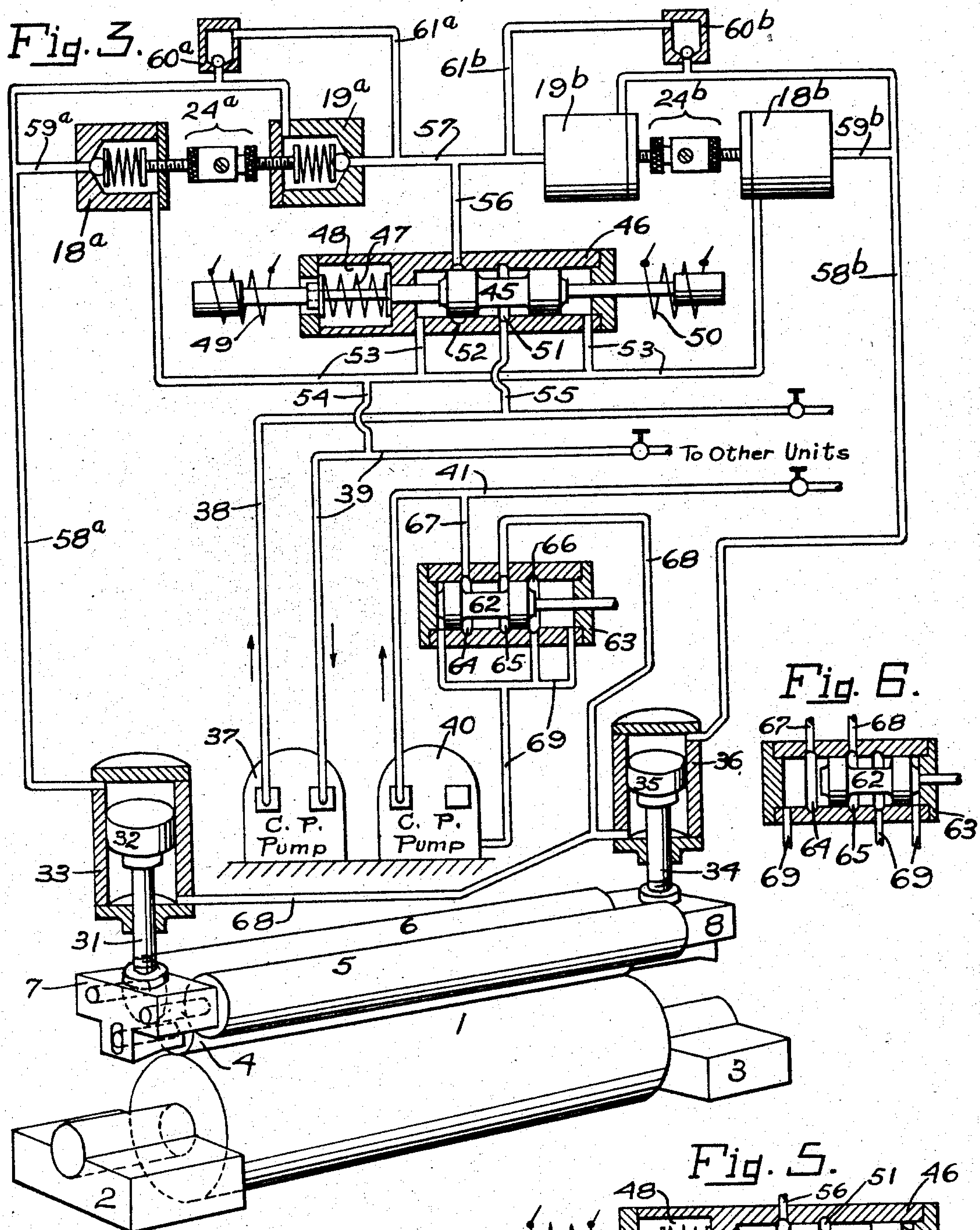

Fig. 6.

Fig. 5.

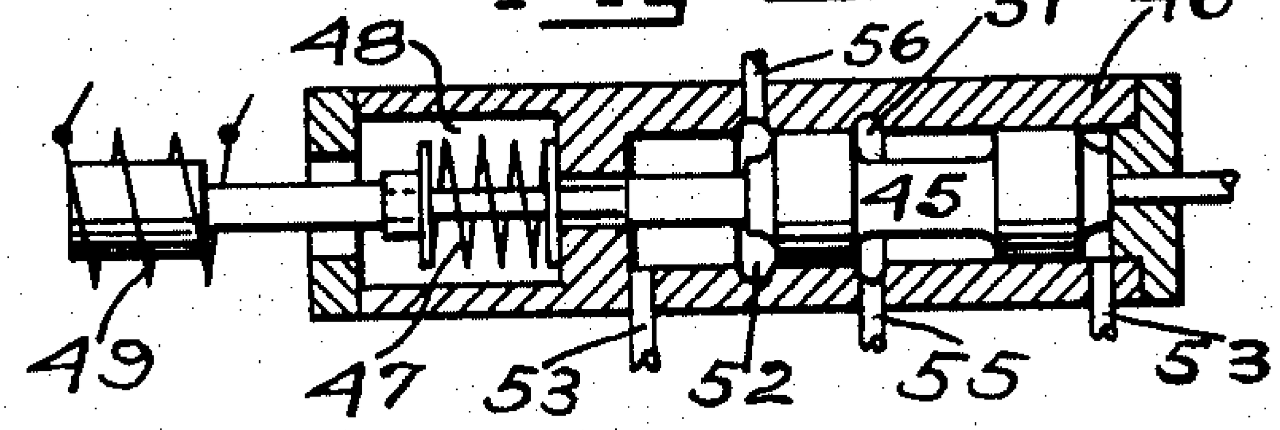

Fig. 4.

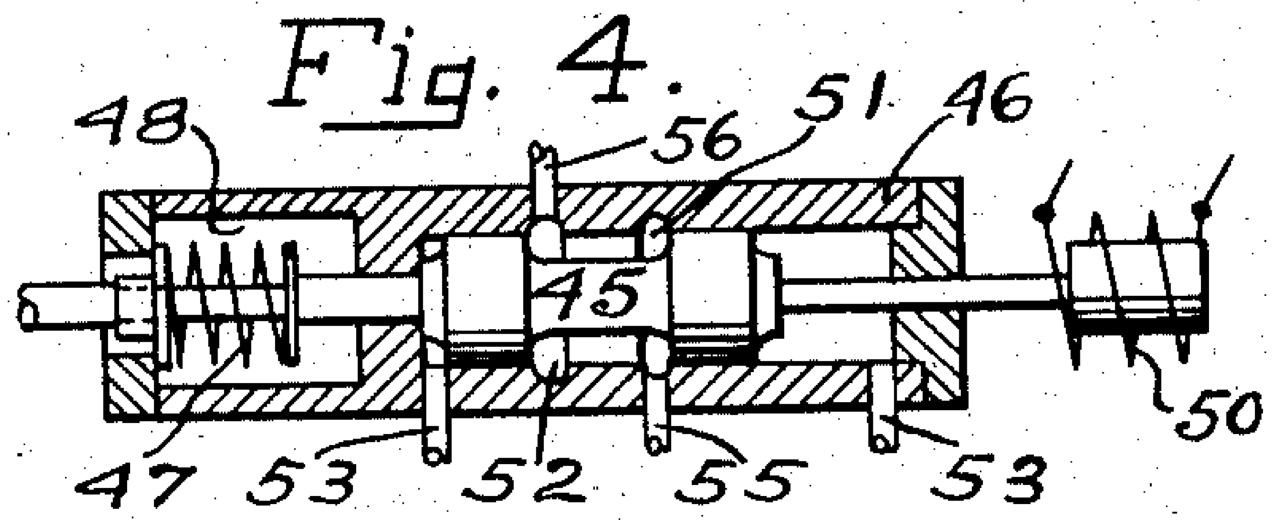

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Fig. 7.

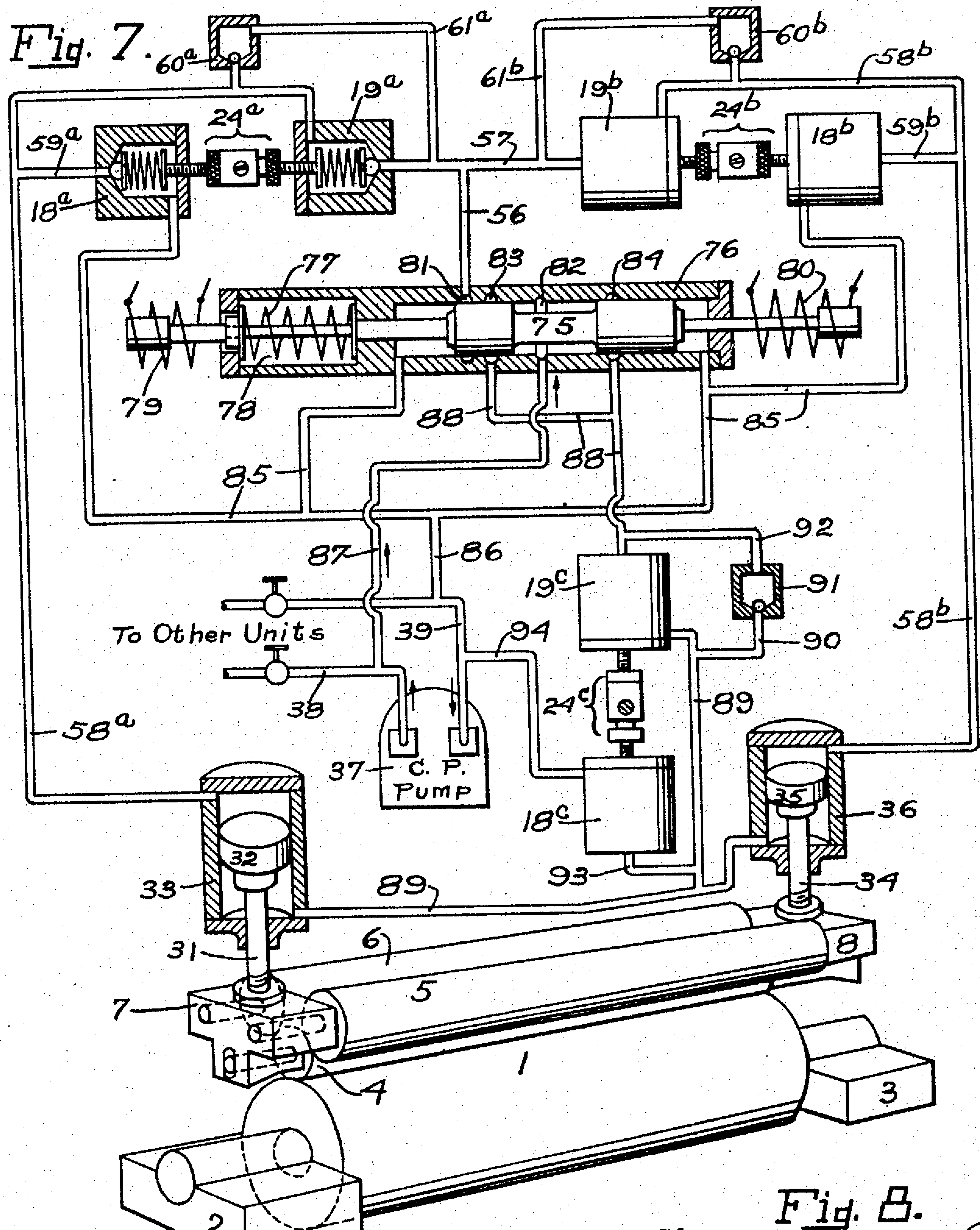


Fig. 8.

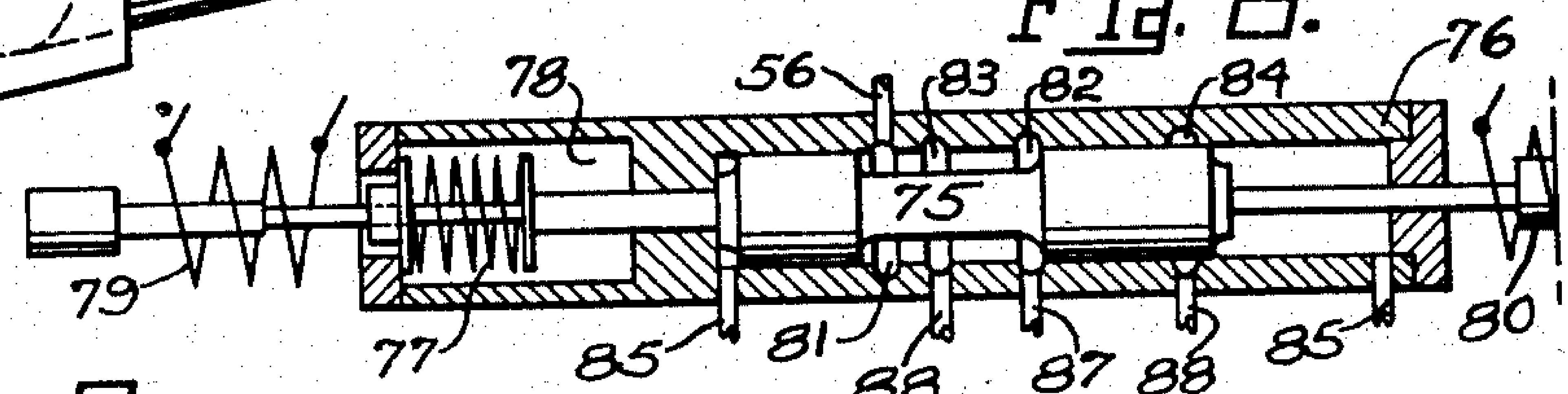
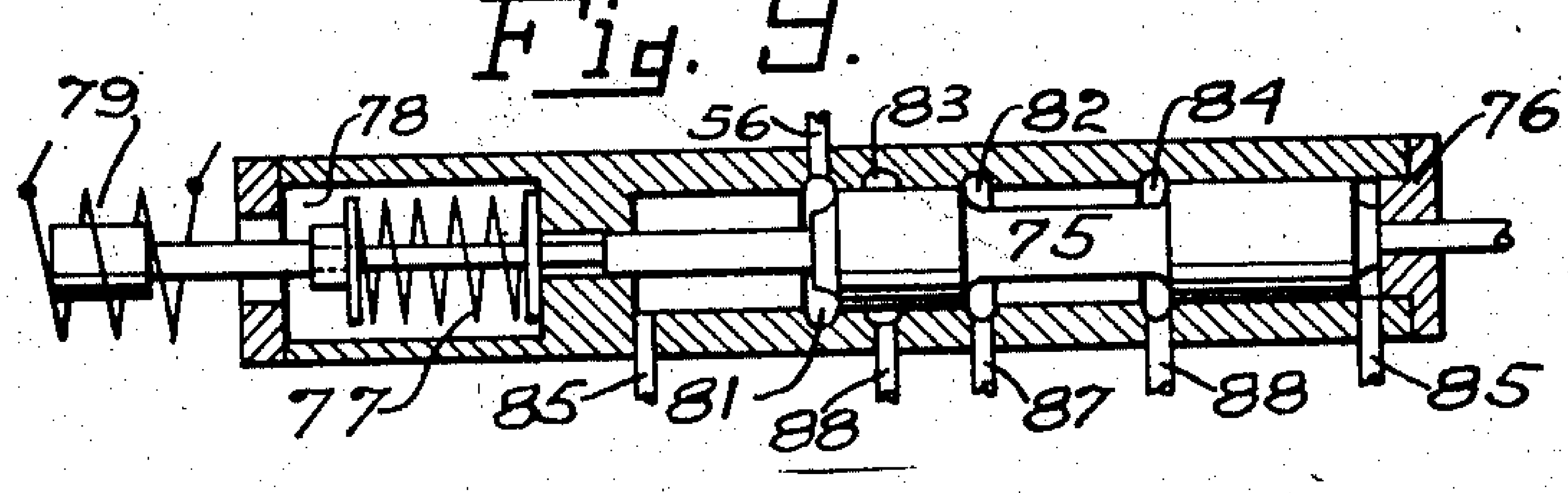


Fig. 9.



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2,267,380

HOLD-DOWN SYSTEM

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Application November 16, 1938, Serial No. 240,668

15 Claims. (Cl. 60—52)

This application is a continuation in part of application Serial No. 94,034, filed August 3, 1936, and now abandoned.

The invention relates to hydraulic mechanisms for exerting holding pressures upon external objects or for pressing one or more objects against one or more other objects, and it is particularly adapted for controlling the pressure between the rolls of printing presses of the type employed to print paper or other material in colors.

A press of this type ordinarily has a lower roll which rotates upon a stationary axis and an upper roll which is movable vertically and exerts a predetermined pressure upon the paper or other material as it passes between the rolls. In order that the printing may be clear and sharp, it is ordinarily necessary that the pressure between the rolls be closely regulated and in some instances be less than the pressure created by the weight of the upper roll assembly.

The present invention has an object to provide a hold-down system in which a plurality of hydraulically actuated hold-down units may be energized by liquid from a common source and be capable of exerting independent holding forces without wasting the motive liquid.

Another object is to provide such a system with means whereby the fluid pressure in one unit may be varied without varying the pressure in another unit.

Another object is to provide a hold-down system which is susceptible of close adjustment and control.

Another object is to provide a hold-down system which may be economically manufactured and operated.

Other objects and advantages will appear from the description hereinafter given of hold-down systems in which the invention is embodied.

The invention is exemplified by the hold-down systems illustrated schematically in the accompanying drawings in which the views are as follows:

Fig. 1 is a view showing one form of the invention applied to a printing press of the type employed to print in colors.

Fig. 2 is a detail view.

Fig. 3 is a view showing another embodiment of the invention applied to a printing press.

Figs. 4 and 5 are views showing a control valve in positions different from that shown in Fig. 3.

Fig. 6 is a view showing another valve in a position different from that shown in Fig. 3.

Fig. 7 is a view showing a hold-down system similar to that shown in Fig. 3 but employing a single pump instead of two pumps.

Figs. 8 and 9 are views showing a control valve in positions different from that shown in Fig. 6.

For the purpose of illustration, the invention has been shown applied to a printing press but it is not limited to such use. Since the printing press per se forms no part of the present invention, it has not been shown in detail.

It is deemed sufficient to state herein that the press has one or more stands of rolls or press sections each of which includes a lower or impression roll 1 which has its trunnions journaled in stationary bearings 2 and 3, an upper roll 4 for pressing the material to be printed against roll 1, and two backing rolls 5 and 6 which engage upper roll 4 throughout the length thereof. Rolls 5 and 6 have the trunnions thereof journaled in a pair of vertically movable bearings 7 and 8 which are shown as having slots formed therein to receive the trunnions of roll 4 so that roll 4 may move vertically a limited distance but, when bearings 7 and 8 are moved upward, they will carry the upper and backing rolls with them.

Fig. 1

In order to show that the same or independent holding pressures may be applied to opposite ends of the same roll, two stands of rolls or press sections A and B have been shown.

In each of sections A and B, each of bearings 7 and 8 has connected thereto a piston or ram 9 which is fitted in a cylinder 10 and forms therewith a hydraulic hold-down motor. Cylinder 10 is shown carried by a rod 11 which forms part of a mechanism for raising and lowering the upper roll assembly to permit roll 1 to be changed or to be replaced by a larger or smaller roll. The mechanism for raising and lowering the upper roll assembly has not been illustrated as it forms no part of the invention. It is deemed sufficient to state that each rod 11 is firmly held in a stationary position when the hold down motors are urging bearings 7 and 8 downward to press roll 4 against roll 1.

Liquid for operating motors 9—10 may be supplied by a pump 15 which has the characteristic of delivering liquid at its full or adjusted volumetric rate until pump pressure reaches a predetermined maximum and then automatically reducing its stroke until it is delivering just sufficient liquid to maintain that maximum pressure substantially constant. A pump of this type is shown in Patent No. 2,080,810. Pump 15 delivers its output into a pressure channel 16 and has liquid returned to it through a return channel 17.

In order that the same or different pressures may be maintained in the several cylinders 10, each cylinder 10 or group of cylinders 10 is provided with a pressure control unit consisting of resistance valve or a relief valve 18 and a resistance valve 19 which open in opposite directions.

The valve 18 of each unit has its inlet connected to a cylinder 10 or to a group of cylinders 10 and its outlet connected to return channel 17, and it is adjusted to open at a pressure at least as great as the pressure desired to be maintained in that cylinder or group of cylinders. The resistance valve 19 of each unit has its inlet connected to pressure channel 16 and its outlet connected to a cylinder 10 or to a group of cylinders 10 and it is adjusted to open at a pressure equal to the difference between the pressure in channel 16 and the pressure desired to be maintained in that cylinder or group of cylinders.

The hold down system may be arranged to cause the same or different pressures to be exerted upon opposite ends of the upper roll or the assembly. For the purpose of illustration, each cylinder 10 in section A is shown as being connected by channels 20 to the outlet of a resistance valve 19 and through channel 20 and a channel 21 to the inlet of relief valve 18, while both of the cylinders in section B are shown as being connected by a branched channel 22 to the outlet of a single resistance valve 19 and through channel 22 and a channel 23 to the inlet of a single relief valve 18. The arrangement is such that different pressing forces may, if desired, be applied to opposite ends of the upper roll assembly in section A while the same pressing force is applied to both ends of the upper roll assembly in section B.

In practice, the valves 18 and 19 of each unit are arranged in alinement in a single casing or in connected casings and are adjusted by a single element but, for the purpose of illustration, they have been shown as being separate and provided with a common adjusting member 24 rotation of which in one direction will increase the tension of the spring in valve 18 and decrease the tension of the spring in valve 19, thereby increasing the pressure required to open valve 18 and decreasing the pressure required to open valve 19, while rotation of member 24 in the opposite direction will decrease the tension of the spring in valve 18 and increase the tension of the spring in valve 19, thereby decreasing the pressure required to open valve 18 and increasing the pressure required to open valve 19. Therefore, the sum of the resistances of the two valves remains constant.

In order that the springs of valves 18 and 19 may be individually adjusted, member 24 is shown in Fig. 2 as being provided with two separate adjusting screws 25 and 26 which are threaded, respectively, through the casings of valves 18 and 19 and into contact with the springs therein.

Screw 25 has a nut 27 fixed thereon near its outer or upper end and that part of the screw beyond nut 27 is unthreaded and fitted in the bore of a hollow nut 28 which is fixed upon the outer or lower end of screw 26. Nuts 27 and 28 may be fixed for simultaneous rotation by means of a set screw 29 threaded through the wall of nut 28 into contact with the unthreaded portion of screw 25.

When set screw 29 is loosened, adjusting screws 25 and 26 may be turned independently of each other to individually adjust the resistances of valves 18 and 19 respectively. Then by tightening set screw 29, nuts 27 and 28 will be fastened together so that rotation of one will cause rotation of the other and thereby cause the resistances of valves 18 and 19 to be simultaneously varied inversely to each other.

If the system is supplied with liquid from a constant pressure source, such as pump 15, and if it is desired to prevent the escape of liquid from the system during normal operation of the apparatus to which the system is applied, the combined resistances of the valves 18 and 19 of each unit should be such that the pressure required to open both valves of each unit would be at least as great as the pressure at the source.

For example, if pump 15 were maintaining a pressure of 1000# per sq. in. in channel 16 and if it were desired to maintain a pressure 800# per sq. in. in a certain cylinder 10 without loss of liquid from the system, the pressure control unit connected to that cylinder should be so adjusted that the valve 19 thereof would open at a pressure of 200# per sq. in. and valve 18 thereof would open at a pressure of at least 800# per sq. in.

It is well known that a resistance valve will remain open at a pressure lower than the pressure at which it opens due to the fact that the area of the valve member exposed to the pressure at the inlet of the valve is greater after the valve opens than before it opens.

The additional valve member area exposed to the inlet pressure after the valve opens depends upon the width of the valve seat for the reason that, as soon as the liquid flowing through the valve passes the valve seat, its pressure drops to the pressure prevailing at the outlet side of the valve member. Therefore, if the valve is provided with a wide seat as is necessary to prevent it from becoming battered if the valve member has considerable movement due to large volumes being passed through the valve, the area exposed to the inlet pressure is considerably greater after the valve opens than before it opens and there will be a considerable difference between the pressure at which the valve opens and the pressure at which it will close.

Since only very small volumes are ever passed through valves 18 and 19, these valves merely "crack" when liquid is passed therethrough so that there is substantially no impact against the seat when the valve closes. Therefore, each of valves 18 and 19 is provided with a very narrow hardened seat which is little more than a sharp edge. Consequently, the difference between the pressure at which the valve opens and the pressure required to hold it open is so small that it is of no significance commercially and has been disregarded in the explanation given herein.

It would seem that the combined resistance of the two valves of each unit could be such that the pressure required to open both valves would be just equal to the pressure at the source but in practice it is found that the combined resistance should be slightly higher so that each valve 18 will open at a pressure which, for instance, is 10 to 50# higher than the pressure in the cylinder to which that valve 18 is connected.

As long as the pressure at the source and the upward force acting upon the ram 9 of any hold-down motor remains constant, there will be maintained in the cylinder 10 of that hold-down motor a substantially constant pressure which in the above example, would be approximately 800# per sq. in. The pressure at the source might vary due, for instance, to inaccurate operation of pump 15, or the upward force acting on ram 9 might vary due, for instance, to the paper breaking and then winding up on roll 1 and thereby raising roll 4. If the pressure at the source should increase or if the upward force acting on ram 9 should vary, the pressure in cylinder 10 would be maintained within narrow limits, which in the above example, would be between approximately 800# and 810# to 850#.

The pressure in any hold-down motor and the holding force exerted thereby may thus be maintained substantially constant or kept within narrow limits, and the pressure in any hold-down motor and the holding force exerted thereby may thus be varied without affecting the pressure in any other hold-down motor or the force exerted thereby.

Figs. 3 to 5

The hold-down system shown in Fig. 3 differs primarily from the previously described system in that it is provided with hold-down motors which are capable of moving the upper roll assembly toward and from lower roll 1 and with means for reducing the pressure between rolls 1 and 4 to a minimum so that the pressure being exerted upon the material being printed will be less than the pressure resulting from the weight of the upper roll assembly.

As shown, the upper roll assembly has its bearing 7 connected by a rod 31 to a piston 32 which is fitted in a stationary cylinder 33, and its bearing 8 connected by a rod 34 to a piston 35 which is fitted in a stationary cylinder 36.

Liquid for moving pistons 32 and 35 downward is supplied by a constant pressure pump 37 which discharges liquid into a supply channel 38 and has liquid returned to it through a return channel 39. Liquid for moving pistons 32 and 35 upward is supplied by a constant pressure pump 40 which discharges into a supply channel 41. The liquid supplied by pumps 37 and 40 may be employed for operating other hold-down units by extending channels 38, 39 and 41 thereto.

The operation of hold-down motors 32—33 and 35—36 is under the control of a control valve 45 which is fitted in a valve casing 46 and yieldingly retained in the position shown in Fig. 3 by a caged spring 47 arranged in a spring chamber 48 formed upon or attached to one end of casing 46. Valve 45 is adapted to be shifted from its central or neutral position as shown in Fig. 3 to the position shown in Fig. 4 or to the position shown in Fig. 5 by one or the other of two solenoids 49 and 50 the cores of which are connected to valve 46 by suitable valve stems.

Valve casing 46 has two annular grooves or ports 51 and 52 formed in the wall of its bore intermediate the ends thereof and the ends of its bore connected to a branched return channel 53 which is connected by a channel 54 to return channel 39. Port 51 is connected by channel 55 to supply channel 38, and port 52 is connected by a channel 56 to a channel 57 intermediate the ends thereof.

When valve 45 is in the position shown in Fig. 3, it blocks communication between port 52 and port 51 and between port 52 and return channel 53 so that no liquid can flow to or from channel 57. When valve 45 is in the position shown in Fig. 4, communication between port 52 and channel 53 is blocked but port 52 is open to port 51 so that liquid can flow into channel 57 from supply channel 38. When valve 45 is in the position shown in Fig. 5, communication between port 52 and port 51 is blocked but port 52 is open to channel 53 so that liquid can escape from channel 57 into return channel 39.

The pressure of the liquid supplied to the upper ends of cylinders 33 and 36 is controlled by two pressure control units which are identical to the pressure control units shown in Figs. 1 and 2 and previously described. Consequently, these units have been indicated by the same reference numerals with the exponents *a* and *b* added thereto, and no detailed description thereof will be given.

As shown, channel 57 has its ends connected to two resistance valves 19^a and 19^b the outlets of which are connected, respectively, by channels 58^a and 58^b to the upper ends of cylinders 33 and 36. Channels 58^a and 58^b are connected, respectively, by channels 59^a and 59^b to the inlets of two relief valves 18^a and 18^b the outlets of which have return channel 53 connected thereto. Valves 18^a and 19^a may be simultaneously adjusted by means of an adjusting member 24^a and valves 18^b and 19^b may be simultaneously adjusted by means of an adjusting member 24^b as previously explained.

In order that pistons 32 and 35 may expel liquid freely from upper ends of cylinders 33 and 36 when motive liquid is supplied to the lower ends of cylinders 33 and 36 and valve 45 is in the position shown in Fig. 5, two check valves 60^a and 60^b have the inlets thereof connected, respectively, to channels 58^a and 58^b and the outlets thereof connected, respectively, by channels 61^a and 61^b to channel 57 intermediate the ends thereof.

If the press is to be employed at all times to print materials which require only a low pressure between rolls 1 and 4, supply pipe 41 from pump 40 may be connected directly to the lower ends of cylinders 33 and 36 but, if a wide range of printing pressures is desired, means should be provided for connecting the lower ends of cylinders 33 and 36 either to pump 40 or to exhaust.

As shown, the delivery of liquid to the lower ends of cylinders 33 and 36 is under the control of a valve 62 which is closely fitted in the bore of a valve casing 63 having three annular grooves or ports 64, 65 and 66 formed in the wall thereof. Port 64 is connected to supply channel 41 by channel 67, port 65 is connected to the lower ends of cylinders 33 and 36 by a branched channel 68, and port 66 and both ends of the bore of casing 63 are connected to a branched exhaust channel 69 which discharges into a suitable reservoir such as the sump of pump 40.

Assuming that the parts are in the positions shown in Fig. 3 and that pumps 37 and 40 are running, the hold-down system will function as follows:

If it is desired to raise upper roll assembly, valve 45 is shifted to the position shown in Fig. 5 so that liquid can escape from the upper ends of cylinders 33 and 36 and liquid from pump 40 can flow to the lower ends of cylinders 33 and 36 and move pistons 32 and 35 upward. The liquid expelled from the upper end of cylinder 33 by piston 32 will flow through channel 58^a, check valve 60^a, channels 61^a, 57 and 56, valve casing 46 and channels 53 and 54 into the return channel 39, and the liquid expelled from the upper end of cylinder 36 by piston 35 will flow through channel 58^b, check valve 60^b, channels 61^b, 57 and 56, valve casing 46 and channels 53 and 54 into return channel 39.

When it is desired to move the upper roll assembly downward, valve 45 is shifted to the position shown in Fig. 4 and liquid from pump 37 will flow through channels 38 and 55, valve casing 46 and channel 56 into channel 57. A part of the liquid entering channel 57 will flow through resistance valve 19^a and channel 58^a to the upper end of cylinder 33 and move piston 32 downward, and another part of the liquid will flow through resistance valve 19^b and channel 58^b to the upper end of cylinder 36 and move piston 35 downward.

The liquid expelled from cylinders 33 and 36 during downward movement of pistons 32 and 35 may flow to pump 40 and be exhausted through the relief valve with which all such pumps are provided, it being understood that pump 40 is so adjusted that pressure required to open its relief valve is but a few pounds higher than the predetermined pressure at which pump 40 reduces its stroke to maintain that predetermined pressure constant.

However, valve 62 may be shifted toward the right to or nearly to the position shown in Fig. 6 and then pistons 32 and 35 may expel liquid from the lower ends of cylinders 33 and 36 through channel 68 and valve casing 63 into exhaust channel 69 until just before the roll 4 engages lower roll 1 and then valve 62 should be shifted to the position shown in Fig. 3 to prevent roll 4 from striking a heavy blow upon lower roll 1.

After roll 4 is in contact with roll 1, the pressure created by pump 40 will act upon the lower faces of pistons 32 and 35 and create upward forces which will oppose the downward forces created by the weight of the upper roll assembly and by the pressure acting upon the upper faces of pistons 32 and 35. If the pressure control units are adjusted to cause sufficient drop in pressure between pump 37 and the upper ends of the hold-down cylinders, the upward forces on pistons 32 and 35 will substantially counter-balance the downward forces thereon and the pressure between rolls 1 and 4 will be approximately zero. If the pressure control units are adjusted to cause a smaller drop in pressure between pump 37 and the upper ends of cylinders 33 and 36, the pressure between rolls 1 and 4 will be correspondingly greater.

If a high pressure between roll 4 and roll 1 is desired, valve 62 may be shifted to the position shown in Fig. 6 after roll 4 is in contact with roll 1. Pressure control units 18^a—19^a and 18^b—19^b will then function to maintain the holding pressure in the upper ends of cylinders 33 and 36 within narrow limits in the same manner that the pressure control units shown in Fig. 1 function to maintain the holding pressures in cylinders 10 within narrow limits.

The pressure between rolls 1 and 4 may thus be varied between zero and a very high pressure by adjusting pressure control units 18^a—19^a and 18^b—19^b and/or by shifting valve 62 to one or the other of its positions.

Figs. 7 to 9

The hold-down system shown in Fig. 7 differs from the system shown in Fig. 3 in that only one pump is employed, liquid is delivered from that pump to the lower ends of the hold-down motors through a pressure control unit similar to the pressure control unit previously described, and the flow of liquid to and from the hold-down motors is controlled by a valve which differs somewhat from the control valve shown in Fig. 3. Since the system is otherwise the same as the system shown in Fig. 3, like parts have been indicated by like reference numerals and no further description thereof will be given.

As shown, liquid for operating hold-down motors 32—33 and 35—36 is supplied by pump 37 which, as previously explained, delivers its output into a supply channel 38 and has liquid returned to it through a return channel 39.

The flow of liquid to and from the hold-down motors is controlled by a valve 75 which is fitted in a valve casing 76 and yieldingly retained in the position shown in Fig. 7 by a caged spring 77 arranged in a spring chamber 78 formed upon or attached to one end of valve casing 76. Valve 75 is adapted to be shifted from its central or neutral position as shown in Fig. 7 to the position shown in Fig. 8 or to the position shown in Fig. 9 by one or the other of two solenoids 79 and 80 the cores of which are connected to valve 75 by suitable valve stems.

Valve casing 76 has four annular grooves or ports 81, 82, 83 and 84 formed in the wall of its bore intermediate the ends thereof, and the ends of the bore are connected to a branched return channel 85 which is connected by a channel 86 to return channel 39.

Port 81 has channel 56 connected thereto, port 82 is connected to supply channel 38 by channel 87, and ports 83 and 84 are connected by branched channel 88 to the inlet of a resistance valve 19^c the outlet of which is connected by branched channel 89 to the lower ends of both of cylinders 33 and 36.

Channel 89 is connected by channel 90 to the inlet of a check valve 91 the outlet of which is connected by a channel 92 to channel 88 intermediate the ends thereof. Channel 89 is also connected by a channel 93 to the inlet of a relief valve 18^c the outlet of which is connected by a channel 94 to a return channel 39. Relief valve 18^c and resistance valve 19^c may be simultaneously adjusted by means of an adjusting member 24^c and form therewith a pressure control unit which is identical to the pressure control unit shown in Fig. 1 and previously described.

When valve 75 is in the position shown in Fig. 7, it blocks communication between ports 81, 82, 83 and 84 so that no liquid can flow to or from the hold-down motors.

When valve 75 is shifted to position shown in Fig. 9, port 81 is open to exhaust channel 85 and port 82 is open to port 84 so that liquid from pump 37 will flow through channels 38 and 87, valve casing 76, channel 88, resistance valve 19^c and channel 89 to the lower ends of cylinders 33 and 36 and cause pistons 32 and 35 to move upward and raise the upper roll assembly.

Piston 32 will expel liquid from the upper end of cylinder 33 through channel 58^a, check valve 60^a and channel 61^a into channel 57, and piston 35 will expel liquid from the upper end of cylinder 36 through channel 58^b, check valve 60^b and channel 61^b into channel 57. From channel 57, the liquid expelled from cylinders 33 and 36 by pistons 32 and 35 will flow through channel 56, valve casing 76 and channels 85 and 86 into return channel 39.

When valve 76 is shifted to the position shown in Fig. 8, communication between channel 85 and the valve ports is blocked so that no liquid can escape into return channel 39, and ports 81 and 83 are open to port 82 so that liquid from pump 37 will at first flow through channels 38 and 87, valve casing 76 and channel 56 into channel 57. From channel 57, a part of the liquid will flow through resistance valve 19^a and channel 58^a to the upper end of cylinder 33 and move piston 32 downward, and another part of the liquid will flow through resistance valve 19^b and channel 58^b to the upper end of cylinder 36 and move piston 35 downward, thereby causing the upper roll assembly to move downward.

Pistons 32 and 35 in moving downward will expel liquid from the lower ends of cylinders 33 and 36 through channels 89 and 90, check valve 91, channels 92 and 88 and valve casing 76 into channel 56 where it will join the liquid supplied to channel 56 by pump 37 so that pistons 32 and 35 are moved downward at high speed due to the fact that pump 37 need supply only a volume of liquid equal to the displacement of rods 31 and 34.

When upper roll 4 engages lower roll 1, further downward movement of pistons 32 and 35 is arrested and pressure will extend through the above described channels to cylinders 33 and 36.

The pressure in the upper end of cylinder 33 is maintained within narrow limits by resistance valve 19^a and relief valve 18^a, and the pressure in the upper end of cylinder 36 is maintained within narrow limits by resistance valve 19^b and relief valve 18^b as previously explained.

Since liquid could not escape from the lower ends of cylinders 33 and 36 through check valve 91 against the higher pressure prevailing in channel 88, relief valve 18^c is provided so that liquid can flow from the lower ends of cylinders 33 and 36 through channels 89 and 93, relief valve 18^c and channel 94 into return channel 39 whenever the pressure in the lower ends of the cylinders exceeds the resistance of relief valve 18^c. Consequently, the pressure in the lower ends of cylinders 33 and 36 is maintained within narrow limits by relief valve 18^c and resistance valve 19^c.

The upward forces exerted upon pistons 32 and 35 by the liquid in the lower ends of the cylinders oppose the downward forces exerted upon the pistons by the weight of the upper roll assembly and by the liquid in the upper ends of the cylinders so that the pressure between rolls 1 and 4 is equal to the difference between the upward and downward forces.

Since the pressure in each end of each cylinder is maintained within very narrow limits as previously explained, the pressure between rolls 1 and 4 may be maintained within very narrow limit and, by proper adjustment of the several pressure control units, the pressure between rolls 1 and 4 may be varied between zero and a predetermined maximum pressure.

The hold-down system herein set forth is susceptible of various other modifications and adaptations without departing from the scope of the invention as hereinafter claimed.

The invention is hereby claimed as follows:

1. A hold-down system, comprising a source of constant pressure motive liquid and a plurality of hold-down units connected to said source, each of said units comprising hydraulically actuated hold-down means, means for supplying liquid from said source to said hold-down means including a resistance valve having a resistance substantially equal to the difference between the pressure at said source and the pressure desired in said hold-down means, and means for permitting liquid to escape from said hold-down means including a relief valve adapted to open at a pressure at least as great as said desired pressure, the sum of the resistances of said valves being such that the pressure required to open both valves simultaneously is greater than the pressure at said source.

2. A hold-down system, comprising a source of constant pressure motive liquid and a plurality of hold-down units connected to said source, each of said units comprising hydraulically actuated hold-down means, means for supplying liquid from said source to said hold-down means including a resistance valve for causing a drop in pressure between said source and said hold-down means, means for permitting liquid to escape from said hold-down means including a relief valve connected thereto, and a single means for simultaneously varying the resistances of said valves inversely to each other, the sum of the resistances of said valves being such that the pressure required to open both valves simultaneously is greater than the pressure at said source.

3. A hold-down system comprising a source of constant pressure motive liquid and a plurality of hold-down units connected to said source, each of said units comprising hydraulically actuated hold-down means, means for supplying liquid from said source to said hold-down means including a resistance valve for causing a drop in pressure between said source and said hold-down means, means for permitting liquid to escape from said hold-down means including a relief valve connected thereto, means for individually adjusting each of said valves to vary the resistance thereof, and means for operating both of said adjusting means simultaneously to vary the resistance of said valves inversely to each other, the sum of the resistances of said valves being at all times such that the pressure required to open both valves simultaneously is greater than the pressure at said source.

4. The combination, with a source of motive liquid having a substantially constant pressure, of a cylinder, means connecting said cylinder to said source and including a resistance valve adapted to close at a pressure substantially equal to the difference between the pressure at said source and the pressure desired in said cylinder, means for permitting liquid to escape from said cylinder including a relief valve adapted to open at a pressure at least as great as said desired pressure, and means for simultaneously adjusting both of said valves to vary the resistance of each while maintaining the combined resistance of the two valves substantially constant.

5. In a machine having a first roll rotatable upon a stationary axis and a second roll movable toward and from said first roll, the combination of hydraulic means for urging said second roll against said first roll, a constant pressure pump, means connecting said hydraulic means to said pump including a resistance valve having a resistance equal to the difference between pump pressure and the pressure desired in said hydraulic means, means connecting said hydraulic means to an exhaust including a relief valve adjusted to open at a pressure at least as great as the pressure desired in said hydraulic means, and means for simultaneously increasing the resist-

ance of one of said valves and decreasing the resistance of the other of said valves to thereby vary the pressure in said hydraulic means while maintaining the combined resistance of said valves substantially constant.

6. The combination, with a plurality of movable members and a source of motive liquid having a constant pressure, of a hold-down unit for each of said members, each of said units comprising a piston and a cylinder, fluid channels connecting the upper end of said cylinder to said source and having connected therein a resistance valve having a resistance substantially equal to the difference between the pressure at said source and the pressure desired in said cylinder, fluid channels connecting the upper end of said cylinder to an exhaust and having connected therein a relief valve which permits liquid to escape from said cylinder upon the pressure therein exceeding said desired value, and means for supplying to the lower end of said cylinder liquid at a predetermined pressure which exerts an upward force on said piston to counterbalance in part the weight of said member and the downward force exerted upon said piston by the liquid in the upper end of said cylinder.

7. The combination, with a plurality of movable members and a source of motive liquid having a constant pressure, of a hold-down unit for each of said members, each of said units comprising a piston and a cylinder, fluid channels connecting the upper end of said cylinder to said source and having connected therein a resistance valve having a resistance substantially equal to the difference between the pressure at said source and the pressure desired in said cylinder, fluid channels connecting the upper end of said cylinder to an exhaust and having connected therein a relief valve which permits liquid to escape from said cylinder upon the pressure therein exceeding said desired value, means for supplying to the lower end of said cylinder liquid at a predetermined pressure which exerts an upward force on said piston to counterbalance in part the weight of said member and the downward force exerted upon said piston by the liquid in the upper end of said cylinder, and valve means for controlling the flow of liquid to and from said cylinder and operable to cause said liquid to raise or lower said piston.

8. The combination, with a plurality of movable members and a source of motive liquid having a constant pressure, of a hold-down unit for each of said members, each of said units comprising a piston and a cylinder, fluid channels connecting the upper end of said cylinder to said source and having connected therein a resistance valve having a resistance substantially equal to the difference between the pressure at said source and the pressure desired in said cylinder, fluid channels connecting the upper end of said cylinder to an exhaust and having connected therein a relief valve which permits liquid to escape from said cylinder upon the pressure therein exceeding said desired value, means for simultaneously adjusting both of said valves to vary the resistance of each while maintaining the total resistance of the two valves substantially constant, and means for supplying to the lower end of said cylinder liquid at a predetermined pressure which exerts an upward force on said piston to counterbalance in part the weight of said member and the downward force exerted upon said piston by the liquid in the upper end of said cylinder.

9. The combination, with a plurality of movable members and a source of motive liquid having a constant pressure, of a hold-down unit for each of said members, each of said units comprising a piston and a cylinder, fluid channels connecting the upper end of said cylinder to said source and having connected therein a resistance valve having a resistance substantially equal to the difference between the pressure at said source and the pressure desired in said cylinder, fluid channels connecting the upper end of said cylinder to an exhaust and having connected therein a relief valve which permits liquid to escape from said cylinder upon the pressure therein exceeding said desired value, means for simultaneously adjusting both of said valves to vary the resistance of each while maintaining the total resistance of the two valves substantially constant, means for supplying to the lower end of said cylinder liquid at a predetermined pressure which exerts an upward force on said piston to counterbalance in part the weight of said member and the downward force exerted upon said piston by the liquid in the upper end of said cylinder, and valve means for controlling the flow of liquid to and from said cylinder and operable to cause said liquid to raise or lower said piston.

10. In a hold-down system having a plurality of units, each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, and means for supplying liquid to the other end of said cylinder at a substantially constant pressure.

11. In a hold-down system having a plurality of units, each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, a second source of substantially

constant pressure liquid, and means including a valve for connecting the other end of said cylinder either to said second source or to an exhaust.

12. In a hold-down system having a plurality of units, each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, and means for supplying liquid from said source to the other end of said cylinder including a resistance valve for reducing the pressure of said liquid to a predetermined value and a relief valve for permitting liquid to escape from said other cylinder end upon the pressure therein exceeding a predetermined value.

13. In a hold-down system having a plurality of units, each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, means for simultaneously adjusting said resistance and relief valves to vary the resistance of each while maintaining the total resistance of the two valves substantially constant, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, and means for supplying liquid to the other end of said cylinder at a substantially constant pressure.

14. In a hold-down system having a plurality of units each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, means for simultaneously adjusting said resistance and relief valves to vary the resistance of each while maintaining the total resistance of the two valves substantially constant, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, a second source of substantially constant pressure liquid, and means including a valve for connecting the other end of said cylinder either to said second source or to an exhaust.

15. In a hold-down system having a plurality of units, each including a piston and a cylinder, the combination of a source of substantially constant pressure liquid, a channel for supplying liquid from said source to said units, a channel for returning liquid from said units to said source, a third channel, a control valve for connecting said third channel to said supply channel or to said return channel alternatively, each of said cylinders having a fourth channel connected to one end thereof, a resistance valve having its inlet connected to said third channel and its outlet connected to said fourth channel, a relief valve having its inlet connected to said fourth channel and its outlet connected to said return channel, the pressure required to open said resistance and relief valves simultaneously being greater than the pressure at said source, means for simultaneously adjusting said resistance and relief valves to vary the resistance of each while maintaining the total resistance of the two valves substantially constant, an oppositely opening check valve connected in parallel with said resistance valve for permitting liquid to escape from said cylinder upon said control valve being adjusted to connect said third channel to said return channel, and means for supplying liquid from said source to the other end of said cylinder including a resistance valve for reducing the pressure of said liquid to a predetermined value and a relief valve for permitting liquid to escape from said other cylinder end upon the pressure therein exceeding a predetermined value.

RANSOM TYLER.