July 15, 1952 A. CARTER 2,603,477

PRESSURE CONTROLLING APPLIANCE

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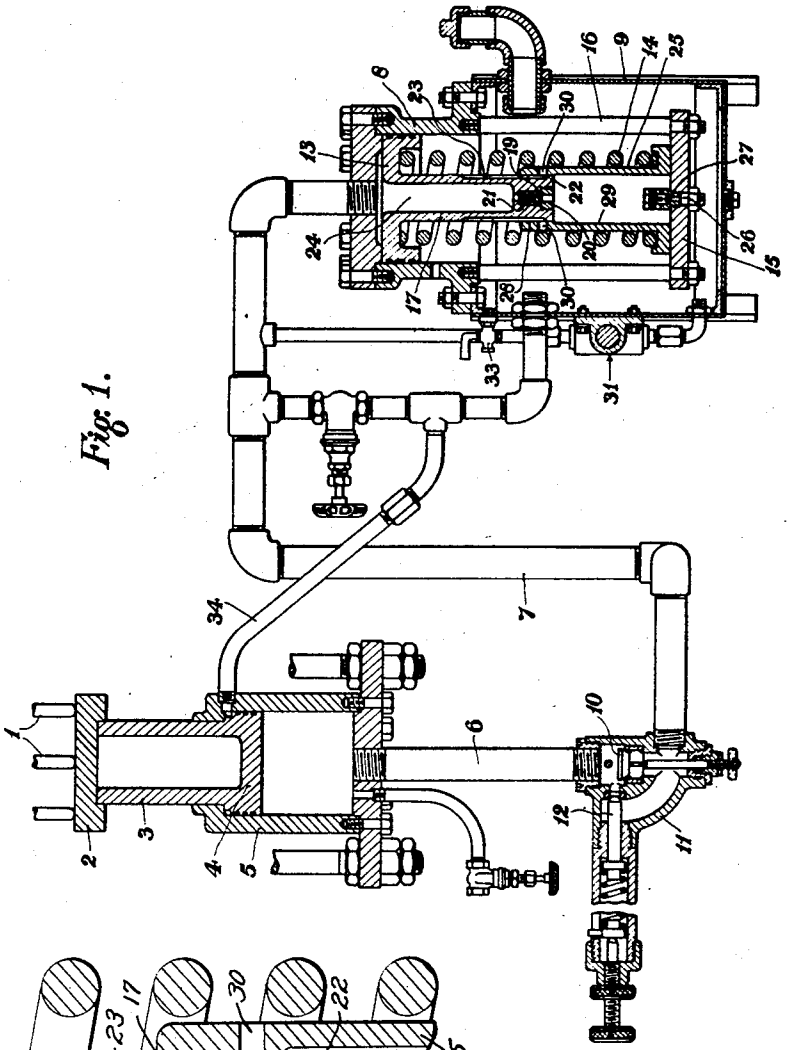


Fig. 1.

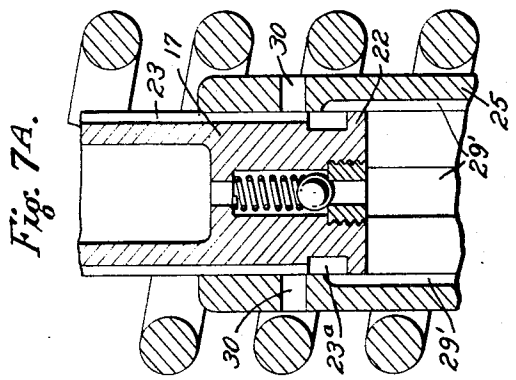


Fig. 7A.

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Fig. 2.

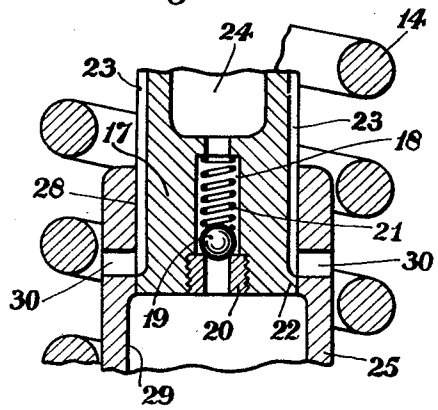
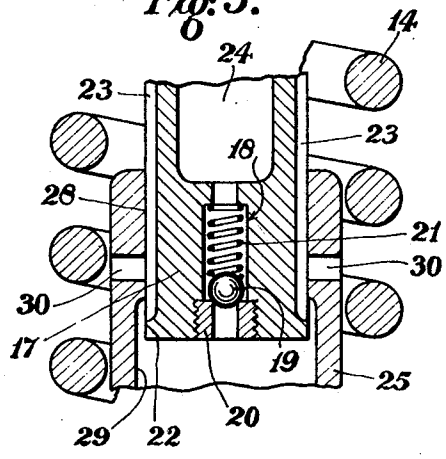


Fig. 3.



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Fig. 4.

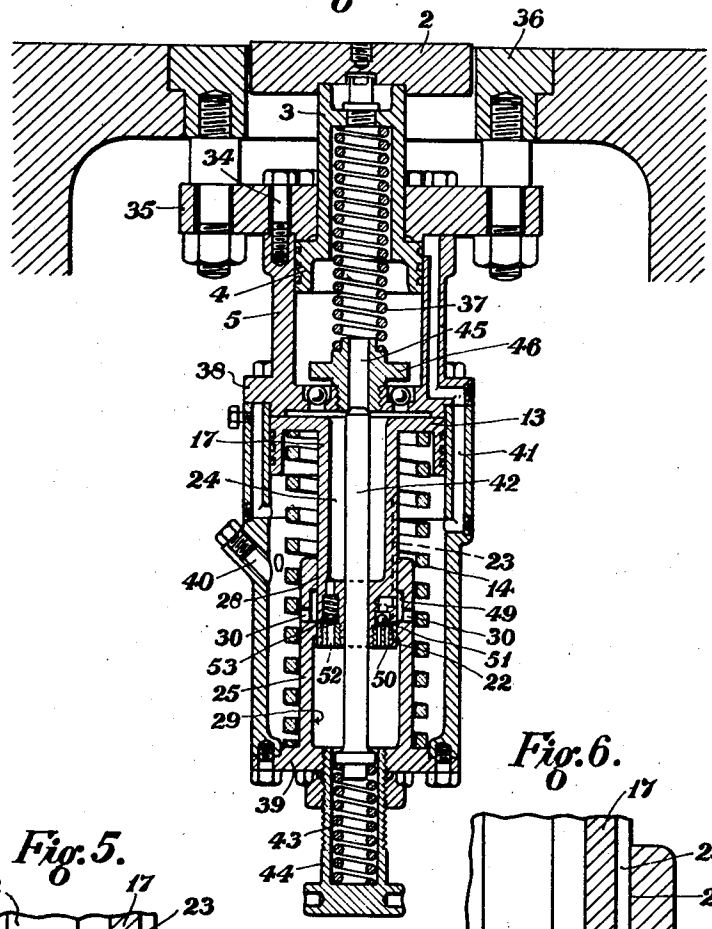


Fig. 5.

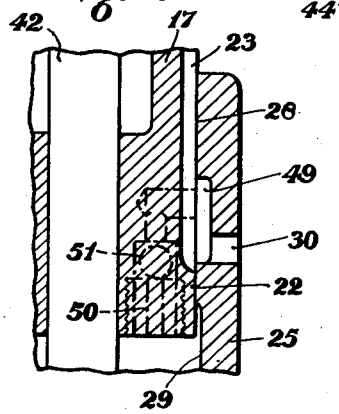
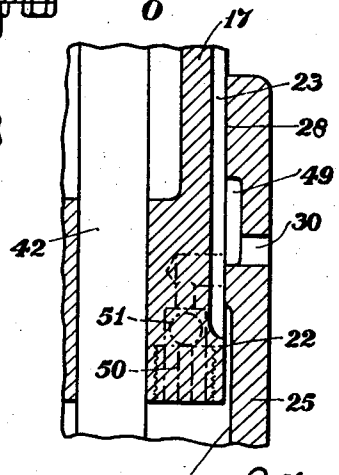


Fig. 6.



Inventor

By

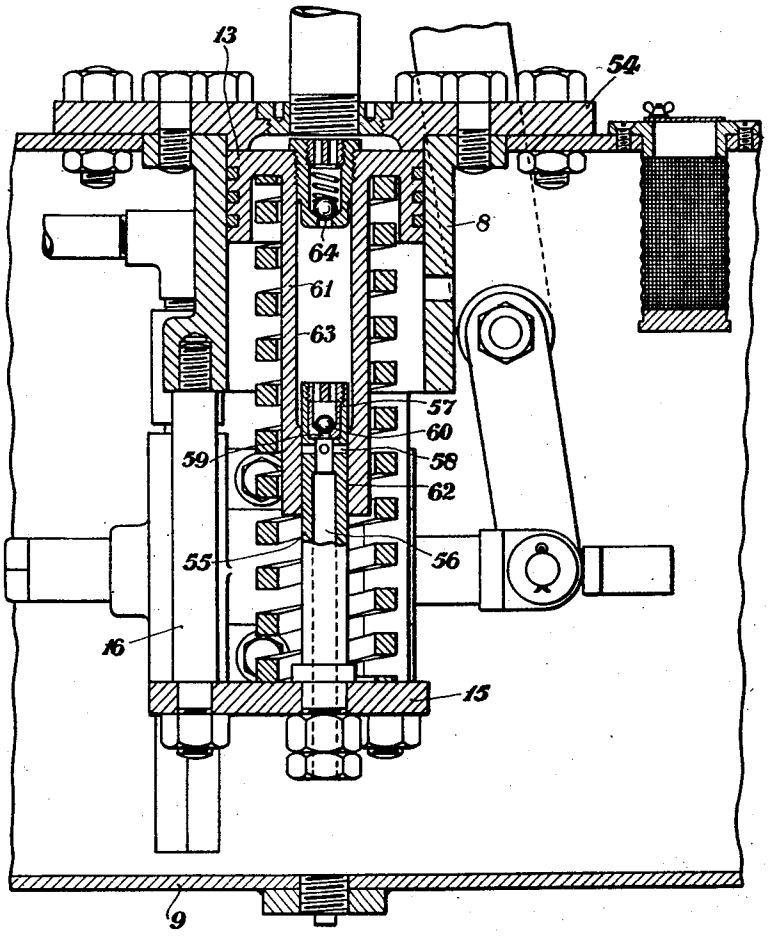
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PRESSURE CONTROLLING APPLIANCE

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Fig. 7.



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Patented July 15, 1952 2,603,477

UNITED STATES PATENT OFFICE

2,603,477

PRESSURE CONTROLLING APPLIANCE

Arthur Carter, Halesowen, near Birmingham, England

Application July 6, 1949, Serial No. 103,273
In Great Britain July 8, 1948

6 Claims. (Cl. 267—1)

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This invention relates to pressure controlling or cushioning appliances applicable to presses for the drawing or cupping of sheet-metal articles from blanks in order to give a controlled resisting pressure to the downward movement of the draw ring, but also being applicable generally for the purpose of offering a controlled resistance to a moving part.

The said pressure controlling or cushioning appliances are of the kind in which a hydraulic fluid is acted upon by a main ram or plunger in a primary cylinder and is forced through a resistance opening or passage into a secondary cylinder in order to act upon and depress a piston therein, said piston operating against a spring or other elastic medium which returns the piston and displaced fluid when the applied force is relieved from the ram or main plunger, and a balancer pump, operated by a moving part of the appliance, being provided for automatically returning to the secondary cylinder a quantity of fluid to compensate for leakage past the plunger and piston in the primary and secondary cylinders.

In apparatus of the kind referred to, the pump has comprised a stationary member and a movable member operated by the piston in the secondary cylinder, the movable member having in it a port or recess which comes to a position that will allow fluid to enter the pump cylinder only after the said piston has moved through a certain distance, with the result that the pump will not charge effectively for small movements, and therefore, during small movements of the main ram, leaking fluid is not replaced and the said ram tends to fall lower and lower in its cylinder.

The object of the present invention is to provide a pressure controlling or cushioning appliance, of the kind referred to, having an improved form of pump which will ensure an effective pumping operation with either large or small movements of the main ram and secondary piston.

According to the invention, a pressure controlling or cushioning appliance, of the kind referred to, is provided with a balance pump, for replacing leakage fluid, comprising plunger and cylinder members, one of which is carried by the piston in the secondary cylinder, and is characterised by the fact that inlet and outlet passages each controlled by a one-way valve are provided respectively for admitting fluid into the pump cylinder from a fluid-containing vessel and for discharging fluid from said cylinder into

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a space above the piston in the secondary cylinder, and that a relief passage or space is provided in the wall of the pump cylinder for co-operation with the pump plunger, the arrangement being such that pumping takes place only while the piston in the secondary cylinder is moving within an upper portion of its full range of stroke limited between the maximum top position and a position at a predetermined distance below said top position, the relief passage or space in the pump cylinder wall being ineffective during this portion of the stroke but co-operating with the pump plunger to connect the working space of the pump cylinder to exhaust during movement of the secondary cylinder piston below said lower pumping-limit position.

In one form of the invention the pump comprises a plunger having behind the head portion a passage or space leading to the fluid-containing vessel, said plunger being relatively movable in a cylinder having two internal diameters the smaller of which corresponds to the diameter of the plunger head, or having relief grooves or channels in one portion, so that pumping takes place only while the plunger head is moving within the smaller diameter or unrelieved portion of the cylinder, the pumping being stopped when the said passage or space of the plunger is uncovered by the larger diameter or relieved portion of the cylinder.

The pump may be submerged in fluid contained in a feeder tank with which the primary and secondary cylinders communicate, said feeder tank being furnished with a hand-pump for charging fluid into the main cylinder.

Figure 1 of the accompanying drawings is a sectional elevation of an appliance for controlling the downward movement of the pressure or draw ring of a press, in accordance with one form of the invention.

Figure 2 is a sectional view, on a larger scale, of a portion of the pump, the plunger being shown in the same position as in Figure 1.

Figure 3 is a similar view to Figure 2, but shows the plunger when depressed from its position in Figures 1 and 2.

Figure 4 is a vertical section through a hydraulic cushioning appliance in accordance with another form of the invention.

Figure 5 is a section, on a larger scale, through a portion of the pump employed in this modification, the plunger being shown in the same position as in Figure 4.

Figure 6 is a similar view to Figure 5, but shows

the plunger depressed below the position in Figures 4 and 5.

Figure 7 represents a section through an appliance having a modified form of pump.

Figure 7A shows a modified form of relief passage in the pump cylinder.

Referring to Figures 1 to 3 of the said drawings, which show a convenient embodiment of the invention in connection with an appliance for controlling the downward movement of the pressure or draw ring of a press, the pins 1 depending from the said ring (not shown) rest upon a pressure plate 2 supported upon the upper end of the shank 3 of a main ram or plunger 4 movable in a primary cylinder 5 the lower end of which is connected by a main pipe or conduit, composed of pipe sections 6, 7, to the upper end of a secondary cylinder 8 mounted on the top of a feeder tank 9 adapted to contain a hydraulic fluid.

An upwardly-opening one-way valve 10 is fitted in the said main pipe or conduit, between the pipe sections 6, 7, so as only to allow fluid to pass freely in an upward direction for charging the primary cylinder 5, but this one-way valve is bypassed by a branch passage 11 fitted with a spring-loaded pressure controlling valve 12, forming the subject-matter of application No. 103,272, which offers a resistance to the passage of fluid from the primary cylinder 5 to the secondary cylinder 8 under the effect of downward pressure exerted upon the main ram 4 by the draw ring.

The secondary cylinder 8 is open at its lower end to the interior of the feeder tank 9, and it contains a control piston 13 adapted to be depressed, by the fluid admitted into the cylinder, against the upward force exerted by a coiled compression spring 14 applied beneath the head of the piston and supported at its lower end upon a stationary thrust plate 15 suspended from the lower open end of the cylinder, in spaced relation thereto, by means of long bolts 16.

The said control piston 13 in the secondary cylinder 8 carries a depending stem adapted to constitute the plunger 17 of a balancer pump. This plunger 17 has a central axial passage 24 through it, this passage opening at its upper end into the space above the control piston 13 and terminating at its lower end in a valve chamber 18 containing a ball valve 19 (Figures 2 and 3) co-operating with a seating at the upper end of a passage in a plug 20 screwed into the lower end of the valve chamber. The ball valve 19 can open upwards against a spring 21 to allow fluid to pass to the top face of the control piston but closes on to its seating to prevent fluid from flowing through the axial passage in the reverse direction. The plunger 17 has a solid head portion 22 at its lower extremity, and above this head portion longitudinal grooves 23 are formed in the sides of the plunger, these grooves extending to positions near the middle of the length of the plunger, as shown in Figure 1.

The said plunger 17 slides within a stationary pump cylinder 25 surrounded by the compression spring 14 and resting at its lower end upon the thrust plate 15 that supports the said spring. An aperture 26 controlled by an upwardly-opening ball valve 27 is provided in the thrust plate 15, so that fluid can enter the cylinder 25 from the feeder tank 9 but cannot be discharged from the cylinder through the bottom passage. The cylinder 25 has two internal diameters, the upper portion of the cylinder having a bore 28 exactly corresponding to the diameter of the pump plunger head 22, which has a sliding fit therein, and the lower bore portion 29 being of larger interior diameter which, when the plunger head 22 is in this enlarged portion, forms a pressure-relief passage or clearance space around the said head. Just above the junction of the two diameters 28, 29, the wall of the upper part of the cylinder has ports 30 therein.

The feeder tank 9 is provided with a hand-operated pump, indicated at 31, from which an outlet pipe 32 is connected with the pipe 7 forming part of the pipe line between the two cylinders 5, 8. By operating the pump fluid can be charged into the system so as to fill the primary cylinder 5 and the pipes 6, 7, between the two cylinders.

In the operation of the appliance, the feeder tank 9 is supplied with fluid up to a suitable level, which may be determined by a pet cock 33, and this fluid enters the pump cylinder 25 through the lower end, the ball valve 27 rising to admit the fluid. When the system has been charged by the hand pump, the appliance is ready to function. When the main ram 4 is depressed, the fluid in the primary cylinder 5 is displaced and is forced through the resistance passage formed by the spring-loaded valve 12, into the upper end of the secondary cylinder 8, thereby depressing the piston 13 therein against the action of the spring 14. When the force applied to the ram is relieved, the spring 14 asserts itself and raises the piston 13 in the secondary cylinder, which thus returns the fluid above it to the primary cylinder 5, by way of the one-way valve 10 in the connecting pipe, thereby causing the ram 4 to be raised.

Any fluid that leaks past the ram 4 in the primary cylinder is transferred to the feeder tank 9 through a pipe 34 connecting the top of said cylinder to the tank; and any fluid leaking past the piston 13 in the secondary cylinder drains directly into the tank. It is necessary to supply fluid to the system to compensate for that which has leaked past the ram and piston, and this effected by the balancer pump which operates so as automatically to restore to the system a quantity that balances the amount of fluid that has leaked. Thus, during each downward movement of the control piston 13 in the secondary cylinder, the pump plunger head 22 first moves a certain distance downwards in the upper bore portion 28 of the pump cylinder 25 which is of smaller diameter (Figure 2), and during this initial movement pumping takes place due to the fluid in the cylinder being displaced upwardly past the ball valve 19 in the plunger stem and through the axial passage 24 to the upper face of the control piston 13. When, however, the pump plunger 17 has descended so far that the longitudinal grooves 23 above its head 22 enter the enlarged lower portion 29 of the cylinder bore, as in Figure 3, pumping ceases, as the working space of the pump cylinder is connected to exhaust, the fluid displaced from the cylinder 25 flowing upwardly along the longitudinal grooves 23 into the feeder tank. Some of this displaced fluid can also enter the tank through the ports 30 in the wall of the upper portion of the pump cylinder. On the upward stroke of the control piston 13, fluid can flow into the pump cylinder through the grooves 23 and ports 30 until the plunger head 22 again moves into the smaller bore 28 of the cylinder (Figure 2), and the filling of the pump cylin-

der 25 is then completed by drawing fluid into it through the bottom ball valve 27.

If the amount of fluid returned to the upper face of the control piston 13 is greater than the amount lost from the system by leakage, then the said control piston will not rise to the top of the secondary cylinder 8, and as the excess amount increases, so will the top position reached by the control piston be lowered. This results in the effective pumping throw of the pump being correspondingly reduced, as the grooves 23 above the pump-plunger head will reach the larger bore 29 of the cylinder after a shorter downward movement. Consequently the amount of fluid pumped back into the system will be proportionately reduced until a condition of balance is reached, when the amount of fluid returned to the system exactly balances the amount lost by leakage.

Rotation of plunger 17 relatively to cylinder 25 may be prevented by any convenient means so as to maintain the grooves 23 in alignment with ports 30. For example, another groove similar to grooves 23 may be provided in the plunger and engaged by a pin or peg carried by cylinder 25.

If the apparatus should be left inoperative for any lengthy period, the ram 4 in the primary cylinder can be allowed to drop by its weight and fluid that has leaked past it will collect above it. To get rid of this accumulated leakage fluid it is only necessary to recharge the primary cylinder by operating the hand pump 31, and the said leakage fluid will be displaced by the ascending ram and returned to the tank 9 by means of the pipe 34 provided for it. Thus, all the fluid leaking is returned directly to the tank, involving only a single system of piping.

Two or more primary cylinders may be connected to one secondary cylinder irrespective of whether they operate simultaneously or in sequence.

Figures 4 to 6 show a modification in which the primary and secondary cylinders are combined to form a self-contained unit apparatus. In this construction, the primary cylinder 5 is fixed by studs 34 to a cover plate 35 bolted to the bed ring 36 of the press, and the pressure plate 2 rests on the shank 3 of the main ram 4 working in the cylinder 5, said ram being supported on a spring 37. The secondary cylinder 8 is attached by bolts to the bottom plate 38 of cylinder 5, and is closed at its lower end by a plate 39, this lower portion of the secondary cylinder forming a sump for containing hydraulic fluid, and a filling orifice 40 being provided. Fluid that leaks past the ram 4 is returned to the cylinder 8 through a passage or passages 41 provided in the walls of cylinders 5, 8. The secondary piston 13 in cylinder 8 is supported upon a spring 14 resting on the bottom plate 39, and a vertical spring-loaded valve 42, equivalent to the valve 12 in Figure 1, is supported vertically upon a spring 43 contained within a housing 44 screwed into said bottom plate 39. This valve 42 co-operates with a seating at the lower end of a passage 45 in a nipple member 46 screwed into the centre of the bottom plate 38 of cylinder 5. When the ram 4 descends, fluid in cylinder 5 is displaced and forced past the valve 42 into the space above the secondary piston 13, which is thus depressed against the action of the spring 14. When the piston 13 rises, fluid is returned from cylinder 8 to cylinder 5 through passages 47, controlled by ball valves 48, provided in the plate 38.

The balancer pump comprises a plunger 17 (being the stem of piston 13) sliding over the valve 42, and having a head portion 22 which is a sliding fit in the smaller-diameter upper bore 28 of the pump cylinder 25 which is carried by the bottom plate 39, the lower bore 29 of said cylinder being of larger bore. An annular space 49 is provided around the smaller bore 28, from which ports 30 lead into the cylinder 8. Longitudinal grooves 23 are provided in the periphery of the plunger 17 above the head 22. A passage 50, controlled by a downwardly-opening ball valve 51, is provided between the lower face of the plunger 17 and at points on the outer periphery thereof above the head 22, whilst another passage 52, controlled by an upwardly-opening ball valve 53, connects the end face of the plunger to the space 24.

The operation of the pump is substantially the same as that shown in Figures 1 to 3. When the piston 13 is at the top of its stroke the head 22 of the plunger 17 lies within the smaller-diameter bore 28, as in Figure 5, and as the plunger descends with the piston 13, valve 51 closes and pumping takes place, fluid being displaced from cylinder 25 through passage 52 into the space 24 above the piston 13. When, however, the head 22 leaves the smaller-diameter bore 28 and is wholly within the larger-diameter bore 29, as in Figure 6, pumping ceases, as the working space is connected to exahust, the fluid merely flowing past the plunger head and through grooves 23 into the cylinder 8. On the upward stroke of piston 13, fluid can flow into the pump cylinder 25 through the grooves 23 and ports 30 until the plunger head 22 again moves into the smaller bore 28 of the cylinder (Figure 5), and the filling of the pump cylinder is then completed by drawing fluid into it through passage 50, the valve 51 being open.

If the amount of fluid returned to the upper face of piston 13 is greater than the amount needed for replenishing the system, then the piston 13 will not rise to the top of the cylinder 8, and as the excess amount increases so will the top position of said piston be lowered, resulting in a correspondingly reduced effective throw of the pump plunger.

In the modification shown in Figure 7, the pump plunger is stationary and the pump cylinder is movable. This pump is shown applied to an apparatus having separate primary and secondary cylinders connected by pipes, as in Figure 1. The secondary cylinder 8 is attached to a cover plate 54 secured to the top of tank 9 so as to depend therein. The pump plunger consists of an upstanding tube 55 supported upon the bottom thrust plate 15 which is connected to cylinder 8 by rods 16. The said plunger 55 has an axial passage 56 open to the tank at its lower end and provided, below the plunger head 57, with lateral ports or passages 58, whilst above these ports or passages is another passage 59 open to the end of the plunger but controlled by an upwardly-opening ball valve 60 that will allow fluid to pass upwards into the pump cylinder 61 but which prevents return flow. The said pump cylinder 61 consists of a hollow stem or tube depending from the control piston 13 in the secondary cylinder 8 and having a bore of two diameters, the lower portion 62 being of smaller diameter than the upper portion 63, which is enlarged. The said smaller bore 62 is of the same diameter as the plunger head 57, which thus has a sliding fit therein. When the control piston 13 is at the top of its stroke, as in Figure 7, the piston head 57 is in the smaller bore 62

of the cylinder with the lateral ports or passages 58 closed by the cylinder wall. When the control piston 13 starts to move downwards, the fluid in the pump cylinder 61 is forced through a non-return valve 64 in the upper end of said cylinder and thus into the space above the control piston 13. This pumping action continues until the lateral ports or passages 58 in the pump plunger reach the larger bore 63 of the cylinder, and when this occurs further pumping ceases, as the working space is connected to exhaust, the fluid displaced by the pump plunger being merely returned through the relief passage or clearance space then produced around the piston head, and through the uncovered relief ports and axial passage in the plunger, and thence into the tank.

If the amount of fluid pumped back into the system exceeds the amount that has leaked, then the control piston 13 will not rise to the top of the secondary cylinder 8 and the throw or effective stroke of the pump will be correspondingly reduced, since the lateral ports 58 will reach the enlarged bore 63 of the cylinder 61 after a shorter downward movement of the control piston. This reduction of pump throw proceeds until a condition of balance is reached and the amount of fluid returned to the system is equal to the fluid that has leaked.

When the control piston 13 rises, the pump cylinder 61 is recharged from the tank 9 through the axial and lateral passages 58, 59, in the plunger until the lateral ports or passages 58 are again closed by the smaller bore, when fluid continues to pass into the cylinder past the ball valve 60 in the pump plunger head.

It is to be understood that, in the arrangements in Figures 1 to 3, Figures 4 to 6 and Figure 7, instead of the relief passage or space being formed by making a portion of the pump cylinder of larger diameter than another portion, one or more longitudinal grooves or channels may be provided in the interior wall surface of that portion of the cylinder that corresponds to the said portion of larger diameter shown in the drawings. Thus, as shown in Figure 7A, as applied to the pump represented in Figures 1 to 3, the pump cylinder 25 may have a main interior diameter which corresponds to the diameter of the head 22 of plunger 17, and formed in the interior surface of the cylinder wall are a number of longitudinal grooves 29^1. The plunger 17 has an annular groove 23^a around it, above the head 22, and the longitudinal grooves 23 in the plunger lead into this annular groove. When the plunger moves downwards, as shown in Figure 7A, the groove 23^a overlaps the upper ends of grooves 29^1, which function as relief passages to allow the fluid to pass upwards through annular groove 23^a, grooves 23 and ports 30, into the liquid container.

I claim:

1. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in said secondary cylinder, an elastic medium in said secondary cylinder opposing the movement of said piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston, said pump consisting of plunger and cylinder members one of which is carried by the piston in the secondary cylinder, a one-way inlet valve for admitting fluid into the pump cylinder from the vessel, and a one-way outlet valve for discharging fluid from said pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and being provided behind the head portion with an exterior passage leading to the fluid-containing vessel, and the pump cylinder having an unrelieved portion of a diameter corresponding to the diameter of the plunger head portion and another portion having its wall recessed to provide a relief passage, so that pumping takes place only while the plunger is moving within the unrelieved portion of the pump cylinder, said pumping being stopped when the exterior passage of the plunger moves into the second-named portion of the pump cylinder.

2. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in said secondary cylinder, an elastic medium in said secondary cylinder opposing the movement of said piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston, said pump consisting of plunger and cylinder members one of which is carried by the piston in the secondary cylinder, a one-way inlet valve for admitting fluid into the pump cylinder from the vessel, and a one-way outlet valve for discharging fluid from said pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and being provided behind the head portion with an exterior passage leading to the fluid-containing vessel, and the pump cylinder having two internal diameters the smaller of which corresponds to the diameter of the plunger head portion, so that pumping takes place only while the plunger head portion is moving within the smaller diameter of the pump cylinder, the pumping being stopped when the exterior passage of the plunger enters the larger diameter portion of the pump cylinder.

3. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in said secondary cylinder, a spring in said secondary cylinder opposing movement of the said piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston to compensate for leakage, said pump consisting of a plunger carried by the piston in the secondary cylinder, a stationary cylinder in the fluid-containing vessel, a one-way inlet valve for admitting fluid into the pump cylinder from the vessel, and a one-way outlet valve for discharging fluid from said pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and being provided behind the head portion with an exterior passage leading to the fluid-containing vessel, and the pump cylinder having an upper portion of a diameter corresponding to the diameter of the plunger head portion and a lower portion having its wall recessed to provide a relief passage, so that pumping takes place only while the plunger is moving within the upper portion of the pump cylinder, said pumping being stopped when the exterior passage of the plunger moves into the lower portion of the pump cylinder.

4. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in said secondary cylinder, a spring in said secondary cylinder opposing movement of the said piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston to compensate for leakage, said pump consisting of a plunger carried by the piston in the secondary cylinder, a stationary cylinder in the fluid-containing vessel, a one-way inlet valve for admitting fluid into the pump cylinder from the vessel, and a one-way outlet valve for discharging fluid from said pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and being provided behind the head portion with an exterior passage leading to the fluid-containing vessel, and the pump cylinder having two internal diameters the smaller of which corresponds to the diameter of the plunger head portion, so that pumping takes place only while the plunger head portion is moving within the smaller diameter of the pump cylinder, the pumping being stopped when the exterior passage of the plunger enters the larger diameter of the pump cylinder.

5. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in the secondary cylinder, a spring in said secondary cylinder opposing movement of the piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston in the secondary cylinder to compensate for leakage, said pump consisting of a plunger carried by the piston in the secondary cylinder, a stationary cylinder in the fluid-containing vessel, a one-way inlet valve controlling a passage in the bottom of the pump cylinder, a one-way outlet valve controlling a passage in the plunger for discharging fluid from the pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and being provided above the head portion with a longitudinal exterior passage leading to the fluid-containing vessel, and the pump cylinder having an upper portion of a diameter corresponding to the diameter of the plunger head portion and a lower portion having its wall recessed to provide a relief passage, so that pumping takes place only while the plunger is moving within the upper portion of the pump cylinder, said pumping being stopped when the exterior passage of the plunger moves into the lower portion of the pump cylinder.

6. A hydraulic pressure-controlling appliance comprising a primary cylinder containing a hydraulic fluid, a pressure-applying ram in said cylinder, a secondary cylinder connected to the primary cylinder through a resistance passage, a piston in the secondary cylinder, a spring in said secondary cylinder opposing movement of the piston, a fluid-containing vessel, and a balancer pump for supplying fluid from said vessel to the space above the piston in the secondary cylinder to compensate for leakage, said pump consisting of a plunger carried by the piston in the secondary cylinder, a stationary cylinder in the fluid-containing vessel, a one-way inlet valve controlling a delivery passage in the plunger between the lower end thereof and the side surface, a one-way outlet valve controlling a passage in the plunger for discharging fluid from the pump cylinder into the space above the piston in the secondary cylinder, the pump plunger having a head portion and a longitudinal exterior passage leading to the fluid-containing vessel, and the pump cylinder having an upper portion which has a diameter corresponding to the diameter of the plunger head portion and has a recess therein co-operating with the delivery passage in the plunger and communicating with the fluid-containing vessel, and a lower portion the wall of which is recessed to provide a relief passage, so that pumping takes place only while the plunger is moving within the upper portion of the pump cylinder, said pumping being stopped when the exterior passage of the plunger moves into the lower portion of the pump cylinder.

ARTHUR CARTER.

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