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PRESSURE AND FORCE MULTIPLYING DEVICES

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2 Sheets-Sheet 2

FIG. 3.

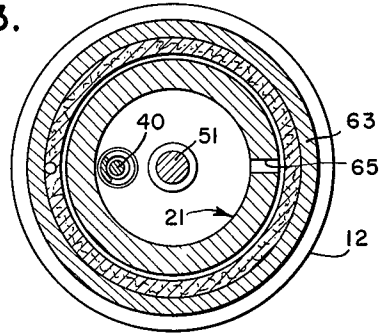


FIG. 4.

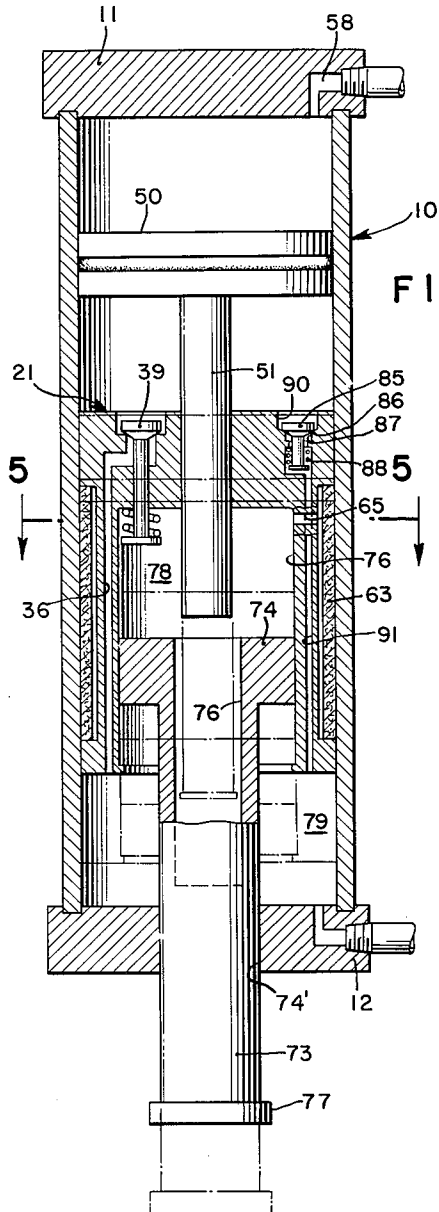


FIG. 5.

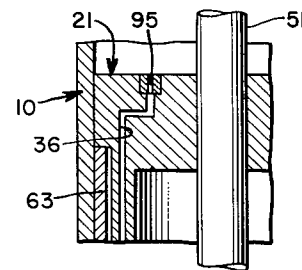
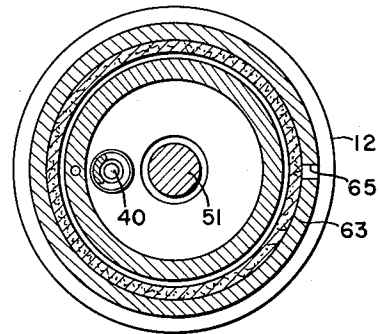


FIG. 6.

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PRESSURE AND FORCE MULTIPLYING DEVICES

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This invention relates to improvements in hydraulic devices for multiplying hydraulic pressures or mechanical forces produced by the pressures. The invention is disclosed herein in various forms which have application as a hydraulic pressure booster, as a pressure intensifier, as a two-stage pump or finally, as a device having any or all of these characteristics operable to directly produce mechanical force for example as a ram. As will appear hereinafter, the various forms of the invention have basic characteristics in common wherein improved means are provided for quickly increasing a hydraulic pressure, and for holding and/or applying and utilizing the said increased pressure.

The invention utilizes hydraulic pistons preferably operated pneumatically, that is, by air driven pistons with either single or double action.

The invention is characterized in the use of a floating hydraulic piston of relatively large size. By reason of its large size, it can relatively quickly build up the hydraulic pressure through an initial or first stage. In fact, this initial build up can be achieved in a single stroke if desired. A second and smaller piston extends through the head of the floating piston into the pressurized chamber. After the initial build up of pressure, the larger piston stops and the smaller piston operates to further build up or intensify, or boost the pressure in a second stage. This arrangement may operate as a stage pressure booster or pressure intensifier or it may operate it as a pump.

In a further form of the invention, means are provided to restrain or hold the floating piston in position after a predetermined boosted pressure has been reached. This arrangement adapts itself very well to operation as a two-stage booster or intensifier. Preferably, the means for restraining the floating piston operate automatically as will be described in detail hereinafter.

In a still further form of the invention, the arrangement is like that last described except that additional means are provided for directly transforming the boosted pressure into a mechanical force such as by a ram actuated by the boosted pressure. Preferably, the ram is formed as a part of a further piston operating in a bore in the floating piston. Also, preferably the ram and its piston have a bore adapted to receive the piston member which operates through the head of the floating piston. This makes possible further boosting and intensifying of pressure in the chamber, that is within the floating piston, and which acts upon the ram.

From the foregoing, it will be understood that a primary object of the invention is to provide improved, simplified, and more effective hydraulic means operative as a pressure booster and/or intensifier and in certain forms operable as a two-stage pump and as a device for producing mechanical force or thrust.

A further object is to provide an improved hydraulic device of the type referred to comprising a cylinder having a floating piston therein, a second piston having a stem or piston member extending through a bore in the head of the floating piston and means whereby the pistons may initially operate together to produce a first stage of fluid pressure increase, with the second piston then operating separately to produce a second stage of pressure increase.

Another object is to make possible the use of a device

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of the type of the foregoing object as a two-stage pump. Another object is to make possible the utilization of a device of the type of the previous objects as a pressure booster and/or intensifier.

5 Another object is to provide a hydraulic device as in the foregoing objects wherein there is normally air pressure between the two pistons while they are operating simultaneously, with automatic means for releasing the pressure for second stage operation wherein the second piston operates by itself to further amplify the pressure.

10 Another object is to provide additional means in devices of the type of the foregoing objects whereby the floating piston may be physically restrained after the first stage operation preferably by way of automatic pressure responsive means.

15 Further objects and many additional advantages of the invention will become apparent from the following detailed description and annexed drawings, wherein:

20 FIG. 1 is a diagrammatic sectional view of one form of the invention;

FIG. 2 is a diagrammatic sectional view of a second form of the invention; and

FIG. 3 is a sectional view taken along line 3-3 of FIG. 2;

25 FIG. 4 is a diagrammatic sectional view of a third form of the invention; and

FIG. 5 is a sectional view taken along line 5-5 of FIG. 4;

30 FIG. 6 shows a slightly modified form of the invention.

Referring now more particularly to FIG. 1 of the drawings, the device as exemplified in this figure comprises a cylinder or cylindrical member 10. The cylinder is closed at one end by an end member 11 and at the other end by an end member 12. The end member 12 has an inlet passage 14 in which is an inlet valve 15 and it has an outlet passage 17 in which is an outlet valve 19.

Within the cylinder 10 is a floating piston 21 having a piston head 22. The piston head 22 is sealed to the inside walls of cylinder 10 by way of a sealing ring 23 in an annular groove 25. The piston 21 has a depending cylindrical skirt 27 of smaller diameter having a flange or collar 28 on its lower end. The skirt 27 passes through a bore in a ring member 29 mounted on the walls of the cylinder 10 as shown. The skirt 27 is sealed against the member 29 by way of a sealing ring 31 in an annular groove 32 in the member 29. As may be seen, the skirt 27 is spaced from the walls of cylinder 10 to provide a space 34. The chamber within the lower part of cylinder 10 and within the skirt 27 is a hydraulic chamber normally occupied by hydraulic fluid such as oil.

40 Numeral 36 designates a channel through the head 22 of the floating piston 21 which provides for communication from the space above the head to the space 34 between the skirt 27 and the cylinder 10. Formed in this channel is a valve seat 38 and cooperating with the seat is a valve 39 on a stem 40 which is sealed by sealing ring 42. The end of stem 40 extends into the space inside of the skirt 27 and it is sealed to the lower side of the head 22 by a flexible sealing bellows 43. Numeral 44 designates a biasing spring within the sealing bellows 43 which normally urges the stem 40 in closing direction of the valve 39.

45 The ring member 29 has a channel 47 formed in it which provides communication to and from the space 34 as will be described more in detail presently.

70 Numeral 50 designates a second piston of a diameter to fit within the cylinder 10. Piston 50 has a stem 51 which is in the form of a third piston member extending through a central bore in the floating piston 21 and sealed by a sealing ring 52 in an annular groove 53 in the head

22. Numeral 55 designates a collar or disc on the end of stem 51 to limit its movement with respect to the head 22.

The upper end piece 11 has a channel 58 formed in it providing communication to and from the cylinder 10 above the piston 50 as will be described.

From the foregoing description, it will be understood that the pistons as described may be operated to pressurize hydraulic fluids such as oil in the lower part of the cylinder 10. The oil may be pumped into and out of the chamber within cylinder 10 and a pressure may be built up as will be described through a first stage and further through a second stage.

Preferably, the pistons of the hydraulic device are operated by fluid pressure and as shown they are operated by air pressure at for example 100 pounds per square inch. The air pressure may be supplied by an automatic or manually operated shuttle valve as designated at 57 controlling the supply of air pressure to and from the channels 47 and 58. Or if desired, instead of using a four-way valve, two three-way valves may be used.

In operation, at the start, normally the valve 39 is closed being held closed by the spring 44. At this time, there is pressure between the piston 50 and the floating piston 21. By operation of the valve or valves 57, the channel 47 is opened to atmospheric pressure and pressure at, for example, 100 pounds per square inch is applied to the chamber above piston 50. Due to the pressure between the pistons, they move downwardly together compressing, that is pressurizing, the hydraulic fluid in the lower part of the cylinder 10. Due to the relatively large size of the floating piston, the pressure can be built up relatively quickly. The ring 29 limits the downward stroke of the floating piston 21 and the collar 28 limits the upward stroke of this piston. One or several strokes may be made by the two pistons operating together while pumping hydraulic fluid in through the valve 15 and out through the valve 19 to any point of usage of the pressurized hydraulic fluid. The pistons are reciprocated by operating the valve or valves 57 by alternately pressurizing the chamber above piston 50 and releasing pressure from the space 34 and then pressurizing the space 34 and releasing pressure from above the piston 50.

When the pressure has been built up through the first stage to a predetermined value, the valve 39 is opened by the pressure in the chamber within the lower part of cylinder 10. This releases pressure from between the piston 50 and the piston head 22 through the channel 36 and the channel 47. The piston 50 is now operated independently of the floating piston 21. That is, pressure is applied above the piston 50 to drive it and the stem or piston 51 downwardly with pressure released from underneath the piston 50. When pressure is applied underneath the piston 50 and released from above it, it will move upwardly relative to the floating piston 21 which may now be in its uppermost position with the collar 28 engaging the lower edge of ring 29.

From the foregoing, it will be observed that the device will initially rapidly pressurize the hydraulic fluid up to a certain pressure by reason of the relatively large area of the floating piston 21. Hydraulic fluid may be pumped at this pressure. During the second stage, the pressure is boosted considerably. This boosting pressure is accomplished using a predetermined air pressure which boosts the hydraulic pressure to a considerably higher value by reason of the difference in area of the pistons 50 and 51. The device may pump into and out of the chamber and cylinder 10 during the second stage as well. It is to be seen, therefore, that the device is a pressure booster and intensifier as well as a two-stage pump.

FIG. 2 shows another form of the invention which is adapted primarily as a two-stage intensifier but which may also be readily adapted to operate as a two-stage pump.

The parts of this form of the invention which are the same as and correspond to similar parts of the previous

embodiment of the invention are similarly numbered. The floating piston 21 in the present embodiment is somewhat longer. The bottom plate or head 12 as shown does not have inlet and outlet channels but instead has only a single channel 60 but may be modified as described hereinafter. In the present embodiment, means are provided to restrain or lock floating piston 21 after the first stage of operation which operation is similar to that described in connection with the previous embodiment. After the first stage of operation in addition to the pressure being released from underneath the piston 50, the floating piston 21 is physically restrained in position. The floating piston 21 has a part 61 of larger diameter extending downwardly from the head 22. This part has an external annular opening or depression 62 in which is disposed the restraining or brake member which is a cylindrical member made of flexible braking material as designated at 63. The bore within the floating piston communicates with the opening or space 62 through a channel 65 so that pressure may be applied to the inner surfaces of the braking member 63 to compress it outwardly with restraining effect against the inside of the walls of the cylinder 10. If desired, circular seals may be used in both ends of the annular depression or opening 62 with a coil spring, for example, urging them axially so as to provide a seal for the space on the inside of the braking member. The valve 39 provides for release of pressure from underneath the piston 50 by way of the channels 36 and 67.

In the operation of the present form of the invention, it may be operated as a single stroke two-stage intensifier if desired. That is, pressure is released similarly to the operation of the previous embodiment from the space 34 and applied to the space above the piston 50. The two pistons move down together increasing the pressure in the lower part of the cylinder 10 as described in the previous embodiment. If desired, the operation may be such that the pressure is increased in a single stroke sufficiently to operate the valve 39 to release the pressure from below piston 50. The brake means 63 is so adjusted or set that at the same time, the pressure in the bore of the floating piston passing through the channel 65 will act on the brake member to firmly restrain or hold the floating piston. The floating piston will at this time be in its downward position with substantial pressure within the lower part of cylinder 10. By reason of the braking or restraining action holding the floating piston in this position, the pressure is held or maintained while the piston 50 now acts independently to move downwardly moving the stem 51 into the pressurized chamber to further increase and intensify the pressure.

It should be understood that pressures developed by this embodiment of the invention as well as the previous embodiment, may be utilized wherever desired such as in actuating cylinders or in any type of hydraulic equipment or hydraulically operated presses or the like.

While the foregoing has described one shot operation of the equipment, it is also readily adaptable to be operated in a manner similar to that of the previous embodiment. As so modified, valves are provided in the lower plate or head 12 corresponding to those of the previous embodiment. With such modification, the equipment may be operated as a two stage pump corresponding to the operation of the previous embodiment. However, the set up is such that at the end of the first stage operation, the pressure has built up to a valve to operate the braking or restraining means to lock or hold the floating piston. Thus, the floating piston is held in a position to maintain the pressure which has been built up and the pistons 50 and 51 then operate to build up the pressure through the second stage.

FIGS. 3 and 4 show another form of the invention which is similar to that of the previous embodiments with similar corresponding parts similarly numbered. In the present form of the invention, the floating piston does not have the same depending skirt as the previous

forms of the invention. In this form of the invention, there is provided a ram 73 which extends through a bore 74 in the lower head or plate 12 at the end of cylinder 10. The ram has a piston part 74 which operates in the bore 76 within the floating piston 21. The ram 73 itself has a bore 76 large enough to receive in it upon downward movement the end of the piston or stem 51 which does not have a collar at its lower end. In the present form of the invention, an additional discrete pressure chamber is formed which is identified by the numeral 78 within the floating piston. The brake member 63 communicates with the chamber 78 of the device through the channel 67.

In all forms of the invention a relief valve 85 may be provided in piston 21. As shown, it seats on a seat 86 at the end of a counterbore 87. The valve is urged closed by spring 88 requiring a predetermined pressure to open it. The valve provides communication from bore 90 through a channel 91 in the depending part of piston 21 so as to be able to relieve excess pressure in chamber 79.

In the operation of the device of the present form of the invention, the piston 50 and floating piston 21 may be initially operated in the manner described in connection with the previous embodiments. With pressure applied above piston 50 and released from the chamber below piston 75, all pistons move down together. This may constitute an initial or approach stroke of the ram 73. If the ram 73 meets resistance, then the pressure in the chamber 78 will be increased by virtue of relative movement of piston 75 in bore 76 in the floating piston. The pressure acting through the channel 67 will operate the brake 63 arresting movement of the floating piston. The increased pressure in chamber 78 will open the valve 39 releasing pressures from underneath the piston 50 so that it is able to move down independently, thrusting the stem or piston 51 into the chamber 78 and into the bore 76 and thus increasing and intensifying the pressure acting on the ram 73. The down stroke of the ram 73 may be completed at this increased pressure or if the resistance met by ram 73 is overcome, this will relieve the pressure in chamber 78 releasing the brake and closing the valve 39 and again allowing all pistons to move downwardly together. The stroke may be completed with all pistons moving together or if the ram 73 again meets the resistance the cycle just described may be repeated. In the upstroke of the present embodiment, pressure is applied in the chamber 79 in the lower part of cylinder 10 which initially causes all pistons to move upwardly. The ram 73 moves upwardly until the collar 77 on its end engages the plate 12. The pressure in chamber 78 builds up, the valve 39 opens and the piston 50 moves to its upper position.

FIG. 6 shows a slightly modified form of the invention wherein a restricted orifice 95 is substituted for the valve 39. This form of the invention has operating characteristics similar to the other form. The characteristics will be modified to the extent that the change in pressure below piston 51 will depend on the rate of flow through orifice 95 and its rate of movement will be similarly modified.

From the foregoing, those skilled in the art will observe that the invention provides a hydraulic device which achieves and realizes the objects stated in the foregoing and possesses the advantages outlined. An improved and simplified device is provided for conveniently and readily boosting and intensifying a hydraulic pressure to be used wherever needed. The device is a simplified and effective two-stage apparatus which is strong and rugged, not requiring any particular maintenance. It is further adaptable in various forms for operation as a two-stage pump. The apparatus in one of the forms provides a simplified, convenient and effective device for

producing mechanical force or thrust in the desired degree. This device is also able to operate in stages operating to automatically increase or intensify the force in proportion to the resistance that is met.

The foregoing disclosure is representative of preferred forms of the invention and is to be interpreted in an illustrative rather than a limiting sense, the invention to be accorded the full scope of the claims appended hereto.

What is claimed is:

1. A stage pressure device comprising a cylinder having floating piston means therein operable to compress a fluid within a chamber, a second piston in the cylinder spaced from the first piston and having a third piston member extending through a bore in the floating piston into the said chamber, said first and second pistons normally having a fluid pressure therebetween, means for applying a fluid pressure for moving said pistons simultaneously to compress a fluid in said chamber, and means for releasing pressure from between the first and second pistons whereby said second piston moves relative to the floating piston, said third piston member moving into said chamber to intensify the pressure therein.
2. A mechanism as in claim 1 wherein said fluid pressure operating means comprises means for driving said first and second pistons together in both directions.
3. A mechanism as in claim 1 wherein said floating piston comprises portions of larger and smaller diameter, means sealing the portion of smaller diameter to provide a space between the said cylinder and the portion of smaller diameter and means for admitting pressure to said space for moving the pistons in one direction.
4. A mechanism as in claim 1 wherein said means for relieving pressure from between the pistons comprising a valve in the head of said floating piston.
5. A structure as in claim 4 wherein said valve means is responsive to pressure developed in said chamber whereby upon development of a predetermined pressure therein the pressure is released from between said pistons.
6. A device as in claim 1 wherein said floating piston has a bore in it open at one end.
7. A device as in claim 1 including means for restraining movement of the floating piston while the second piston moves relatively thereto.
8. A device as in claim 7 wherein the said restraining means is responsive to pressure developed in said chamber.
9. A device as in claim 8 wherein said restraining means comprises an expansible sleeve around a part of said floating piston and engageable with adjacent walls of the cylinder.
10. A device as in claim 9 including means for admitting pressure to said expansible sleeve means for activating said sleeve means.
11. A device as in claim 1 wherein said chamber has inlet and outlet valves communicating therewith so that the device may operate as a two-stage pump.
12. A device as in claim 1 including a fourth piston moving in a bore within said floating piston and having a part thereof extending exteriorly of said cylinder.
13. A device as in claim 12 wherein said fourth piston has a bore in it open at one end positioned to have the said third piston member extending from the second piston move thereinto.
14. A device as in claim 1 including a fourth piston having a part extending exteriorly of said cylinder and movable in response to pressure in said chamber.

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