May 9, 1944. S. SCHNELL 2,348,367

COMPOUND MASTER CYLINDER

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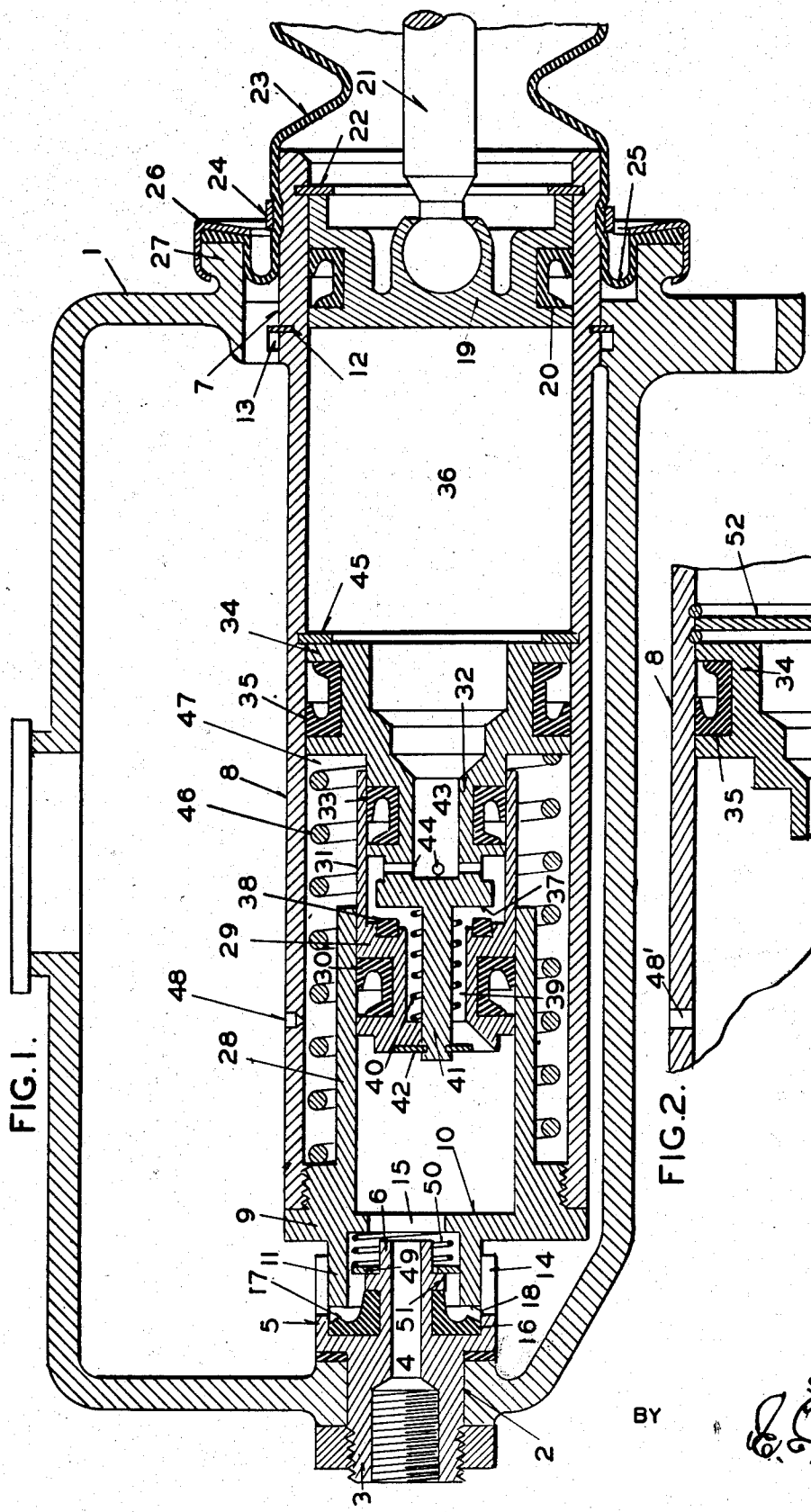


FIG. 1.

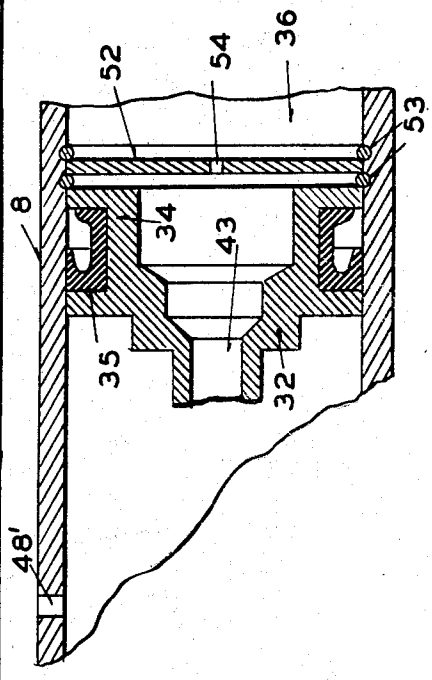


FIG. 2.

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COMPOUND MASTER CYLINDER

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9 Claims. (Cl. 60—54.6)

My invention relates to master cylinder devices for fluid pressure actuated systems, and more particularly to a compound master cylinder wherein the pressure created may be increased without proportionally greater increase in the applied operating force.

One of the objects of my invention is to provide an improved compound master cylinder which will permit transition from the low pressure producing means to the high pressure producing means in a smooth manner.

Another object of my invention is to produce a compound master cylinder wherein no compensating portholes are employed which must be passed by sealing cups associated with the pressure producing pistons.

A more general object of my invention is to produce a compound master cylinder which is efficient in operation and economical to manufacture.

Other objects will become apparent from the following description taken in connection with the accompanying drawing in which Figure 1 is a sectional view of a master cylinder device embodying my invention, and Figure 2 is a sectional view showing a modified construction thereof.

Referring to Figure 1 in detail, 1 indicates a reservoir casing provided with an opening 2 at its forward end in which is mounted a plug 3 having an outlet passage 4 therein to which is adapted to be connected the usual conduit leading to the fluid motor or other device to be actuated by fluid pressure. The inner end of plug 3 is provided with a cylindrical flange 5 and a central projection 6 through which the outlet passage extends. The rear end of the casing is provided with an enlarged opening 7, the axis of which is offset with respect to the axis of the forward opening 2 in which the plug is positioned.

Within the reservoir casing is positioned a cylinder 8 mounted for limited reciprocable movement. The forward end of this cylinder has mounted thereon a member 9 forming an end wall 10 for the cylinder. This member 9 is provided with a cylindrical extension 11 adapted to be slidably received in a flange 5 of plug 3 whereby a support is established for the forward end of the cylinder 8. The rear end of the cylinder extends through the opening 7 in the reservoir casing, the wall of said casing forming a bearing support for the cylinder. In order to limit the amount of reciprocation of the cylinder, the rear end of the cylinder carries a ring 12 which projects into an annular groove 13 in the wall of the casing.

The flange 5 on plug 3 is provided with slots 14 which permit the reservoir to communicate with outlet passage 4 and with the interior of cylinder 8 through the cylindrical extension 11 and an opening 15 in member 9. Positioned in the annular space between flange 5 and the extension 6 of plug 3 is a sealing member 16 of rubber or like material having an annular ridge 17 for cooperation with the flat end surface 18 on the cylindrical extension 11. Thus it is seen that when the cylinder 8 is moved forwardly, slots 14 will be closed and the sealing member 16 will be engaged and compressed, thereby preventing communication between either the cylinder 8 or outlet passage 4 and the reservoir.

Positioned in cylinder 8 at the rear end thereof is a piston 19 having a packing cup 20. A piston rod 21 is connected to the piston for actuating it by either the foot of the operator or by some other means. A stop 22 limits the retractile movement of the piston. A dust boot 23 surrounds the piston rod and is clamped to the rear end of cylinder 8 by a clamping ring 24. This boot is also provided with an extension 25 which is adapted to be clamped by ring 26 to a flange 27 surrounding opening 7. Thus the boot extension seals the opening 7 and at the same time permits the cylinder to have its limited reciprocable movement with respect to the reservoir casing.

Member 9, which is screwed into the forward end of the cylinder 8, carries an integral cylinder 28 which extends rearwardly into cylinder 8, said cylinder 28 being of smaller diameter than cylinder 8. Positioned for reciprocation in cylinder 28 is a piston 29 carrying a packing element 30. The rear end of this piston 29 is formed with a rearwardly projecting cylinder 31 and positioned for reciprocation in this latter cylinder is a piston 32 carrying a packing cup 33. The piston 32 is formed as a reduced extension on a larger piston 34 which fits the large cylinder 8 forwardly of the previously referred to piston 19 at the rear end of the cylinder. A packing cup 35 prevents fluid from passing the piston 34 from chamber 36 between said pistons 34 and 19.

The forward end of piston 32 is formed with a flat surface 37 which is adapted to engage a rubber valve seat 38 by the piston 29 and surrounding a passage 39 through said piston 29. The surface 37 is normally biased away from the valve seat 28 by a light spring 40 of predetermined strength which is interposed between pistons 29 and 32 and surrounds a connecting projection 41 which

projects through passage 39. A washer 42 on the end of projection 41 limits the separation of pistons 29 and 32 and also the extent of disengagement of surface 37 with valve seat 38. The cylinder 31 ahead of piston 32 is in communication with chamber 36 by a passage 43 extending through pistons 34 and 32 and connecting radial passages 44 at the forward end of piston 32.

The piston 34 is normally held against a stop 45 by a spring 46 which is interposed between piston 34 and the member 9 at the forward end of cylinder 8 and positioned in chamber 47 between cylinder 8 and the two inner cylinders 28 and 31. This spring 46 is of such predetermined strength that it will hold piston 34 against stop 45 until surface 37 and seat 38 are engaged. The chamber 47 is in constant communication with the reservoir by a small opening 48 in the wall of cylinder 8.

The friction between sealing cup 20 of piston 19 and cylinder 8 will insure that the cylinder will be moved with the piston when it is initially moved. Thus the valve means at the forward end of cylinder 8 can be closed before relative movement between the piston and cylinder takes place. In order to prevent any rapid flow of fluid from cylinder 8 to the reservoir in the event the piston should be moved quickly and thus have some relative movement with respect to the cylinder before the valve means at the forward end is closed, there is provided a washer 49 of slightly less diameter than the internal diameter of the cylindrical extension 11. A weak spring 50 maintains the washer in engagement with a shoulder 51 on the projection 6. Thus it is seen that the washer restricts the flow of fluid from the cylinder to the reservoir when the valve means is open. By restricting the flow of fluid, a pressure will be developed in cylinder 28 which can act on wall 10 and assist in moving cylinder 8 forwardly to close the valve means. Fluid may flow from the reservoir to the cylinder without appreciable restriction since the washer can be moved away from the shoulder by compressing the weak spring 50.

Referring to the operation of the master cylinder device, the parts will be in the positions shown in Figure 1 when the master cylinder is inoperative. The reservoir will be filled with fluid as will also the cylinder 8, including chambers 36 and 47 and cylinder 28. The valve means at the forward end of the cylinder will be open and thus any expansion or contraction of the fluid is permitted. It is also to be noted that in the inoperative position of the master cylinder, surface 37 will be disengaged from valve seat 38 and there will be free communication between chamber 36 and cylinder 28 ahead of piston 29.

When piston rod 21 is moved to the left to operate the master cylinder, piston 19 will also be moved to the left. Due to the friction between cup 20 and the wall of cylinder 8, the cylinder will be moved forwardly with the piston until surface 18 on the extension 11 engages the sealing member 16. The reservoir will now be cut off from communication with cylinder 28 and, of course, also with the outlet passage 4. As piston 19 is caused to continue to move to the left, it will have relative movement with cylinder 8 and pressure will be developed in chamber 36 whereby fluid under pressure will be forced through passages 43, 44 and 39 and then out through the outlet passage 4 to operate the fluid motors which are connected with said outlet passage as previously stated by a suitable conduit. As pressure is developed by piston 19, piston 34 will not be moved away from stop 45 due to the strength of spring 46. The fluid pressure being developed will act upon the wall 10 of member 9 and as a result, a force will be produced which will tend to maintain surface 18 in engagement with the sealing member 16. It is to be noted that this force will be proportional to the pressure being developed and, therefore, the greater the pressure developed, the greater will be the pressure tending to hold the valve means at the forward end of the cylinder in closed condition. It will be noted, however, that the sealing member cannot be excessively compressed as the movement of cylinder 8 forwardly is limited by the engagement of member 9 with the end of flange 5.

Since the diameter of cylinder 28 is greater than the diameter of cylinder 31, there will be a differential pressure acting on piston 29 which tends to force it to the right. When the pressure developed by piston 19 reaches such predetermined value that the differential pressure acting on the piston 29 will overcome spring 40 and move this piston rearwardly relative to piston 32, surface 37 will become engaged with valve seat 38 and consequently no more fluid can pass from chamber 36 to cylinder 28 ahead of piston 29. Seat 38 cannot be excessively compressed as this will be prevented by piston 34 engaging the rear end of cylinder 31.

After the closing of passage 39, the fluid in chamber 36 will be confined and will, therefore, act as a block between piston 19 and piston 34. Continued movement of piston 19 will cause piston 34 to be moved to the left away from stop 45, thereby compressing spring 46. As piston 34 moves, chamber 47 will be contracted but the fluid therein is free to escape to the reservoir through opening 48. As piston 34 moves, it will carry with it piston 29 and this latter piston will develop additional pressure in cylinder 28 and force it out through outlet passage 4. Since piston 29 is of smaller diameter than piston 19, the pressure developed will be at a higher ratio than that previously developed by piston 19. As previously mentioned, since the fluid in chamber 36 acts as a block, the result will be the same as if the piston rod 21 were acting directly on piston 29 to force it forwardly. When piston 29 becomes effective to develop pressure, less manual force will be necessary to increase the fluid pressure being developed.

When it is desired to release the developed pressure, piston 19 is permitted to be retracted. This will cause a drop in pressure in chamber 36 and consequently spring 46 will begin to expand and move piston 34 rearwardly. The piston 29 will also move rearwardly with piston 34 due to the previously developed pressure ahead of this piston acting thereon. The surface 37 will continue to remain engaged with seat 38 and this condition will prevail as long as the pressure ahead of piston 29 is above the predetermined value at which surface 37 was caused to engage seat 38. When piston 34 engages stop 45, then cylinder 8 will be caused to move rearwardly and open the valve means at the forward end of the cylinder and thus place the reservoir in communication with the system and relieve the remaining developed pressure. This will be brought about by the remaining developed pressure which will cause a differential force to act through piston 34 and stop 45 to cylinder 8 and thereby move the cylinder rearwardly. The opening of the valve means at the forward end of the cylinder will be assisted

by the friction of cup 20 as piston 19 continues to be retracted. When the valve means at the forward end of cylinder 8 opens, spring 40 will expand and disengage surface 37 and seat 38. When piston 19 is returned to its retracted position against stop 22 the parts will again assume their normal inoperative position as shown in Figure 1. If any sub-atmospheric pressure should tend to develop in cylinder 28 or in chamber 36 during the retractible movement of piston 19, fluid from the reservoir can flow therein through the open valve at the forward end of cylinder 8. If a large amount of fluid is required, washer 49 will be readily unseated from shoulder 51 and thus prevent any appreciable restriction to the flow.

If it is desired to release only a part of the pressure developed, piston 19 will be partially retracted, thus permitting pistons 34 and 29 to move rearwardly and cause a decrease in the previously developed pressure. The fluid pressure can be partially released down to the predetermined pressure at which surface 37 was caused to engage seat 38. If the pressure should be released below this point then the valve means at the forward end of the cylinder will be opened to relieve all the developed pressure. To again develop pressure, piston 19 will have to be again moved rearwardly.

When the master cylinder is employed as a pump to bleed the system with which it is associated, the forward movement of piston 19 will cause the closing of the valve means at the head of the cylinder in the usual manner as a result of the friction of the cup. The piston 34 will not be moved, nor will surface 37 be seated on the seat 38 as no great pressure can be developed due to the fluid system at the motors being open to accomplish the bleeding. Upon return movement of the piston 19, the friction of the cup moves cylinder 8 rearwardly and opens the valve means to reconnect the reservoir and permit the system to be replenished.

It is to be noted that the opening 48 is quite small. The reason for this is to prevent piston 34 from being moved away from stop 45 in the event piston 19 should be given a rapid initial movement. By having a small opening, fluid will be restricted from flowing from chamber 47 to the reservoir and thus it will act as a check against rapid movement of piston 34 thereby compressing spring 46 prior to spring 40 being compressed. Another means by which this same result can be accomplished is shown in Figure 2. Instead of having opening 48 small, it is made large as shown at 48'. The stop 45 for piston 34 is replaced by a partition 52 held in the cylinder by snap rings 53. This partition is provided with a small opening 54 to restrict the flow of fluid from chamber 36 to passage 43 through pistons 32 and 34. Thus it is seen that if there is a rapid initial movement of piston 19, the fluid pressure developed cannot act instantaneously on piston 34 and move it to the left as fluid under pressure cannot pass rapidly through the small opening 54.

Being aware of the possibility of modifications in the particular structure herein described without departing from the fundamental principles of my invention, I do not intend that its scope be limited except as set forth in the appended claims.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fluid pressure producing apparatus, a cylinder, an outlet for the cylinder, a piston in said cylinder, a second piston in said cylinder positioned between the first piston and the outlet passage and provided with a passage therethrough for permitting fluid pressure developed by the first piston to pass to the outlet, a spring for resisting the movement of said second piston, a second cylinder of smaller diameter than the first named cylinder positioned between the second piston and the outlet passage, a third piston in said second cylinder having a passage therethrough and provided with a cylindrical portion of smaller diameter than the small cylinder and extending toward the second piston, a fourth piston carried by the second piston and positioned in the cylindrical portion of the third piston so as to be subject to fluid pressure developed by the first piston, valve means carried by the third and fourth pistons for controlling the passages through the second and third named pistons, said valve means being controlled by a relative movement of the third and fourth pistons toward each other, means for biasing the two last named pistons apart and the valve means open, said valve means being caused to be closed when the pressure developed by the first named piston creates such a differential force as to move the third and fourth pistons toward each other and said valve means when closed causing fluid to be trapped between the first two named pistons whereby the second and third pistons can be actuated simultaneously with the first named piston against the resistance of the spring to thus cause the third piston to develop pressure.

2. In a fluid pressure producing apparatus, a reservoir, a member mounted for limited reciprocable movement in said reservoir and embodying therein two cylinders of different diameters, an outlet for the cylinders, means providing communication between the large cylinder and the outlet a piston in the large cylinder, means for actuating said piston, a piston in the small cylinder, valve means controlled by the reciprocable movement of said member for controlling communication between the reservoir and the cylinders, means for moving said member and closing said valve means by an initial movement of the piston in the large cylinder, said valve means when closed and the large piston moved relatively to its cylinder causing fluid pressure to be developed and forced out the outlet, means comprising valve means for cutting off communication between the large cylinder and the outlet and thereby cause fluid to be trapped in the large cylinder when the fluid pressure developed by the large piston is a predetermined value, and means for permitting the moving of the small piston through the medium of the trapped fluid to thus cause said small piston to develop pressure.

3. In a fluid pressure producing apparatus, a reservoir, a member mounted for limited reciprocable movement in said reservoir and embodying therein two cylinders of different diameters, an outlet for the cylinders, means providing communication between the large cylinder and the outlet, a piston in the large cylinder, means for actuating said piston, a piston in the small cylinder, valve means controlled by the reciprocable movement of said member for controlling communication between the reservoir and the cylinders, means for moving said member and clos-

ing said valve means by an initial movement of the piston in the large cylinder, said valve means when closed and the large piston moved relatively to its cylinder causing fluid pressure to be developed and forced out the outlet, means comprising valve means for cutting off communication between the large cylinder and the outlet and thereby cause fluid to be trapped in the large cylinder when the fluid pressure developed by the large piston is a predetermined value, and means for permitting the moving of the small piston through the medium of the trapped fluid to thus cause said small piston to develop pressure, said last named means comprising an additional piston in the large cylinder adapted to be connected with the piston in the small cylinder and a spring resisting movement of said additional piston until said passage through the piston in the small cylinder is closed.

4. In a fluid pressure producing apparatus, a reservoir, a member mounted for limited reciprocable movement in said reservoir and embodying two cylinders of different diameters, an outlet for the cylinder, a large piston in the large cylinder, means for actuating said piston, a small piston in the small cylinder, a passage through the last named piston, valve means controlled by the reciprocable movement of said member for controlling communication between the reservoir and the cylinders, means for moving said member and closing said valve means by initial movement of the large piston in its cylinder, said valve means when closed and the large piston moved relatively to its cylinder causing fluid pressure to be developed and forced through the passage in the small piston, through its cylinder and out the outlet, valve means for controlling the passage, a spring for biasing the valve means open, means for closing said valve means by a rearward movement of the small piston in its cylinder, means for causing a differential force to act on said last named piston to move it rearwardly to close the valve means against the bias of the spring when the piston in the large cylinder creates a predetermined pressure, said valve means when closed trapping fluid between the pistons, and means for permitting the large piston to move the small piston through the medium of the trapped fluid to thus cause said small piston to develop pressure.

5. In a fluid pressure producing apparatus, a reservoir, a member mounted for limited reciprocable movement in said reservoir and embodying two cylinders of different diameters, an outlet for the cylinders, valve means controlled by the reciprocable movement of said member for controlling communication between the reservoir and the cylinders, first and second pistons in spaced relation in the larger of said cylinders, means for moving the first piston toward the second piston to develop fluid pressure, a piston in the smaller of said cylinders, means forming a passage through the second piston and the smaller piston to the outlet passage, said second piston and the smaller piston being mounted for limited relative movement, means for biasing the last two named pistons away from each other, valve means for controlling said passage and being closed by relative movement of the second and smaller pistons toward each other by a differential force resulting from a predetermined pressure developed by the first named piston, and means for moving said member to close the first named valve means to thereby cut off the reservoir from communication with the cylinders when the first named piston is initially moved in a pressure producing direction.

6. In a fluid pressure producing apparatus, a reservoir, a cylinder mounted for limited reciprocable movement, an outlet for the cylinder, valve means controlled by the reciprocable movement of the cylinder for controlling communication between the reservoir and the cylinder, means comprising a piston within the cylinder for developing a low fluid pressure, a second piston in the cylinder having a passage therethrough and through which fluid is forced when the first piston is effective in developing pressure, a high pressure producing means comprising a third piston of smaller diameter than either of the first named pistons, means for moving said smaller piston by the second named piston, valve means controlled by relative movement between the second and third pistons for closing said passage when the first named piston has developed a predetermined pressure and to thereby trap fluid between the two first named pistons whereby force can be transmitted from the first named piston to the third piston and cause fluid pressure to be developed by the latter, and means for moving the cylinder to close the first named valve means when the first named piston is initially moved.

7. In a fluid pressure producing apparatus, a reservoir, a cylinder mounted for limited reciprocable movement, an outlet for the cylinder, valve means controlled by the reciprocable movement of the cylinder for controlling communication between the reservoir and the cylinder, means comprising a piston within the cylinder for developing a low fluid pressure, a second piston in the cylinder having a passage therethrough and through which fluid is forced when the first piston is effective in developing pressure, a high pressure producing means comprising a third piston of smaller diameter than either of the first named pistons, means for moving said smaller piston by the second named piston, valve means controlled by relative movement between the second and third pistons for closing said passage when the first named piston has developed a predetermined pressure and to thereby trap fluid between the two first named pistons whereby force can be transmitted from the first named piston to the third piston and cause fluid pressure to be developed by the latter, a spring for establishing a resistance to movement of the second piston until the pressure developed is the predetermined value necessary to close the second valve means, and friction means for moving the cylinder to close the first named valve means when the first named piston is initially moved.

8. In a fluid pressure booster for interpositioning between a pressure producing device and a member to be actuated, said means comprising a cylinder, a piston in said cylinder provided with a passage therethrough for permitting fluid pressure developed by the fluid pressure producing device to pass to the member to be actuated, a spring for resisting the movement of said piston, a second cylinder of smaller diameter than the first named cylinder positioned between the piston and the device to be actuated, a piston in said second cylinder having a passage therethrough and provided with a cylindrical portion of smaller diameter than said smaller cylinder and extending toward the large cylinder piston, a piston carried by the large cylinder piston and positioned in the cylindrical portion so as to be subject to fluid pressure developed by the fluid

pressure producing device, valve means for controlling said passages through the pistons, said valve means being controlled by relative movement of the small cylinder piston toward the piston carried by the large cylinder piston, and means for biasing the two valve controlling pistons apart and the valve means open, said valve means being caused to be closed when the pressure developed by the pressure producing device creates such a differential force as to move the valve controlling pistons toward each other and said valve means when closed causing fluid to be trapped between the pressure producing device and the first named piston whereby said first and the small cylinder piston can be actuated simultaneously against the resistance of the spring to thus cause the small cylinder piston to develop pressure.

9. In a fluid pressure producing apparatus, a reservoir, a cylinder, an outlet to be connected to a device to be actuated, a piston in said cylinder, a second cylinder of smaller diameter than the first named cylinder positioned between the first piston and the outlet, a piston in said second cylinder, a yieldable wall having an area greater than the second piston and being subject at all times to the pressure developed by the first piston, a passage through said last named piston, valve means for controlling the passage and comprising an element carried by the last named piston and an element carried by the yieldable wall, a spring for biasing the valve means open, means for closing said valve means by a movement of the last named piston toward the yieldable wall and without any movement of the wall, means for causing a differential force to act on said last named piston to close the valve means against the bias of the spring when the first named piston creates a predetermined pressure less than that necessary to cause yielding movement of the wall, said valve means when closed trapping fluid between said pistons and said wall being yieldable to permit the first named piston to move the second named piston through the medium of the trapped fluid to thus cause said second piston to develop pressure, and means for placing the second cylinder in communication with the reservoir without re-opening the valve means when developed fluid pressure is released by retractile movement of the first piston.

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