Feb. 17, 1948. S. SCHNELL 2,436,268

FLUID PRESSURE COMPOUNDING SYSTEM

Filed July 2, 1943 2 Sheets-Sheet 1

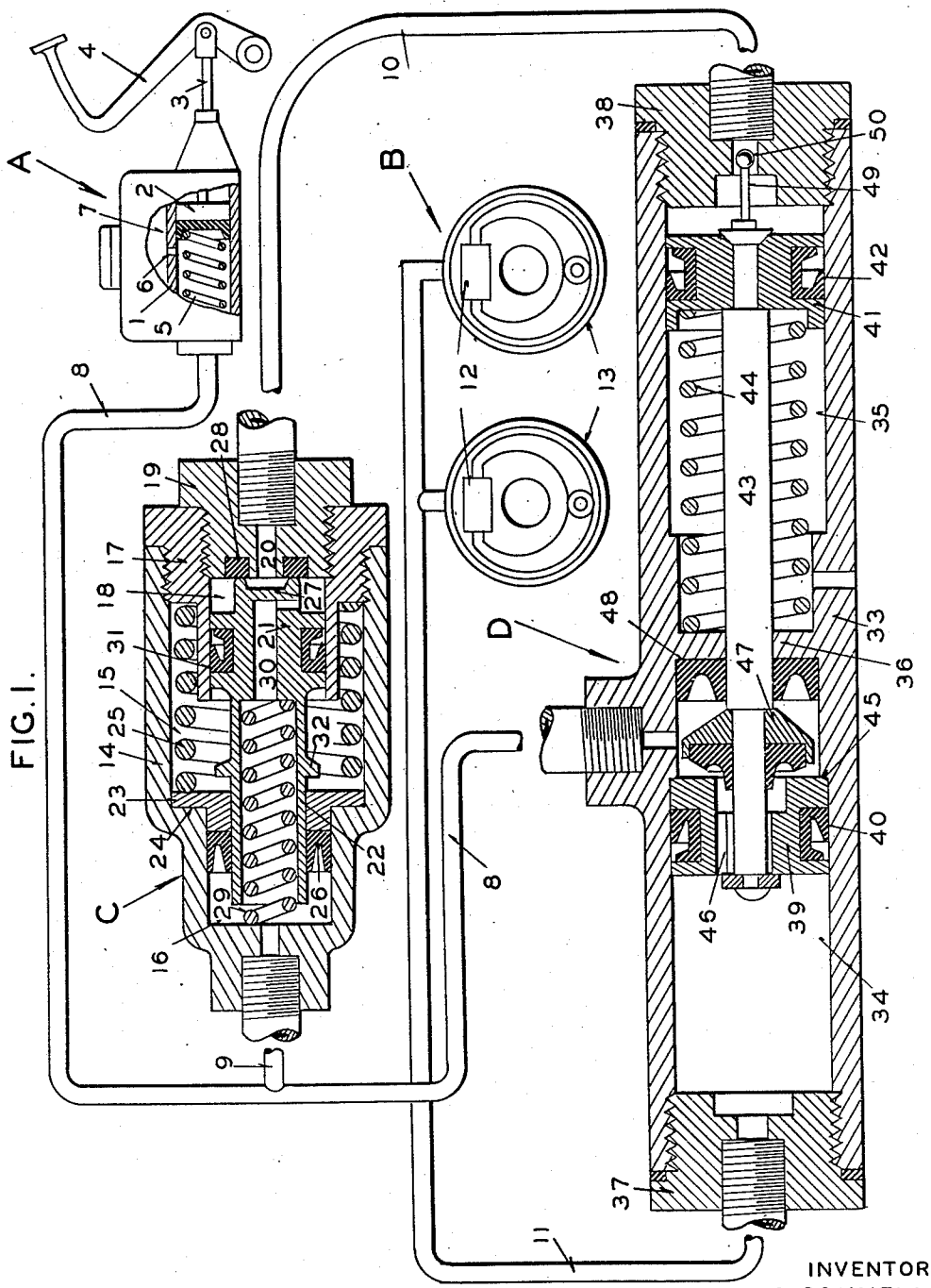

FIG. 1.

INVENTOR
S. SCHNELL

BY E. E. Kuffman

ATTORNEY

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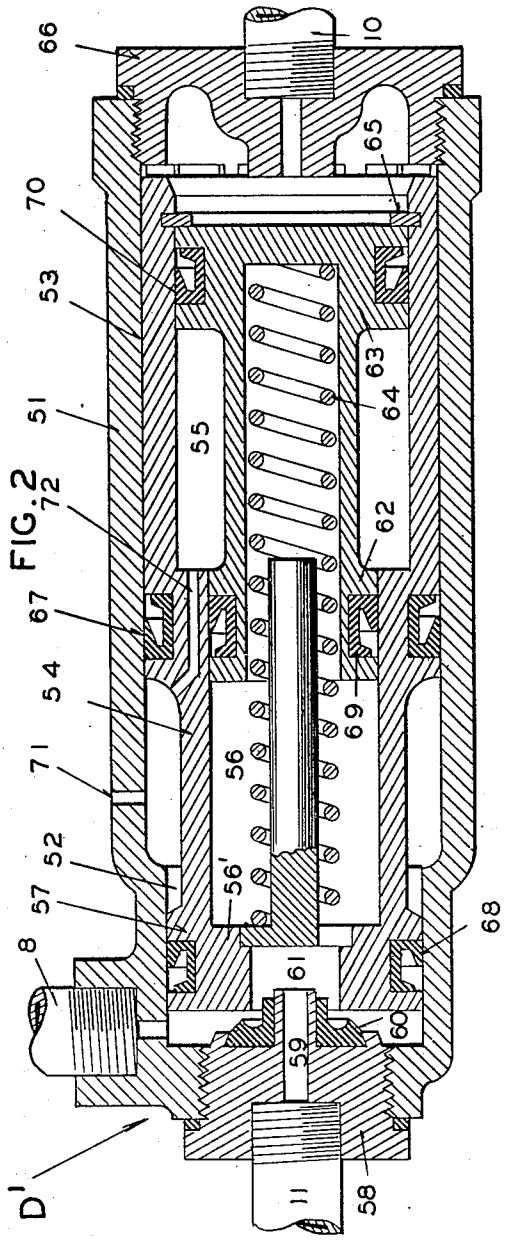

FIG. 2.

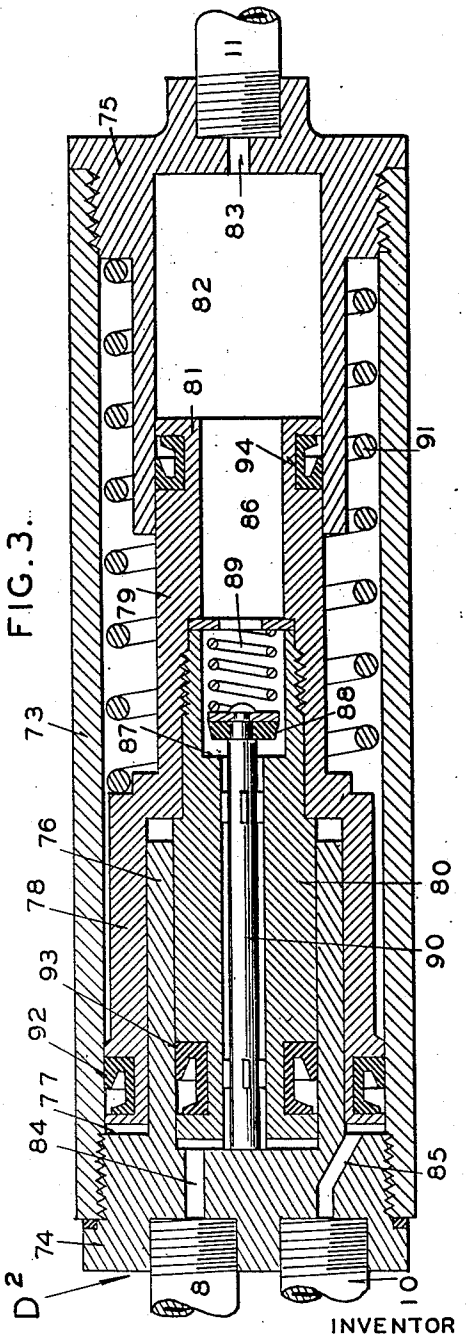

FIG. 3.

INVENTOR
S. SCHNELL

BY E. A. Huffman

ATTORNEY

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FLUID PRESSURE COMPOUNDING SYSTEM

Steve Schnell, Kirkwood, Mo., assignor to Wagner Electric Corporation, St. Louis, Mo., a corporation of Delaware

Application July 2, 1943, Serial No. 493,231

19 Claims. (Cl. 60—54.5)

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My invention relates to a fluid pressure actuating system and more particularly to one in which fluid pressure developed at a source can be directly transmitted to an actuating motor until a predetermined pressure is reached, after which the pressure fluid effective in the motor will be caused to be greater than that developed at the source.

One of the objects of my invention is to provide improved pressure fluid ratio changing or compounding means for a pressure fluid system of the kind referred to.

Another object of my invention is to provide an improved cut-off valve means and compounding units for association with a pressure fluid system for causing the source of pressure to be cut off from an actuated fluid motor and thereafter the pressure fluid of the source to produce increased pressure effective in the motor.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawings in which Figure 1 is a schematic view of a fluid pressure system embodying my invention, with the cut-off valve means and the compounding unit thereof being shown in section; and Figures 2 and 3 are sectional views of other compounding units which may be employed in place of the unit shown in Figure 1.

Referring to the drawings in detail and first to Figure 1, the pressure fluid actuating system in which my invention is embodied is shown, by way of example, as being employed for operating brakes but it is understood that it may be employed, if desired, for operating any device or apparatus. The system shown comprises essentially four units, namely, a manually-controlled master cylinder device A, brakes B, a control valve unit C, and a compounding unit D.

The master cylinder device A is of known construction and comprises a cylinder 1 having reciprocable therein a piston 2 connected by a piston rod 3 to a pedal 4. The piston is biased to retracted position by a spring 5 where it uncovers a porthole 6 for placing the portion of the cylinder ahead of the piston in communication with a reservoir 7. The outlet of the master cylinder device is connected to the central part of the compounding unit D by a conduit 8. This conduit 8 has a branch conduit 9 which is connected to one end of the control valve unit C. The other end of this control valve unit is connected to one end of the compounding unit D by means of a conduit 10. The other end of unit D

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is connected by a conduit 11 with the fluid motors 12 for operating the brake assemblies 13.

The control valve unit C is embodied in a casing 14 having a large cylinder 15 and a small cylinder 16, the latter being connected to conduit 9 previously referred to. Carried by the casing is a member 17 provided with a cylinder 18 extending into cylinder 15 and slightly smaller in diameter than cylinder 16. The outer end of cylinder 18 is closed by a fitting 19 to which conduit 10 is connected, said fitting 19 having a passage 20 for placing the conduit in communication with cylinder 18. Cylinder 18 has mounted therein a piston 21 provided with a hollow extension 22 extending into cylinder 16. This extension projects through a movable piston in the form of a wall 23 at the juncture of cylinders 15 and 16, said wall being biased into engagement with the shoulder 24 between said cylinders by means of a coil spring 25 interposed between the wall and member 17 which carries cylinder 18. A packing cup 26 is associated with the wall and extension 22 for preventing fluid from flowing past the wall.

The piston 21 is provided at its forward end with a valve element 27 for engagement with a valve seat 28 surrounding passage 20 in fitting 19. This valve element is biased to seated position by a spring 29 positioned in extension 22 and interposed between piston 21 and the end of cylinder 16. A passage 30 through piston 21 connects the portion of cylinder 18 ahead of the piston with the hollow extension 22 so that fluid under pressure entering cylinder 16 through conduit 9 may also be effective in cylinder 18 ahead of piston 21. A packing cup 31 is associated with piston 21 for preventing leakage past the piston. In order to limit the unseating movement of piston 21, extension 22 carries an annular flange 32 for engaging the movable wall 23. By means of this flange wall 23 can act to move the piston and re-seat the valve element under certain conditions.

The compounding device D is embodied in an elongated casing 33 provided with cylinders 34 and 35 on opposite sides of a partition 36, said cylinders being shown of like diameters but they may be different. The outer end of cylinder 34 is connected by a fitting 37 to conduit 11 leading to the fluid motors of the brake assemblies and the outer end of cylinder 35 is connected by a fitting 38 to conduit 10 coming from the control valve unit C. The cylinder 34 has mounted therein a piston 39 provided with a packing cup

40 and cylinder 35 has mounted therein a piston 41 provided with a packing cup 42. Piston 41 is connected to piston 39 by a rod 43 which extends through partition 36. Both pistons 39 and 42 are biased to normally retracted positions by a spring 44 interposed between piston 41 and partition 36, said retracted positions being determined by a shoulder 45 which is engaged by piston 39. The inner end of cylinder 34 at the rear of piston 39 is connected to the previously referred to conduit 8 coming from the master cylinder device and in order that fluid may by-pass piston 39 when it is in retracted position, said piston is provided with a central passage 46 through which piston rod 43 extends. This piston rod at the rear of piston 39 carries a valve element 47 for cooperation with the rear of the piston to prevent flow of fluid through passage 46. In order to seal the piston rod and prevent any flow of fluid from cylinder 34 to cylinder 35, a packing element 48 surrounds the piston rod at the partition 36

In order that the flow of fluid from conduit 10 to cylinder 35 may be restricted but only when piston 41 is in its normally retracted position, said piston carries a pin 49 provided with a spherical end for reception in passage 50 of fitting 38 to which conduit 10 is connected. Thus it is seen that this passage 50 will be restricted by the spherical end of the rod until piston 41 has moved such distance inwardly in cylinder 35 as to remove the end from passage 50.

Referring now to the operation of my improved system, all the conduits, the master cylinder device, control valve unit A, compounding unit D, and the fluid motors 12 are filled with a suitable liquid. The parts of the various units will be in the positions shown when the system is inoperative. Under such conditions the piston 21 in the control valve unit C will be positioned so that the valve element 27 engages seat 28 to prevent any flow of fluid through the control valve unit. The valve element 47 carried by piston rod 43 in the compounding unit will be open so that fluid may flow through passage 46 in piston 39.

If the brake pedal should be operated to cause piston 2 of the master cylinder device to develop pressure fluid, this fluid under pressure will be transmitted through passage 46 in piston 39 through cylinder 34 and conduit 11 to the fluid motors 12 of the brake assemblies to apply the brakes. The pressure fluid in the fluid motors 12 will be the same as that developed by the master cylinder device.

When the pressure fluid developed by the master cylinder device is such that the pressure present in cylinder 18 and acting on piston 21 is great enough to move piston 21 to the left against the bias of spring 29 and opposing pressure fluid acting on the piston, valve element 27 will be unseated. This places conduit 8 in communication with conduit 10 and permits pressure fluid from the source to be effective on piston 41 of the compounding device. The valve unit C may be constructed so that valve element 27 is unseated at any desired pressure. For the purposes of this description it is assumed as one hundred pounds per square inch. The pressure fluid acting on piston 41 causes it to be moved to the left, as viewed in Figure 1. This causes the closing of passage 46 in piston 39 by the engagement of valve element 47 with the rear of the piston 39. Communication is now cut off between conduits

8 and 11 and the pressure fluid being developed by the master cylinder device will be effective on both pistons 39 and 41. If the areas of these pistons are assumed to be twice the area of piston 2 of the master cylinder device, then the force acting to compress the fluid in cylinder 34 ahead of piston 39 will be twice the force necessary to move the rod of piston 2 of the master cylinder device. With this force acting on the fluid in cylinder 34, it will have a pressure twice that of the pressure fluid being developed by the master cylinder device and since this fluid under pressure acts in the fluid motors 12, the brakes will be applied by a pressure twice that of the master cylinder developed pressure fluid. Thus it is seen that when the compounding unit D comes into operation after the pressure developed by the master cylinder device reaches a predetermined value, the master cylinder developed pressure will be compounded and will continue to be compounded as long as the master cylinder device continues to be operated to develop pressure beyond the predetermined value at which the compounding unit comes into operation. With the compounding unit in operation the brakes may be applied with a manual force which would be half that of the force which would be required if the master cylinder device were directly connected to the fluid motors 12 at all times.

When the pressure fluid being developed by the master cylinder device reaches such a value as to move the movable wall 26 and piston 21 to the right, valve element 27 will be re-seated, thereby cutting off any additional flow of fluid through conduit 10 to cylinder 35. The pressure fluid at which valve element 27 is re-seated will be determined by the strength of spring 15 and the relationship of the area of cylinder 16 with respect to cylinder 18 and also the strength of spring 29 which tends to re-seat the valve element. For the purpose of this description the pressure at which the valve element re-seats is assumed to be seven hundred and fifty pounds per square inch. When valve element 27 is re-seated, both pistons 41 and 39 will no longer be moved and no more fluid pressure will be developed in the fluid motors 12.

With the valve element 27 re-seated when the pressure fluid developed by the master cylinder device reaches seven hundred and fifty pounds per square inch, then the maximum pressure fluid which can be built up in fluid motors 12 will be fifteen hundred pounds per square inch. Before any more pressure fluid can be developed in the fluid motors, it will be necessary to develop such a high pressure by the master cylinder device that piston 39 could be moved away from valve element 47 to re-open passage 46. However, this would not be likely since sufficient manual force could not be applied to the pedal by the operator to bring about the required master cylinder developed pressure to move piston 39 against the fifteen hundred pounds per square inch pressure ahead of the piston. Thus it is seen that the control valve unit is not only so designed to bring about the functioning of the compounding unit D when a predetermined pressure is developed by the master cylinder device but it also functions to limit the amount of pressure fluid which may be developed in the fluid motors 12 by manual effort. If valve element 27 were not re-closed at a predetermined pressure, it might be possible to develop as high as one thousand or twelve hundred pounds per square inch by the master cylinder device and

with the functioning of the compounding unit such pressure would result in two thousand or twenty-four hundred pounds per square inch pressure in the fluid motors. Such high pressures are not necessary and may cause failure of the system.

When the pressure fluid developed by the master cylinder device is released, the parts of the units C and D will return to the positions shown in Figure 1. If the valve element 27 has been re-closed due to a high pressure fluid developed by the master cylinder device, this valve will first become re-opened as the developed pressure fluid is lowered and when it reaches the assumed value of one hundred pounds per square inch, it will become re-closed. During the time that valve element 27 is open, the pressure fluid in cylinder 34, together with spring 44, will return the pistons to their normally retracted positions. When piston 39 engages shoulder 45, the fluid pressure in cylinder 34 and the action of spring 44 will unseat valve element 47 and permit the pressure fluid in the fluid motors to be totally released.

In the event the pedal should be operated suddenly, resulting in the development of more than one hundred pounds per square inch and the opening of the control valve unit C prior to the effectiveness of said pressure in the fluid motors, the compounding unit will not be immediately operated and valve element 47 closed due to the restricting means associated with passage 50. This restricting means causes a slow build-up of pressure in cylinder 35, thus giving time for the pressure fluid from the source to build up in the fluid motors 12. Thus, regardless of the rapidity of operation of the master cylinder, the compounding unit will come into operation at the time desired. The restricting action at passage 50 will be removed after initial movement of piston 41.

In Figure 2 there is disclosed a modified compounding unit D' which can be employed in place of the compounding unit D described in connection with Figure 1. In this unit D' there is provided a casing 51 having stepped cylinders 52 and 53. Within cylinder 52 is positioned a piston member 54 having stepped cylinders 55 and 56. The forward end of this member 54 carries a head 57 in cylinder 52 which is smaller than cylinder 51. The portion of cylinder 52 ahead of head 57 is connected at one side to conduit 8 coming from the master cylinder device as shown in Figure 1. The outer end of cylinder 52 is closed by a fitting plug 58 which is provided with a central outlet passage 59 to which conduit 11 is connected, said conduit being the one connected to the fluid motors of the brakes as shown in Figure 1. This fitting carries a valve seat 60 surrounding the outlet passage 59 for cooperation with the end surface of head 57 in order that conduit 8 may be cut off from direct communication with conduit 11 but remain in communication with the smaller cylinder 56 in the forward end of the piston member 54 by way of a passage 61 through the head 57. Cylinders 55 and 56 have reciprocable therein integrally connected pistons 62 and 63. A spring 64 biases these pistons to retracted position against a stop ring 65 carried by the rear end of the cylindrical member 54. The rear end of casing 51 having cylinder 53 is closed by a plug 66 to which conduit 10 coming from the control valve unit C is connected. The piston member 54 carries a packing cup 67 for sealing

it with cylinder 53. The head 57 and pistons 62 and 63 also have packing cups 68, 69, and 70 to seal them with the cylinders in which they reciprocate. In order that the space between the piston member 54 and cylinder 53, together with the space between pistons 62 and 63, may be maintained at atmospheric pressure, casing 51 is provided with a passage 71 and the piston member 54 with a passage 72.

Referring to the operation of the modified compound unit D', the parts thereof will be in the positions shown in Figure 2 when the system is not being operated. When the pressure fluid is initially developed by the master cylinder device and forced into conduit 8, it will be directly transmitted to conduit 11 and the fluid motors of the brake assemblies since head 57 will not be seated against seat 60. When the pressure developed by the master cylinder device reaches a predetermined pressure assumed as one hundred pounds per square inch, it will cause opening of valve element 27 of the control valve unit C (Figure 1) and pressure fluid will be forced through conduit 10 and act on piston 63 and the end of the piston member 54. This pressure is sufficient, due to the proportioning of the parts, to move piston member 54 to the left to cause head 57 to engage seat 60 and cut off communication between conduits 8 and 11. Movement of piston member 54 to close the valve will result from pressure acting on the end of the member together with the pressure transmitted through spring 64 and also the frictional drag of the packing cups of pistons 62 and 63 on the cylinder walls. The pressure fluid acting on piston 63 will now force pistons 63 and 62 to the left and cause piston 62 to develop pressure fluid and transmit it through conduit 11 to the brake fluid motors. When head 57 seats on seat 60, it will be held seated as the arrangement is such that the force acting on the rear end of piston member 54, plus the force of spring 64, is greater than the pressure fluid from the master cylinder acting on head 57 tending to unseat the head. The pressure fluid acting on the end wall 56' of cylinder 56 also tends to aid in holding head 57 seated.

Since piston 63 is larger than piston 62, there will be a compounding action and, as a result thereof, the pressure fluid effective in the fluid motor will be greater than the pressure fluid being developed by the master cylinder device. If the ratio of the areas of pistons 63 and 62 is two to one, the pressure fluid effective in the fluid motors will be approximately twice that developed in the master cylinder device.

If the pressure fluid developed by the master cylinder device should exceed the value of seven hundred and fifty pounds per square inch, conduit 10 will be cut off from the master cylinder device by the closing of the control valve unit C in the manner already described and, therefore, no additional pressure fluid will be transmitted to the fluid motors.

When the pressure fluid developed by the master cylinder device is released, the parts of the compounding unit D' will return to their positions shown in Figure 2. When piston 63 abuts against stop ring 65, the forces which become operative on the piston member 54 will cause head 57 to be unseated from seat 60 and pressure fluid will be released from the fluid motors to the master cylinder device.

In Figure 3 there is shown still another compounding unit indicated at D^2 which may be

substituted for the compounding unit D of the system shown in Figure 1. This unit D^2 comprises a cylinder 73 open at both ends. A fitting plug 74 closes one end and a fitting plug 75 closes the other end. The plug 74 is provided with an integral cylinder 76 which extends into cylinder 73 and is concentric therewith to form an annular chamber 77. Positioned within the annular chamber is an annular piston 78 having an extension 79. Secured to extension 79 is a piston 80 which is positioned in the cylindrical extension 76. The forward end of extension 79 forms a piston 81 which is positioned in a cylinder 82 carried by the fitting plug 75.

Cylinder 82 communicates through a passage 83 with conduit 11 leading to the fluid motors of the brake. The cylinder 76 communicates by a passage 84 in plug 74 with conduit 8 coming from the master cylinder device. Fitting 74 also has a passage 85 to which conduit 10 is connected to communicate with the annular chamber 77.

A passage 86 extends through piston 80, extension 79, and piston 81 for placing conduit 8 directly in communication with cylinder 82 and conduit 11. This passage is formed with a valve seat 87 which has cooperating therewith a valve element 88 acted upon by a spring 89 to bias it toward seated position. The valve element 88 is carried by a stem 90 extending through passage 86 and projecting slightly beyond piston 80 when valve element 88 is seated. The pistons are biased by a spring 91 to a retracted position where piston 80 engages the fitting plug 74. This positioning of piston 80 results in relative movement between it and valve stem 90, thereby causing valve element 88 to be unseated. The pistons 78, 80, and 81 are provided with suitable packing cups 92, 93, and 94 to prevent leakage of fluid.

The parts of the compounding unit will be as as shown in Figure 3 when the system is inoperative. When pressure fluid is initially developed by the master cylinder device, the fluid from conduit 8 will flow through passage 86 to conduit 11 and the fluid motors since valve element 88 is open. When the master cylinder device develops the assumed one hundred pounds per square inch pressure to cause opening of the control valve unit C, fluid under pressure will flow through conduit 10 and become effective on the annular piston 78. This will result in all the pistons being moved forwardly and the automatic closing of valve element 88. When this valve element is closed, pressure fluid from the master cylinder will act on both pistons 78 and 80 and cause piston 81 to develop pressure. Since piston 81 has an area smaller than the combined areas of the annular piston 78 and piston 80, there will be a compounding action which will result in greater pressure fluid being developed in the brake fluid motors than that developed by the master cylinder device. If the total area of pistons 78 and 80 is twice that of piston 81, the ratio betwwen the pressure fluid in the fluid motors and that developed by the master cylinder device will be approximately two to one.

When the pressure fluid developed by the master cylinder device is released, the parts will return to the positions shown in Figure 3. Pistons 78 and 80 will be returned by the action of the pressure fluid in the fluid motors acting on piston 81, together with the action of spring 91. When piston 80 is returned to its retracted position, valve stem 90 will engage fitting plug 74 and thereby cause opening of valve element 88 to release all the pressure fluid in the fluid motors to the master cylinder device.

The action of the control valve unit C in preventing excessive pressure from being developed in the fluid motors is the same as previously described.

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 by 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 pressure fluid system, a manually-operated source of pressure fluid; a fluid motor to be actuated; conduit means between said source and said motor; valve means associated with said conduit means for cutting off communication from said source to said motor which comprises a cylinder, two spaced pistons therein, a rod connected between said pistons and said valve associated with said rod, said pistons movable relatively to each other until said valve is closed; means comprising conduit means and other valve means independent of said first valve means for connecting the pressure fluid operated means to the source when the pressure from the source is at a predetermined value to thereby cause closing of said first valve means; means in said other valve operable by an increased pressure from said source to place said pressure fluid effective in said motor under increased pressure, said increased pressure being a multiple of the pressure produced by said source; and means in said other valve operable by pressure fluid derived from said source to reclose said other valve when the pressure developed by said source exceeds a value higher than said predetermined value to thereby cause said manually-operated source to become effective on said fluid motor.

2. In a pressure fluid system, a manually-operated source of pressure fluid; a fluid motor to be actuated; conduit means between said source and said motor; valve means associated with said conduict means for cutting off communication from said source to said motor which comprises a cylinder and two operatively associated pistons therein, said valve associated with one of said pistons; other valve means for connecting the pressure fluid operated means with said source when the pressure from said source is at a predetermined value to thereby cause the closing of said first mentioned valve means by moving one of said pistons relatively to the other piston; means in said other valve operable by an increased pressure from said source to place said pressure fluid effective in said motor under increased pressure, said increased pressure being a multiple of the pressure produced by said source; and means in said other valve operable by the increased pressure fluid derived from said source to re-close said valve when the pressure developed by said source exceeds a value which is higher than said first predetermined value.

3. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, conduit means between the source and motor, valve means associated with said conduit means for cutting off communication from the source to the motor, pressure fluid operated means for closing said valve means, conduit means between the source and said pressure fluid operated means, normally closed valve means for

said last named conduit means, means for opening the last named valve means by a predetermined fluid pressure from the source, means for applying force to the fluid under pressure in the motor by the pressure fluid operated means after the first valve means is closed, and means for reclosing the last named valve means by fluid pressure from the source when it reaches a second predetermined value.

4. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, conduit means between the source and motor, valve means associated with said conduit means for cutting off communication from the source to the motor, pressure fluid operated means for closing said valve means, conduit means between the source and said pressure fluid operated means, normally closed valve means for said last named conduit means, means for opening the last named valve means by predetermined fluid pressure from the source, means for applying force to the fluid under pressure in the motor by the pressure fluid operated means after the first valve means is closed, and means independent of the second valve means for restricting the flow of fluid under pressure to the pressure fluid operated means during its operation to close the first named valve means.

5. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, conduit means between the source and motor, valve means associated with the conduit means for cutting off communication between the source and motor, a second fluid motor for controlling the closing of the valve means, means including valve means for connecting the last named fluid motor with the source but only when the pressure from the source reaches a predetermined value, a third fluid motor independent of the second motor for applying pressure to the fluid effective in the first motor, and means for causing the third fluid motor and the second fluid motor to be simultaneously operated by pressure fluid from the source after the closing of the first valve means to thereby cause greater fluid pressure to be effective in the first motor than that from the source.

6. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source with said piston passage, other conduit means for connecting the cylinder ahead of the piston with the fluid motor, valve means for closing the piston passage, pressure fluid operated means for closing the valve means and for applying pressure to the piston, conduit means for connecting said pressure fluid operated means with the source, a normally closed valve for said last named conduit means, means for opening said last named valve when the fluid pressure from the source reaches a predetermined value, and means for applying pressure fluid from said source directly to the first named piston when the valve means is closed, said last named means being independent of the pressure fluid means for closing the valve means and moving the piston.

7. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source to the cylinder on one side of the piston, conduit means for connecting the cylinder on the opposite side of the piston to the fluid motor, a movable valve element for closing the piston passage, a fluid motor for closing the valve means and applying pressure to the piston when the valve element is closed, and other valve means operable independently of movement of said valve element for connecting the second fluid motor to the source when the fluid pressure therefrom reaches a predetermined value.

8. In a pressure fluid system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source to the cylinder on one side of the piston, conduit means for connecting the cylinder on the opposite side of the piston to the fluid motor, a valve element for closing the piston passage, a fluid motor for closing the valve means and applying pressure to the piston when the valve is closed, other valve means for connecting the second fluid motor to the source when the the fluid pressure therefrom reaches a predetermined value, and means for closing said valve means and preventing operation of the second fluid motor when the fluid pressure from the source reaches a predetermined value above the first predetermined value.

9. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source to the cylinder on one side of the piston, conduit means for connecting the cylinder on the opposite side of the piston to the fluid motor, a valve element for closing the piston passage, a fluid motor independent of the piston and cylinder for closing the valve element and applying pressure to the piston when the valve element is closed, conduit means between the source and the second fluid motor, a normally closed valve means for said last named conduit means, and means for opening said last named valve means by a predetermined fluid pressure from the source.

10. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source to the cylinder on one side of the piston, conduit means for connecting the cylinder on the opposite side of the piston to the fluid motor, a valve element for closing the piston passage, a second cylinder aligned with the first cylinder, a piston in said second cylinder, a piston rod connecting the last named piston with the valve element and for moving said first named piston when the valve element is in closed position, and means comprising other valve means for connecting the second cylinder to the source when the pressure fluid therefrom reaches a predetermined value to thereby cause the piston in the second cylinder to close the valve element and the two pistons to be moved in unison to develop pressure in the first cylinder.

11. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, a cylinder, a piston therein provided with a passage therethrough, conduit means for connecting the source to the cylinder on one side of the piston, conduit means for connecting the cylinder on the opposite side of the piston to the fluid motor, a valve element for closing the piston passage, a second cylinder aligned with the first cylinder, a piston in said second cylinder, a piston rod connecting the last named piston

with the valve element and for moving said first named piston when the valve element is in closed position, means comprising other valve means for connecting the second cylinder to the source when the pressure fluid therefrom reaches a predetermined value to thereby cause the piston in the second cylinder to close the valve element and the two pistons to be moved in unison to develop pressure in the first cylinder, and means for restricting the rate of flow of fluid to the second cylinder but only prior to the substantial movement of the piston therein.

12. In a pressure fluid system, a manually-controlled source of pressure, a fluid motor to be actuated, two cylinders, conduit means for connecting one cylinder to the source, conduit means for connecting the other cylinder to the fluid motor, connected pistons in the cylinders, a passage through the pistons, normally open valve means for controlling said passage, a cylinder surrounding the cylinder connected to the source and provided with an annular chamber, an annular piston positioned in the annular chamber and connected to the other piston, means for controlling the closing of the valve means by movement of the annular piston, conduit means for connecting the annular chamber to the source of pressure fluid, normally closed valve means in said last named conduit means, and means for opening said last named valve means when fluid pressure from the source reaches a predetermined value.

13. In a pressure fluid system, a manually-controlled source of pressure fluid, a fluid motor to be actuated, conduit means between the source and the motor, valve means associated with the conduit means for cutting off communication between the source and motor and comprising a normally open valve element, a cylinder, a piston in the cylinder connected to the valve element and provided with stepped cylinders, interconnected piston in said stepped cylinders, means for connecting the smaller cylinder of said stepped cylinders to the conduit means at a point between the motor and the valve means, conduit means for connecting the first named cylinder and the larger cylinder of said stepped cylinders with the source of pressure, a normally closed valve means for said last named conduit means, and means for opening said last named valve means when the fluid pressure from the source reaches a predetermined value to thereby apply pressure to the piston connected with the valve element and the larger of the interconnected pistons to close the first valve means and subsequently cause the smaller of the interconnected pistons to apply pressure to the fluid in the fluid motor.

14. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a casing provided with a cylinder, conduit means for connecting one end of the casing with a source of fluid pressure, conduit means including an outlet port for connecting the same end of the casing with the fluid motor, a valve seat surrounding the outlet port, a piston mounted in the cylinder of the casing and provided with a valve element engaging the valve seat and cutting off communication between the conduit means, said piston being provided with stepped cylinders the smaller of which is in communication at all times with the outlet port, interconnected pistons in said stepped cylinders, a spring for biasing all of said pistons to inoperative positions wherein the valve element is unseated, conduit means for connecting the cylinder of the casing and the larger cylinder of the stepped cylinders with the source of fluid pressure so that the pistons therein may be acted upon by fluid pressure, normally closed valve means associated with the last named conduit means, and means for opening said valve means when the fluid pressure from the source reaches a predetermined value to thereby operate the piston in the cylinder of the casing and the pistons in the stepped cylinders to seat the valve element and actuate the fluid motor with greater fluid pressure than that from the source.

15. In a pressure fluid system, a manually-operated source of pressure fluid; a fluid motor to be actuated; conduit means between said source and said motor; valve means associated with said conduit means for cutting off communication from said source to said motor; pressure fluid operated means for closing said valve means which comprises two cylinder and piston means therein movable relatively to said cylinder and one of said pistons engageable with said valve to cut off communication between said source and said valve; and a control valve unit for connecting said fluid motor with and disconnecting it from said source of pressure fluid, said unit comprising a valve having a movable element, a piston connected to said element, a spring for biasing said piston to close said valve element, means for connecting said source of pressure fluid with said piston in order to act thereon in a direction to move said piston and open said valve element against the bias of said spring when the pressure fluid from said source is at a predetermined value, a second piston acted upon by pressure fluid from said source, means operatively connecting said second piston to apply force to said first piston to move it in a valve element closing direction but only when said valve is open, and a spring acting on said second piston to oppose its movement by pressure fluid.

16. In a pressure fluid system, a master cylinder, a fluid motor to be actuated thereby, a first cylinder, a piston therein, conduit means connecting said master cylinder and said motor including a passage through said piston, a valve for closing said piston passage, a second cylinder coaxially disposed with respect to said first cylinder, a second piston in said second cylinder, means connecting said valve and said second piston, said second piston moving said first piston after said valve is closed, and means for applying pressure fluid to said second piston from said master cylinder after a predetermined pressure has been developed in said first cylinder including a valve operable when the pressure developed by said master cylinder is higher than said predetermined pressure, said higher pressure developed by said master cylinder applied to both pistons to compound the pressure in said motor.

17. In a pressure fluid system, a source of pressure, a fluid motor to be operated thereby, a first cylinder, a piston therein having a passage therethrough, conduit means connecting said source with said motor including said passageway, a valve element for said passageway, a second cylinder axially aligned with said first cylinder, a piston in said second cylinder, a piston rod connecting said valve and said piston in said second cylinder, said second cylinder and said first cylinder moving as a single unit after closure of said valve, means causing pressure from said source to be applied to said second piston after a predetermined pressure has been developed in said conduits leading to said motor, and said pressure fluid from said source acting

on both of said pistons after said valve has been closed in order to compound the pressure within said motor.

18. In a pressure fluid system, a master cylinder, a brake cylinder, a compounding device, conduit means connecting said master cylinder and said brake cylinder, a first piston in said compounding device having a passageway therethrough included in said conduit means, a valve to close said passageway, a second piston in said compounding device, means connecting said valve and said second piston, said valve closable after a predetermined pressure has been developed in said brake cylinder, means to control the admission of pressure fluid against said second piston including a valve and a piston responsive to a pressure higher than said predetermined pressure in order to open said valve, and means to reclose said second valve after a predetermined compounded pressure has been developed in said motor.

19. In a pressure fluid system, a master cylinder, a fluid motor to be actuated thereby, a compounding device having a first and second cylinder therein, a piston in each of said cylinders, conduit means including a passage in one of said pistons to connect said master cylinder with said motor, a valve for said passage in said first piston, means connecting said valve and said second piston, a control means, a second valve in said control means, a piston device associated with said second valve operable by pressure fluid developed by said master cylinder above a predetermined pressure to thereby move said second piston to close said first valve and cause said master cylinder to apply pressure to both of said pistons in order to compound the pressure fluid in said motor, and means to reclose said second valve after said higher pressure exceeds a higher and different predetermined value.

STEVE SCHNELL.

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