

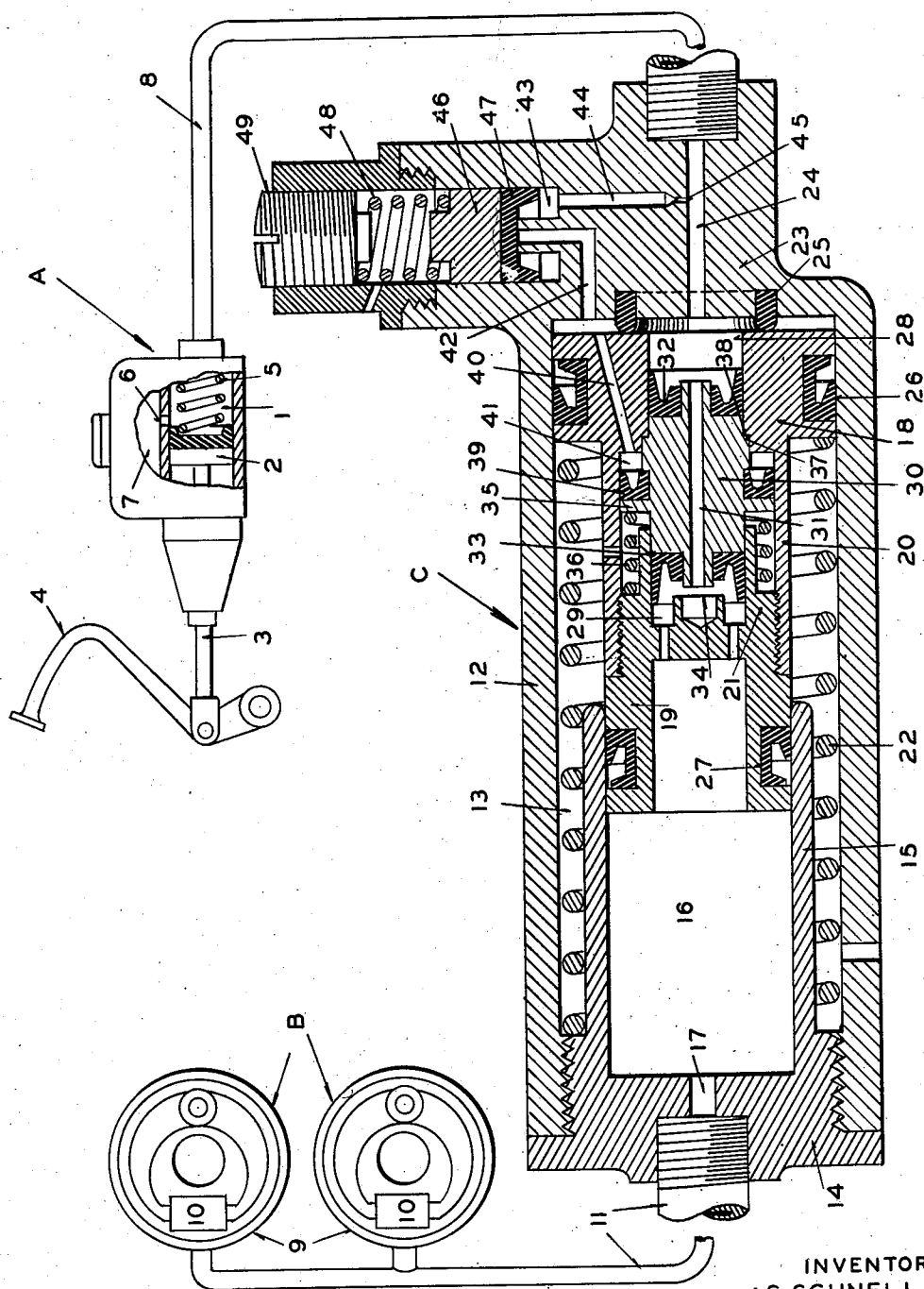
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FLUID PRESSURE COMPOUNDING SYSTEM

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FLUID PRESSURE COMPOUNDING SYSTEM

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My invention relates to fluid pressure systems and more particularly to one which will permit the fluid pressure effective in an actuating motor to be compounded with respect to the fluid pressure at the source after a predetermined pressure has been reached.

The primary object of my invention is to provide improved compounding means for a fluid pressure system of the kind described which is so constructed that functioning of the compounding means cannot occur when sudden high fluid pressures are initially transmitted from the source of fluid pressure.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawing, the single figure of which is a schematic view of a fluid pressure system embodying my invention, the compounding unit thereof being shown in section.

Referring to the figure in detail, my improved fluid pressure system comprises essentially three units, namely, a source of fluid pressure in the form of a master cylinder device "A," an actuated unit "B," and a compounding unit "C." The master cylinder device 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 its retracted position by a spring 5 where it uncovers a porthole 6 for placing the cylinder ahead of the piston in communication with the reservoir 7. The outlet of the master cylinder is connected to one end of the compounding unit "C" by a conduit 8. The actuated unit is shown as a brake assembly 9 having an operating fluid motor 10, said motor being connected to the other end of the compounding device by a conduit 11. The actuated unit may be any device or devices which can be operated by a fluid motor, the brake assembly being shown by way of example only.

The compounding unit comprises a casing 12 provided with a cylinder 13 open at its forward end. This open end is closed by a fitting plug 14 which carries a cylindrical extension 15 projecting into cylinder 12 to provide a cylinder 16 of smaller diameter than cylinder 13. The outer end of cylinder 16 is connected to conduit 11 by way of an outlet passage 17 through the fitting plug. Within cylinder 13 is a piston 18 and within cylinder 16 is a piston 19, said pistons being connected together by means of a cylindrical extension 20 on piston 18 being threaded to an extension 21 on piston 19. The

pistons are normally held in their retracted positions by a spring 22 of predetermined strength and when in their retracted positions, piston 18 will be biased to engage the end wall 23 of cylinder 13, which end wall is integral with the casing. This end wall is provided with a passage 24 which connects the end of cylinder 13 with conduit 8 coming from the master cylinder device. Surrounding passage 24 where it enters the cylinder is a ring 25 of yieldable material which is adapted to be engaged by the face surface of piston 18 when it is in its retracted position. When cooperating with the end surface of the piston, this ring results in the area of the piston, which is exposed to the fluid pressure entering the cylinder through passage 24, to be less than the area of piston 19 exposed to the fluid pressure in cylinder 16.

Pistons 18 and 19 are provided with suitable packing cups 26 and 27 to prevent leakage past their peripheries. Piston 18 has a bore 28 and piston 19 has an axially aligned bore 29 of the same diameter as bore 28. Positioned to have limited reciprocation in these two bores is a piston 30 having a passage 31 therethrough in order that fluid coming from passage 24 may flow through the piston and into cylinder 16 and from there to fluid motor 10 by way of conduit 11. The ends of piston 30 carry packing cups 32 and 33, the latter of which also functions as a valve element for cooperation with a seat 34 carried by piston 19.

Piston 30 is provided with a flange 35 of a diameter to fit into the cylindrical extension 20 of piston 18 and cooperating with this flange is a spring 36 for biasing piston 30 to a position where the packing cup 33 is held off seat 34. Cooperating shoulders 37 and 38 are provided on pistons 30 and 18 for limiting the movement of piston 30 by spring 36. Associated with flange 35 is a packing cup 39 for preventing fluid from flowing past the flange.

Piston 18 is provided with a passage 40 there-through for placing chamber 41 forwardly of flange 35 and packing cup 39 with the face surface of piston 18 at a point outside the portion engaging ring 25. The end wall 23 of cylinder 13 is also provided with a passage 42 which enters cylinder 13 outside ring 25 and, when the piston engages ring 25, places this portion of the cylinder and passage 40 in communication with the inner end of a bore 43 formed in the end wall of casing 12. This bore is in constant communication by way of a passage 44 with passage 24 in the end wall which connects conduit

8 with the end of cylinder 13 inside ring 25. Passage 44 has a restricted portion 45 so that the rate of transmission of fluid under pressure through passage 44 is retarded. The end of passage 42 at bore 43 is adapted to be closed by a piston 46 having a sealing cup 47 cooperating with the surface surrounding the end of the passage. Piston 46 is backed by a spring 48 to bias the packing cup 47 on the open end of passage 42 with a predetermined force. This spring 48 may be adjusted by a threaded plug 49 in order to vary the spring force acting on the piston.

When the fluid pressure system is inoperative, the parts of the master cylinder device and the compounding unit will be in the positions shown in the figure. Under these conditions piston 30 will be so positioned that fluid under pressure from the master cylinder device can flow through the piston passage 31 and directly to fluid motor 10 to be actuated. Initial operation of the master cylinder device will result in fluid under pressure being transmitted at the same pressure to the fluid motor, thereby causing its actuation. The piston 30 will not be moved under these conditions since the opposite ends thereof are of equal diameter and exposed to equal fluid pressures. Also, pistons 18 and 19 will not be moved by fluid pressure from the master cylinder device since the developed fluid pressure is effective on that area of the end surface of piston 18 within ring 25, which area is less than the area of piston 19 which is acted upon by fluid under pressure in cylinder 16.

When the fluid pressure reaches such a predetermined value that it can cause piston 46 in bore 43 to be moved against the bias of spring 48 and open passage 42, the fluid pressure coming from the master cylinder device will become effective on the face of piston 18 outside ring 25. The fluid pressure necessary to move piston 46 will depend upon the force of spring 48 and the area of the piston exposed to fluid pressure. This can be assumed for the purpose of this description as one hundred pounds per square inch. By moving the adjusting plug, the pressure necessary to move piston 46 can be varied within limits. The fluid pressure flowing through passage 42 will also flow through passage 40 and act on flange 35 of the piston 30 to cause movement of this piston to the left and the seating of sealing element 33 on seat 34. This closes passage 31 and simultaneously with the closing thereof, the fluid pressure now acting on the total face of piston 18 will move it to the left against the force of the retracting spring 22 which is so predetermined as to be compressed by substantially one hundred pounds per square inch acting on the total end surface of the piston.

The area of the total end surface of piston 18 acted upon by the fluid pressure from the master cylinder will be greater than that of the area of piston 19 acting on the fluid in cylinder 16 and effective in the fluid motor 10. If these areas have a ratio of two to one, then the fluid pressure developed in cylinder 16 will be twice that developed by the master cylinder device and as the master cylinder device continues to be operated to increase the developed fluid pressure, the fluid pressure effective in the fluid motor 10 will be increased at twice the rate. Thus it is seen that when passage 31 is closed and pistons 18 and 19 are moved relatively to their cylinders, a compounding action will take place and the

manual force necessary to continue to actuate the fluid motor will need to be only half that which would be required if the compounding unit were eliminated from the system and only a direct communication between the master cylinder device and the fluid motor.

When the master cylinder device is released to release the developed fluid pressure, the parts will be returned to the positions shown in the figure. If the drop in fluid pressure of the master cylinder device is rapid, the fluid pressure in cylinder 16 will move piston 30 to the right and open passage 31 so that fluid can flow back to the master cylinder device. The action of fluid pressure on piston 19 and the force of retracting spring 22 will return the pistons to their retracted or inoperative positions wherein the end surface of piston 18 will again engage the yieldable ring 25 to thereby prevent fluid pressure from the source from acting on the outer portion of the end surface of said piston 18 outside ring 25. Passage 42 will be closed under the action of spring 48 when the fluid pressure acting on piston 46 drops to such a value that the spring can position the sealing element 47 to close the end of passage 42.

By providing the restriction 45 in passage 44, it is impossible for any sudden initial actuation of the master cylinder device to cause opening of passage 42 and closing of passage 31 to piston 30 before fluid under pressure built up in the fluid motor approximates 100 pounds per square inch causing the compounding unit to begin to function. Thus there is little possibility of operating the fluid motor solely under conditions involving the functioning of the compounding unit. This will insure conserving of pedal travel since, when the compounding unit is functioning, a larger displacement of fluid by the master cylinder device is required.

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 fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder at the rear of the piston therein to the source, spring means for biasing the pistons to inoperative positions, means for restricting the area of the larger piston subject to the fluid pressure from the source only when the piston is in its inoperative position, means establishing a passage between the source and the fluid motor to permit fluid to by-pass the pistons, a normally open valve for the passage, fluid pressure operated means for closing the valve, conduit means for connecting the fluid pressure-operated means with the source to produce relative movement between said fluid pressure operated means and the larger piston, and valve means for permitting flow of fluid through the last named conduit means when the fluid pressure from the source reaches a predetermined value.

2. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder at the rear of the piston therein to the source, spring means for biasing the pistons to inoperative positions, means for restricting the area of the larger piston subject to the fluid pressure from the source only when the piston is in its inoperative position, means establishing a passage between the source and the fluid motor to permit fluid to by-pass the pistons, a normally open valve for the passage, fluid pressure-operated means for closing the valve, conduit means for connecting the fluid pressure-operated means with the source to produce relative movement between said fluid pressure operated means and the larger piston, valve means for permitting flow of fluid through the last named conduit means when the fluid pressure from the source reaches a predetermined value, and means associated with said last named conduit means between the valve means and the source for restricting the flow of fluid under pressure through the conduit means.

3. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means engageable with the larger piston and the end wall for causing a partial area of the larger piston to be initially subjected to fluid pressure from the source entering the cylinder through the port but only when the piston is in its retracted position, means establishing a passage through the pistons, a normally open valve associated with the passage, fluid pressure-operated means for closing the valve means, and valve means for connecting the fluid pressure-operated means to the source to close the valve when said fluid pressure reaches a predetermined value, said last named connecting means also connecting the remaining area of the larger piston to be subject to the pressure from the source to produce relative movement between said fluid pressure operated means and the larger piston.

4. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means associated with the larger piston and the end wall for causing a partial area of the larger piston to be subject to the fluid pressure from the source entering the cylinder through the port but only when the piston is in its retracted position, means establishing a passage through

the pistons, a movable valve element for closing the passage, a fluid motor for closing the valve element, conduit means for connecting the source to the last named fluid motor and being so associated with the larger piston as to also cause the remaining area thereof to be subject to fluid pressure from the source to produce relative movement between said fluid pressure operated means and the larger piston, and fluid pressure-operated valve means for placing said conduit means in communication with the source only when the pressure from the source is above a predetermined value.

5. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means associated with the larger piston and the end wall for causing a partial area of the larger piston to be subject to the fluid pressure from the source entering the cylinder through the port but only when the piston is in its retracted position, means establishing a passage through the pistons, a movable valve element for closing the passage, a fluid motor for closing the valve element, conduit means for connecting the source to the last named fluid motor and being so associated with the larger piston as to also cause the remaining area thereof to be subject to fluid pressure from the source to cause said fluid pressure operated means to move relatively to the larger piston, fluid pressure-operated valve means for placing said conduit means in communication with the source only when the pressure from the source is above a predetermined value, and means for preventing rapid rise of fluid pressure from the source from acting to instantaneously open the last named valve means.

6. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder at the rear of the piston therein to the source, spring means for biasing the pistons to inoperative positions, means establishing a passage through the pistons and comprising a cylinder having a valve seat associated therewith at one end, a movable piston having a passage and being mounted in the cylinder to engage the seat to cut off communication through the pistons, means for biasing said member to valve open position, fluid motor means for moving said valve to closed position, and means for connecting said last named fluid motor means to the source to cause it to move relatively to the pistons when the fluid pressure from said source is above a predetermined value.

7. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, interconnected pistons in the cylinders for simultaneous movement, con-

duit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder at the rear of the piston therein to the source, spring means for biasing the pistons to inoperative positions, means for restricting the area of the larger piston subject to the fluid pressure from the source only when the piston is in its inoperative position, means establishing a passage through the pistons and comprising a cylinder having a valve seat associated therewith at one end, a movable piston having a passage and being mounted in the cylinder to engage the seat to cut off communication through the pistons, means for biasing said member to valve open position, fluid motor means for moving said valve to closed position, means for connecting said last named fluid motor means to the source to cause same to move relatively to the pistons when the fluid pressure from said source is above a predetermined value, and means for causing fluid pressure flowing through the last named connection to be effective on the remaining area of the larger piston.

8. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder at the rear of the piston therein to the source, spring means for biasing the pistons to inoperative positions, means for restricting the area of the larger piston subject to the fluid pressure from the source only when the piston is in its inoperative position, means establishing a passage between the source and the fluid motor to permit fluid to by-pass the pistons, a normally open valve for the passage, a fluid motor for closing the valve, conduit means for connecting the fluid motor to the source and comprising a passage in the larger piston having a port in the area of the piston outside said restricted area and a second passage placing the source in communication with the port, and valve means for controlling the last named passage so that fluid pressure from the source will be effective on the area of the larger piston outside the restricted area and effective in the valve closing fluid motor only when the pressure from the source is above a predetermined value.

9. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means associated with the larger piston and the end wall for causing a partial area of the larger piston to be subject to the fluid pressure from the source entering the cylinder through the port but only when the piston is in its retracted position, means establishing a passage through the pistons, a movable valve element for closing the passage, a fluid motor for closing the valve element, conduit means for connecting the source to the last named fluid motor

and comprising a passage having a port in the remaining area of the larger piston and a passage in the end wall of the cylinder connected to the source of pressure and communicating with said port, and valve means associated with the last named conduit means for placing the last named passage in communication with the source only when the fluid pressure therefrom is above a predetermined value.

10. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means associated with the larger piston and the end wall for causing a partial area of the larger piston to be subject to the fluid pressure from the source entering the cylinder through the port but only when the piston is in its retracted position, means establishing a passage through the pistons, a movable valve element for closing the passage, a fluid motor for closing the valve element, conduit means for connecting the source to the last named fluid motor and comprising a passage having a port in the remaining area of the larger piston and a passage in the end wall of the cylinder connected to the source of pressure and communicating with said port, a valve element for closing the last named passage and subject to fluid pressure from the source to move it toward open position, and a spring acting on the valve element for biasing it toward closed position.

11. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous movement, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, a yieldable ring surrounding said port, spring means for biasing the pistons to positions where the end surface of the larger piston engages the yieldable ring to thereby prevent fluid pressure entering the cylinder through the port from being effective on the surface of the piston outside the yieldable ring, means establishing a passage by-passing the pistons, a normally open valve means for the passage, means for closing said valve means when the fluid pressure from the source reaches a predetermined value, and means for causing fluid pressure from the source to be effective on the surface of the larger piston outside the ring simultaneously with the closing of the valve means to cause relative movement between the means for closing said valve and the larger piston away from seating engagement with the ring.

12. In a fluid pressure system, a manually-controlled source of fluid pressure, a fluid motor to be actuated, a member provided with cylinders of different diameters, the larger of which is provided with an end wall, interconnected pistons in the cylinders for simultaneous move-

ment, conduit means for connecting the smaller cylinder ahead of the piston therein to the fluid motor, conduit means for connecting the larger cylinder to the source of pressure and comprising a port in the central part of the end wall, spring means for biasing the pistons to inoperative positions, means associated with the larger piston and the end wall for causing a partial area of the larger piston to be subject to the fluid pressure from the source entering the cylinders through the port but only when the piston is in its retracted position, means establishing

5 a by-pass passage around the pistons, a normally open valve associated with the passage, fluid pressure-operated means for closing the valve means, and means for causing fluid pressure from the source to be effective in the fluid pressure-operated means and also simultaneously effective on the remaining area of the larger piston and to cause relative movement between said fluid pressure operated means and said larger piston when the fluid pressure from the source reaches a predetermined value.

STEVE SCHNELL.