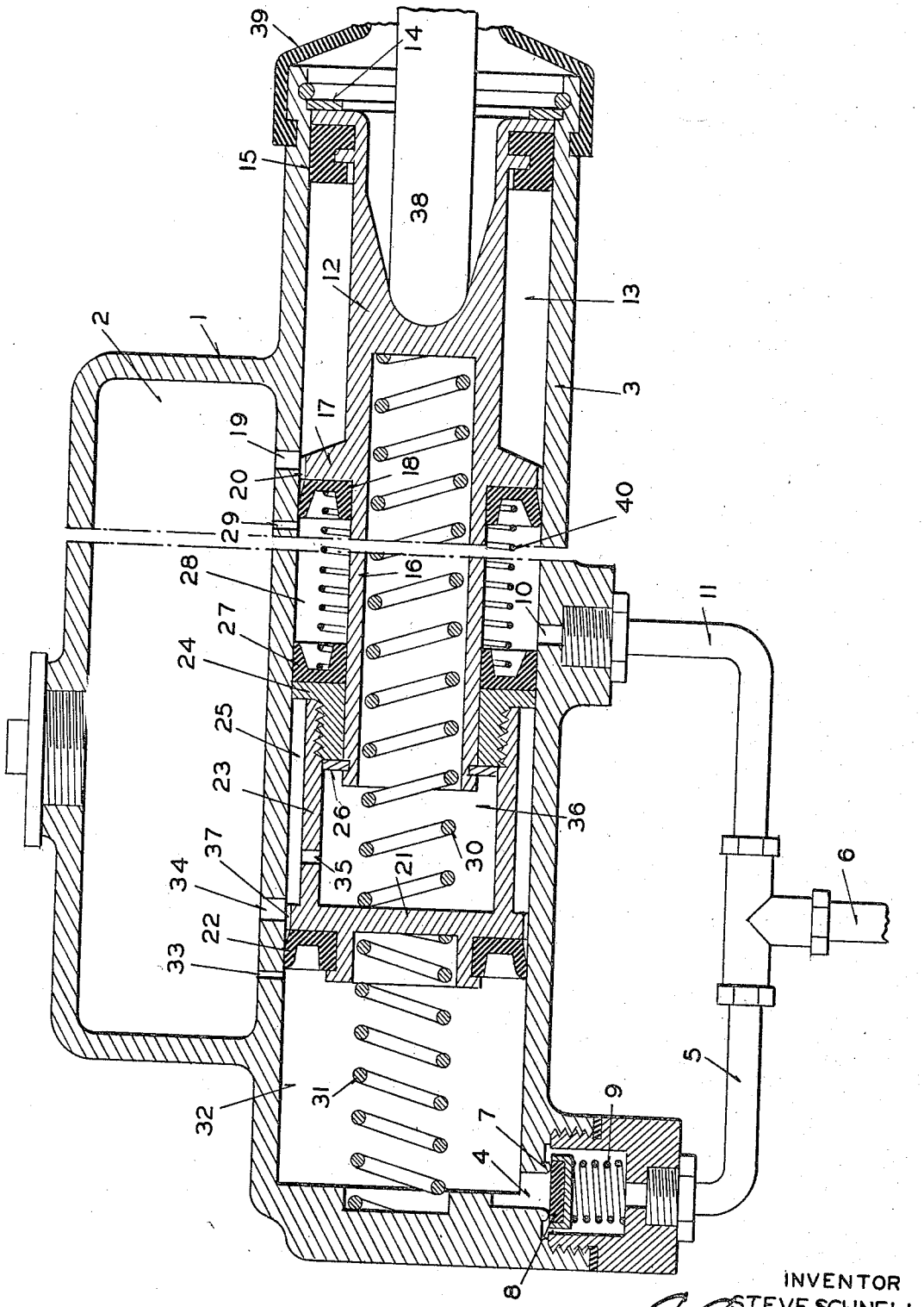
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COMPOUND MASTER CYLINDER

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COMPOUND MASTER CYLINDER

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

One of the objects of my invention is to construct an improved compound master cylinder wherein the transition from the low pressure producing means to the high pressure producing means may be effected in a smooth manner.

Another object of my invention is to produce a simple and compact master cylinder device in which the low pressure and high pressure producing pistons may be mounted in a single cylinder of uniform diameter and wherein the low pressure producing piston will be held stationary when a predetermined pressure is developed thereby and the high pressure producing piston will be capable of independent movement to produce the high pressure.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawing in which the single figure is a sectional view of a compound master cylinder device embodying my invention.

Referring to the drawing in detail, the numeral 1 indicates a casing in which is embodied a reservoir 2 and a cylinder 3 of uniform internal diameter. The forward end of the cylinder is provided with an outlet 4 connected with a branch conduit 5 leading to a conduit 6 which is connected to the fluid motor (not shown) to be actuated by the developed fluid pressure. The outlet 4 has associated therewith a valve seat 7 with which cooperates a valve element 8 biased onto said seat by a light spring 9. Because of this valve it is seen that fluid may flow out of the forward end of the cylinder to conduit 5 by unseating the valve element but fluid is prevented from flowing in the opposite direction. The central part of the cylinder is also provided with an outlet 10 which is connected by a branch conduit 11 with the conduit 6.

Positioned within the rear portion of the cylinder is a piston 12 having an annular recess in order to form with the cylinder a chamber 13. The retracted position of this piston is determined by stop 14 at the rear end of the cylinder. Associated with the rear end of the cylinder is a packing cup 15 for preventing the fluid from leaking out of chamber 13. The forward end of piston 12 is provided with a cylindrical extension 16 which extends a considerable distance beyond the head 17 of the piston. The piston head is sealed by an annular packing cup 18 surrounding extention 16. The piston 12, when in its retracted position as shown, has its head spaced considerably to the rear of outlet 10. The chamber 13 at the rear of the head is in constant communication with the reservoir by an opening 19, and in order that fluid may freely pass the head of the piston and packing cup 18 from chamber 13, the head is provided with grooves 20.

A second piston 21 is positioned in the forward portion of cylinder 3 and carries a packing cup 22. This second piston is provided with a rearwardly extending skirt 23 of smaller diameter than the cylinder and threaded into the rear end is an annular member 24. Since skirt 23 is of smaller diameter than the cylinder, there is formed a chamber 25 surrounding the skirt between piston 21 and member 24. The annular member 24 is adapted to receive the forward end of the projection 16 and in order to prevent the member from sliding off the extension, said extension carries a washer 26 for engaging the inner end of the annular member. An annular packing cup 27 is associated with annular member 24 in order to seal it with the cylinder wall and the extension 16. The annular member 24, together with the head 17 of piston 12, the cylinder wall and the extension 16, form an annular chamber 28 which is in communication the reservoir by a porthole 29 which is uncovered when piston 12 is retracted.

The pistons 21 and 12 have interposed therebetween a spring 30 of predetermined strength, said spring normally holding the pistons in their extreme separated positions determined by the engagement of washer 26 with the annular member 24. There is also provided a spring 31 which is interposed between the end of the cylinder and piston 21, this spring being considerably weaker than spring 30. In order that chamber 32 ahead of piston 21 may be in constant communication with the reservoir when the piston is in retracted position, there is provided a porthole 33 positioned just forward of the piston packing cup when said piston is retracted. The reservoir is also in constant communication with the annular chamber 25 by an opening 34. An opening 35 in the skirt also permits interchange of fluid between chamber 25 and chamber 36 within the skirt 23 and the extension 16. In order to aid fluid in passing the periphery of piston 21 from chamber 25 said piston has its periphery provided with grooves 37.

The pistons are actuated by a piston rod 38

cooperating with piston 12. A dust excluding boot 39 is associated with the rear end of the cylinder and the piston rod. Also, a light spring 40 is interposed between annular cups 18 and 27 to hold these cups, respectively, against the faces of piston head 17 and annular member 24.

Referring to the operation, the parts of the master cylinder device will be in the positions shown in the figure when the master cylinder is inoperative. The reservoir will be filled with fluid as will also chambers 13, 28, 32, 25 and 36. When the master cylinder is inoperative, all these chambers will be in communication with the reservoir and, therefore, expansion and contraction of the fluid will be freely permitted.

When it is desired to operate the master cylinder device to develop fluid pressure, the piston rod 23 is moved to the left, thereby moving piston 12. Due to the strength of spring 30, piston 21 will also be moved to the left simultaneously with piston 12. Initial movement of pistons 12 and 21 will result in the portholes 29 and 33 being cut off by their respective packing cups 18 and 22. As soon as porthole 33 is cut off, piston 21 will begin to develop pressure in chamber 32 and fluid will be forced out of the outlet 4 past valve element 8 and into the branch conduit 5 and conduit 6. The developed fluid pressure will also be effective in chamber 28 between the piston head 17 and the annular member 24 since this chamber is connected to conduit 6 by branch conduit 11 and it cannot expand.

When the pressure developed by piston 21 reaches a predetermined value, as determined by the strength of spring 30, the spring will begin to be compressed and there will be relative movement between piston 12 and piston 21. Due to this relative movement the chamber 28 will be decreased in volume and the piston head 17 will begin to develop additional pressure and force fluid out the outlet 10. Since this additional pressure cannot be effective in the chamber 32 ahead of piston 21 due to valve element 8, the pressure effective in the system connected to conduit 6 will now be solely controlled by piston 12. The area of piston head 17, which is capable of developing pressure, is smaller than the pressure developing area of the piston head 21 and, therefore, less actuating force on the piston rod 38 will be necessary to produce the increase in pressure after spring 30 begins to be compressed. The piston 21 will no longer be moved forwardly since any pressure it is capable of developing will be less than that necessary to unseat valve element 8 which is held seated by the higher fluid pressure being developed by piston head 17 of piston 12. As piston 12 moves relatively to piston 21, the volume of chamber 36 will decrease but the fluid therein can freely pass to the reservoir through chamber 25 and opening 34.

When it is desired to release the developed pressure, piston rod 38 will be permitted to be retracted. Spring 30 will now be free to expand and fluid under pressure can flow back into chamber 28 which will increase in volume due to the relative movement between piston 12 away from piston 21. When spring 30 has fully expanded and washer 26 becomes engaged with the annular member 24 on piston 21, spring 31 will begin to expand and force pistons 21 and 12 rearwardly as a unit. During the movement of piston 21 rearwardly, fluid will flow from chamber 25 past the periphery of piston 21 and the periphery of cup 22 into chamber 32 to maintain this chamber filled with fluid. When piston 21 reaches its retracted position, as shown in the figure, piston 12 will also reach its retracted position. Under these conditions the porthole 29 will be uncovered to thus release the remaining developed fluid pressure in chamber 28 and the system connected to conduit 6. If, during the retracting movement of piston 12 and prior to full expansion of spring 30, there should be created a sub-atmospheric pressure in chamber 28 due to slow return of developed pressure from the system, additional fluid may flow into said chamber 28 from chamber 13 by passing piston 17 and cup 18.

If it is desired to release only a part of the developed fluid pressure, piston rod 38 is permitted to be partially retracted. This will permit expansion of chamber 28 and a decrease in the developed pressure.

When it is desired to employ the master cylinder device as a pump for bleeding, the system connected to conduit 6 is opened and then piston rod 38 is moved forward. Pistons 12 and 21 will be moved as a unit and fluid forced out of chamber 32. The spring 30 will not be compressed as no large pressure will be developed. When the piston rod is retracted and spring 31 pushes piston 21 rearwardly, fluid will flow into chamber 32 from the reservoir by way of chamber 25 past the periphery of piston 21.

Although I have shown a porthole 33 positioned ahead of the packing cup 22 when piston 21 is retracted in order to directly connect chamber 32 to the reservoir, such porthole may be eliminated, if desired, without effecting the free expansion of fluid in chamber 32 when the device is inoperative. When porthole 33 is eliminated and fluid in chamber 32 expands, the pressure will be relieved by way of valve 8, branch conduits 5 and 11, chamber 28, and porthole 29 to the reservoir. If the fluid in chamber 32 contracts, fluid can by-pass the cup 22 from the reservoir by way of opening 34.

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 fluid pressure producing apparatus, aligned pistons having different pressure developing areas, a fluid chamber having fluid therein acted upon by the piston of larger area, a second chamber between the pistons and having fluid therein capable of being acted upon by the other piston, a spring of predetermined strength interposed between the pistons and permitting the piston of larger area to be moved as a unit with the piston of smaller area only until a predetermined pressure is produced by the piston of larger area, means for moving the piston of smaller area, outlets for placing said chambers in communication with a device to be actuated, and a check valve for preventing the fluid pressure developed by the piston of smaller area from being effective in the first chamber when said piston of smaller area is moved relatively to the piston of larger area, said check valve being held closed by the fluid pressure developed by the piston of smaller area to thereby prevent escape of fluid from the first chamber and maintain the piston of larger area stationary.

2. In fluid pressure producing apparatus, a sin-

gle cylinder of uniform diameter, a piston in said cylinder for producing a low pressure, a second piston in said cylinder, means forming an annular chamber and comprising an annular surface carried by the first piston and an annular surface on said second piston, a spring of predetermined strength between the pistons, means for actuating the pistons simultaneously through the spring, an outlet from the cylinder ahead of the first piston, an outlet from the annular chamber, and means causing the first piston to be held stationary when the fluid pressure resistance to its movement is such that the spring will be compressed, said second piston being movable relatively to the first piston when held stationary to thereby decrease the volume of the annular chamber and create a higher fluid pressure than that developed by the first piston.

3. In fluid pressure producing apparatus embodying low pressure producing means and high pressure producing means having a single cylinder of uniform diameter, said low pressure producing means comprising a piston in the forward end of the cylinder and said high pressure producing means comprising means forming an annular chamber one end wall of which is carried by the piston and the other end wall of which is a second piston provided with an annular pressure developing surface capable of relative movement with respect to the first piston, a spring of predetermined strength interposed between the pistons, means for actuating the second piston, connected outlets for the forward end of the cylinder and the annular chamber, and means comprising a check valve for causing the first piston to be held stationary when the fluid pressure developed thereby is such that the spring will be compressed and the annular piston moved relatively to the first piston to decrease the volume of the annular chamber.

4. In fluid pressure producing apparatus embodying low pressure producing means and high pressure producing means having a single cylinder of uniform diameter, said low pressure producing means comprising a piston in the forward end of the cylinder and said high pressure producing means comprising means forming an annular chamber one end wall of which is carried by the piston and the other end wall of which is a second piston provided with an annular pressure developing surface capable of relative movement with respect to the first piston, a spring of predetermined strength interposed between the pistons, means for actuating the second piston, means comprising outlet ports for placing the forward end of the cylinder and the annular chamber in communication with a fluid pressure actuated device, and a check valve for preventing fluid from flowing to the forward end of the cylinder through the outlet port thereof.

5. In pressure producing apparatus, a cylinder of uniform internal diameter, a piston in the forward end of said cylinder, a second piston of the same external diameter as the cylinder positioned in said cylinder rearwardly of the first piston, means forming a chamber between the pistons, one wall of which comprises an area of the second piston which is smaller than the area of the first piston, a spring of predetermined strength interposed between the pistons, means for actuating the second piston, means for placing the forward end of the cylinder ahead of the first piston and the chamber in communication with a fluid pressure actuated device, and a check valve for preventing fluid from flowing from the chamber to the cylinder ahead of the first piston when the second piston develops pressure.

6. In pressure producing apparatus, a cylinder of uniform internal diameter, a piston in the forward part of said cylinder, an outlet from the forward part of the cylinder, a check valve associated with the outlet, an annular member carried by the rear of the piston, a second piston positioned in the rear portion of the cylinder and provided with a cylindrical extension projecting through the annular member, said second piston, the cylinder, the annular member and the extension forming a pressure producing chamber, a spring of predetermined strength interposed between the pistons, an outlet from the chamber, and means for placing the two outlets in communication with each other, said check valve preventing flow of fluid from the chamber to the forward end of the cylinder.

7. In pressure producing apparatus, a cylinder of uniform internal diameter, a piston in the forward part of said cylinder, an outlet from the forward part of the cylinder, a check valve associated with the outlet, an annular member carried by the rear of the piston, a second piston positioned in the rear portion of the cylinder and provided with a cylindrical extension projecting through the annular member, said second piston, the cylinder, the annular member and the extension forming a pressure producing chamber, a spring of predetermined strength interposed between the pistons, an outlet from the chamber, means for placing the two outlets in communication with each other, said check valve preventing flow of fluid from the chamber to the forward end of the cylinder, a retractile spring for the pistons, and means for supplying fluid to the chamber ahead of the first piston during the retractile movement of the piston.

8. In fluid pressure producing apparatus, pistons having different pressure developing areas, a fluid chamber having fluid therein acted upon by the piston of larger area, a second chamber having fluid therein capable of being acted upon by the other piston, an actuating member for the pistons, means for connecting the pistons to the actuated member for initial simultaneous movement thereby and comprising a spring of predetermined strength interposed as an element between the member and the piston of larger diameter, separate outlets for placing the chambers in communication with a device to be actuated, and a check valve for preventing the fluid pressure developed by the piston of smaller area from being effective in the first chamber when said piston of smaller area is moved relatively to the piston of larger area by compressing said spring, said check valve being held closed by the fluid pressure developed by the piston of smaller area to thereby prevent escape of fluid from the first chamber and thus maintain the piston of larger area stationary, said second chamber having the larger piston so associated therewith that when the pistons are moved simultaneously the volume of the second chamber will not be varied.

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