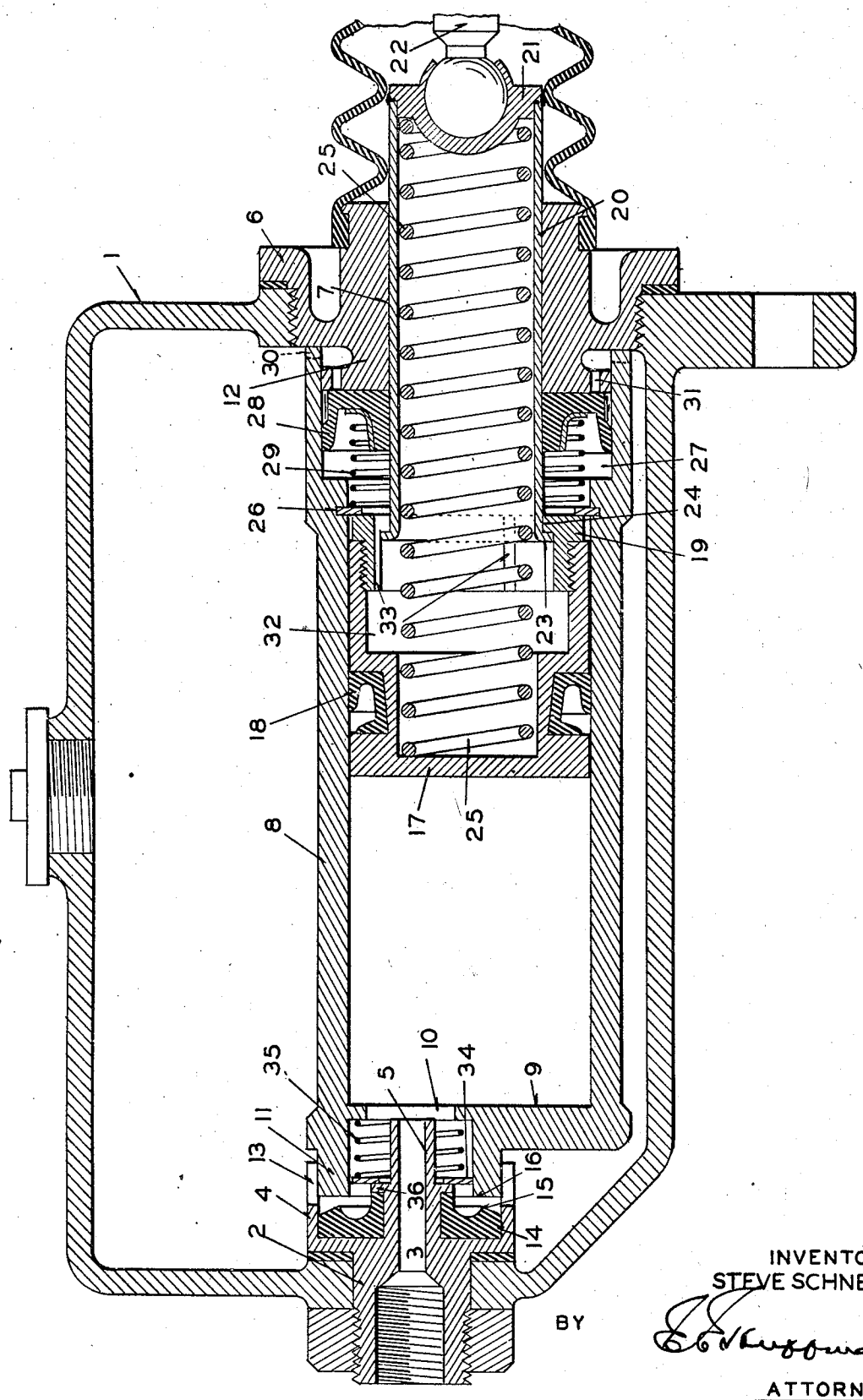
March 9, 1943. S. SCHNELL 2,313,273

COMPOUND MASTER CYLINDER

Filed Oct. 3, 1941



INVENTOR
STEVE SCHNELL

BY

ATTORNEY

Patented Mar. 9, 1943

2,313,273

UNITED STATES PATENT OFFICE

2,313,273

COMPOUND MASTER CYLINDER

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

Application October 3, 1941, Serial No. 413,461

6 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 whereby the actuating 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 wherein there will be a gradual transition from the low pressure producing means to the high pressure producing means.

Another object of my invention is to provide a compound master cylinder wherein compensation for contraction and expansion of fluid in the system can be accomplished without the employment of portholes which must be passed by sealing cups associated with pressure producing pistons.

Another and more specific object of my invention is to produce an improved compound master cylinder device wherein the piston of the low pressure producing means acts directly upon the fluid of the actuating system and the piston of the high pressure producing means acts upon fluid in a confined chamber, one wall of which is formed by the low pressure piston.

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

Referring to the figure in detail, the numeral 1 indicates a reservoir casing provided with a plug 2 at its forward end having an outlet passage 3 therein to which is connected the usual conduit leading to the fluid motor or other device to be actuated by fluid pressure. The inner end of the plug is provided with a cylindrical flange 4 and a central projection 5 through which the outlet passage extends. At the rear end of the casing there is also provided a threaded member 6 having a cylindrical bearing 7.

Within the reservoir casing is positioned a cylinder 8 mounted for limited reciprocable movement. The forward end of this cylinder is formed with an end wall 9 having an opening 10 placing the cylinder in communication with a cylindrical extension 11 which is slidably received in flange 4 to thus constitute a support for the front end of cylinder 8. The rear end of the cylinder is slightly enlarged and fits over an extension 12 on the member 6 to thus constitute a support for the rear end of the cylinder 8.

The flange 4 on plug 2 is formed with slots 13 which permit the reservoir to communicate with outlet 3 and with the interior of cylinder 8 through the cylindrical extension 11 and opening 10 when cylinder 8 is in its rearmost position as shown. Positioned in the annular space between flange 4 and extension 5 is a sealing member 14 of rubber or like material having an annular rib 15 for cooperation with the flat end surface 16 on extension 11. Thus it is seen that when cylinder 8 is moved forwardly, slots 13 will be closed and the sealing member 14 will be engaged and compressed to thereby prevent any communication between cylinder 8 or outlet 3 and the reservoir. The sealing member is prevented from being excessively compressed by the engagement of the end of cylinder 8 with the end of flange 4.

Positioned within cylinder 8 for reciprocation is a hollow piston 17 having a sealing cup 18. The rear of the skirt of this piston carries a threaded ring 19 through which projects a cylinder member 20 having bearing in the cylindrical bearing 7. The outer end of the cylindrical member 20 is closed by a plug 21 forming a piston. To this is connected a piston rod 22 for actuation by the usual brake pedal or some other means, and with which is associated the usual spring for retracting the piston rod.

The inner end of the cylindrical member 20 is provided with a flange 23 for engaging an inwardly extending flange 24 or ring 19. Between piston 17 and plug 21 is interposed a coil spring 25 of predetermined strength, said spring maintaining the piston and plug in their extreme separated positions as determined by the engagement of the flanges 23 and 24. The spring 25 may be compressed and the piston and cylinder moved relatively toward each other when the resistance to the movement of piston 17 is greater than the predetermined strength of spring 25. The retracted position of piston 17 is determined by a stop 26 carried by cylinder 8, the piston being returned to this retracted position by the pull of piston rod 22 under the action of the usual spring (not shown).

In order that chamber 27 at the enlarged rear end of cylinder 8 may be properly sealed, there is provided an annular sealing cup 28 cooperating with the wall of the cylinder and the external surface of the cylindrical member 20. This sealing cup is held against the extension 12 by a light spring 29 interposed between the sealing cup and stop 26. Said sealing cup is capable of preventing fluid from flowing out of chamber 27 but fluid may flow into the chamber from the

reservoir in the event the pressure therein is below atmospheric pressure. The path of flow is through slots 30 at the end of the cylinder and openings 31 in extension 12 and then past the periphery of the cup in a well-known manner. In order that chamber 27 may freely communicate with chamber 32 formed by the hollow piston and the cylindrical member 20, threaded ring 19 is provided with slots 33. Thus fluid may freely interchange between chambers 27 and 32 whenever there is any relative movement between the cylindrical member 20 and piston 17.

The friction between sealing cup 18 on the piston and the cylinder wall insures that the cylinder may be moved forwardly with the piston when the piston is initially moved. In the event the friction should be found insufficient, a friction ring may be additionally employed. Thus the valve means at the forward end of the cylinder will be closed before relative movement between the piston and cylinder takes place to develop pressure. In order to prevent any rapid flow of fluid in cylinder 8 in 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 34 of slightly less diameter than the internal diameter of the cylindrical extension 11. A weak spring 35 maintains this washer in engagement with the shoulder 36 on projection 5. Thus it is seen that the washer restricts flow of fluid from cylinder 8 to the reservoir when the valve means is open. Fluid may flow from the reservoir to the cylinder without appreciable restriction as the washer can be moved away from the shoulder 36 by compression of the weak spring.

Referring to the operation of the master cylinder device, the parts will be in the positions shown in the figure when the master cylinder is in inoperative condition. The cylinder 8 ahead of piston 17 will be filled with fluid as will also chambers 27 and 32 at the rear of the piston. The valve means at the forward end of the cylinder will be open, due to the fact that the retracting spring (not shown) acting on the piston rod will cause the cylinder to be pulled rearwardly by the engagement of ring 19 of piston 17 with the retractile stop 26. Thus expansion and contraction of the fluid in cylinder 8 ahead of piston 17 can freely take place. If the fluid in chambers 27 and 32 expands, fluid can flow past the periphery of piston 17 (loose fit) and cup 18. If fluid in the chambers contracts, additional fluid can flow to the chambers from the reservoir through slots 30, opening 31, and past cup 28.

When it is desired to operate the master cylinder, the piston rod 22 is moved to the left. Due to the predetermined strength of spring 25, the cylindrical member 20 and piston 17 will be moved as a unit with the piston rod. Initial movement of piston 17 will cause the cylinder 8 to be carried with it due to the friction of cup 18. Therefore, the surface 16 on extension 11 will engage with the sealing member 14 and cut off communication between the reservoir and the forward end of cylinder 8. When this occurs there can be relative movement between piston 17 and cylinder 8 and thus fluid pressure will be developed by piston 17. As fluid pressure is developed in the cylinder, there will be a differential force acting on the forward wall 9 which will hold surface 16 in engagement with the sealing member to maintain this valve means closed. It is to be noted that the force acting to hold the valve closed will be proportional to the pressure being developed in cylinder 8.

As piston 17 moves forwardly and develops pressure, the volume of chamber 27 will increase and there will be a tendency to be established in said chamber a sub-atmospheric pressure. This, however, will be prevented and the chamber maintained full of fluid by fluid entering from the reservoir past the periphery of the sealing cup 28.

When the pressure developed by piston 17 reaches a predetermined value (such value being determined by the strength of spring 25), the spring will begin to be compressed and there will be relative movement of the cylindrical member 20 and piston 17 toward each other. This relative movement will result in the fluid in chambers 27 and 32 being compressed due to the fact that the total volume of these chambers will now be decreased instead of increased. Before spring 25 begins to be compressed, the pressure being developed for a given applied force is determined by the cross-sectional area of piston 17. When spring 25 begins to be compressed, the force moving piston 17 will no longer be the force applied to the piston rod but the force applied through the spring plus the force caused by the fluid pressure developed by the cross-sectional area of the cylindrical extension 20. Thus it is seen that there is obtained an increased force for moving piston 17 to develop pressure, said increased force being greater than that which is applied to piston 22. In other words, increased pressure will be created without proportionally greater increase in the applied operating force. As greater pressures are developed by piston 17, there will be greater relative movement between the cylindrical member 20 and piston 17, thus causing spring 25 to be additionally compressed. Fluid does not pass the cup 18 during the relative movement between the piston 17 and the cylindrical extension 20 because the fluid pressure is greater ahead of piston 17 than at the rear thereof due to the action of spring 25.

When it is desired to release the developed pressure, piston rod 22 is permitted to be retracted. The spring 25 will expand until the relative position of piston 17 and the cylindrical member 20 is as shown in the drawing. Also, the piston 17 will be forced rearwardly until the stop 26 is engaged. This rearward movement of piston 17 is caused by the return flow of the developed pressure through the outlet passage 3 and also by the pull of the retracting spring associated with piston rod 22. The valve means at the forward end of the cylinder will remain closed until piston 17 reaches its retracted position wherein stop 26 is engaged. When this occurs, cylinder 8 will be moved rearwardly and the surface 16 disengaged from the sealing member 14 to thus relieve the pressure ahead of piston 17 and allow fluid to flow back into the reservoir. The rearward movement of cylinder 8 to open the valve means is brought about by a differential fluid pressure force acting through piston 17 and stop 26 on the cylinder 8.

As piston 17 moves rearwardly toward stop 26, the total volume of chambers 27 and 32 will be decreased and the fluid therein placed under pressure. This fluid will be forced out by way of the periphery of piston 17 and past cup 18, the piston 17, as previously noted having a loose fit

with the cylinder in order to permit the fluid to slip by said piston. The excessive fluid which passes piston 17 will return to the reservoir when the valve means at the forward end is opened as piston 17 reaches its retracted position.

If it is desired to release a part of the developed pressure, this can be accomplished by allowing the piston rod 22 to be retracted the desired distance since the valve means at the forward end of the cylinder will not be opened until piston 17 reaches its retracted position. It is seen that the developed pressure can be decreased as desired by merely permitting piston 17 to move rearwardly.

When it is desired to bleed the system and employ the master cylinder device as a pump, the initial forward movement of piston 17 will cause the closing of the valve means at the forward end of the cylinder. The fluid in the cylinder will now be forced out through the valve in the system which has been opened for bleeding purposes. The spring 25 will not be compressed as no great pressure will be developed. When the piston rod 22 is retracted, the initial return movement of piston 17 will carry with it cylinder 8 due to the friction of cup 18, thus immediately opening the valve means at the forward end of the cylinder and allowing fluid to enter the cylinder ahead of piston 17 as the piston moves to its retracted position where stop 26 is engaged. Fluid which enters chamber 27 from the reservoir during the forward movement of piston 17 slips past piston 17 on its return movement.

Being aware of the possibilities 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, 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, a piston within the cylinder for developing a low fluid pressure, means forming a chamber at the rear of the piston, a second piston having a smaller pressure producing area than the first piston and capable of acting on the fluid in the chamber, means for actuating the second piston, a spring of predetermined strength interposed between the pistons and causing the pistons to move as a unit until the pressure developed by the large piston offers such a resistance to the movement of the first piston that the spring will be compressed and the smaller area piston permitted to move relatively to the larger piston, means for permitting fluid to flow from the reservoir to the chamber when the fluid pressure therein is less than atmospheric pressure but not permitting fluid to flow in the reverse direction, and means for moving the cylinder to close the valve means when the larger piston is initially moved to develop pressure.

2. In 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, a piston within the cylinder for developing a low fluid pressure, means forming a chamber at the rear of the piston and provided with a fixed rear wall, means for permitting fluid to pass the piston from the chamber but not in the reverse direction, a cylindrical plunger of smaller diameter than the first piston and extending through the rear wall into the chamber, means for actuating the plunger, a spring of predetermined strength interposed between the piston and the plunger and causing said piston to be moved as a unit with the plunger until the pressure developed by the piston offers such a resistance to movement thereof that the spring will be compressed and the plunger permitted to move relatively to said piston, an annular packing cup surrounding the plunger and positioned adjacent the fixed wall of the chamber, a passage through the wall in communication with the reservoir, said packing cup permitting fluid to flow from the reservoir through the passage and into the chamber when the fluid pressure therein is less than atmospheric pressure, said packing cup preventing flow of fluid in the opposite direction, and means for moving the cylinder and closing the valve means when the piston is initially moved to develop pressure.

3. In fluid pressure producing apparatus, a reservoir, a cylinder mounted for limited reciprocable movement and having an enlarged cylindrical rear end, an outlet for the forward end of the cylinder, valve means controlled by the reciprocable movement of the cylinder for controlling communication between the reservoir and the cylinder, a piston within the cylinder for developing a low fluid pressure, a retractile stop for the piston, means forming a chamber at the rear of the piston and comprising the enlarged cylindrical rear end of the cylinder and a fixed rear wall, a cylindrical plunger of smaller diameter than the first piston and extending through the rear wall into the chamber, means for actuating the plunger, a spring of predetermined strength interposed between the piston and the plunger and causing said piston to be moved as a unit with the plunger until the pressure developed by the piston offers such a resistance to movement thereof that the spring will be compressed and the plunger permitted to move relatively to said piston, means for limiting the amount of separation of the piston and plunger by the spring, an annular packing cup surrounding the plunger and positioned adjacent the fixed wall of the chamber, a spring for biasing the cup against the wall, means for permitting fluid to flow from the reservoir past the fixed wall and the cup into the chamber when the fluid pressure therein is less than atmospheric pressure, said packing cup preventing flow of fluid in the opposite direction, and means for moving the cylinder and closing the valve means when the piston is initially moved to develop pressure.

4. In fluid pressure producing apparatus, a reservoir, a cylinder, an outlet for the cylinder, a piston in said cylinder, means for placing the reservoir in communication with the cylinder ahead of the piston when the piston is in retracted position, means forming a fluid containing chamber at the rear of said piston, means permitting fluid to pass the piston from the chamber at the rear to the portion of the cylinder ahead of said piston when the fluid pressure in the chamber is greater than that in the cylinder but not in the reverse direction, a second piston

of smaller pressure developing area than the first piston and capable of acting on the fluid in the chamber, means for actuating the second piston, a spring of predetermined strength interposed between the pistons for causing the pistons to move as a unit until the pressure developed by the large piston offers such a resistance to the movement of the first piston that the spring will be compressed and the pistons permitted to move relatively to each other, and means for permitting fluid to flow from the reservoir to the chamber but not in the reverse direction.

5. In fluid pressure producing apparatus, a reservoir, a cylinder, an outlet for the cylinder, a piston in said cylinder, means for placing the reservoir in communication with the cylinder ahead of the piston when the piston is in retracted position, means forming a fluid containing chamber at the rear of said piston, means comprising a packing cup associated with the piston permitting fluid to pass the piston from the chamber at the rear to the portion of the cylinder ahead of said piston when the fluid pressure in the chamber is greater than that in the cylinder but not in the reverse direction, a second piston of smaller diameter than the first piston and capable of acting on the fluid in the chamber, means for actuating the second piston, a spring of predetermined strength interposed between the pistons for causing the pistons to move as a unit until the pressure developed by the large piston offers such a resistance to the movement of the first piston that the spring will be compressed and the pistons permitted to move relatively to each other, and a packing cup associated with the second piston and the wall of the chamber for preventing fluid from flowing out of the chamber but permitting fluid to flow from the reservoir to the chamber when the fluid therein is less than atmospheric pressure.

6. In a fluid pressure producing apparatus, a reservoir, a cylinder, an outlet for the cylinder a piston in said cylinder, means for placing the reservoir in communication with the cylinder ahead of the piston when the piston is in retracted position, means forming a fluid containing chamber at the rear of said piston, means permitting fluid to pass the piston from the chamber at the rear to the portion of the cylinder ahead of said piston when the fluid pressure in the chamber is greater than that in the cylinder but not to pass in the reverse direction, a second piston of smaller pressure developing area than the first piston and capable of acting on the fluid in the chamber, connecting means between the pistons for positively limiting their extent of separation but not interfering with their relative movement toward each other, a spring of predetermined strength interposed between the pistons for normally maintaining said pistons at their extreme limit of separation and for causing the pistons to move as a unit when the second piston is operated until the pressure developed by the large piston offers such resistance to the movement of said piston that the spring will be compressed and the pistons permitted to move relatively toward each other, and means for permitting fluid to flow from the reservoir to the chamber but not in the reverse direction.

STEVE SCHNELL.