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HYDRAULIC PRESSURE SYSTEM

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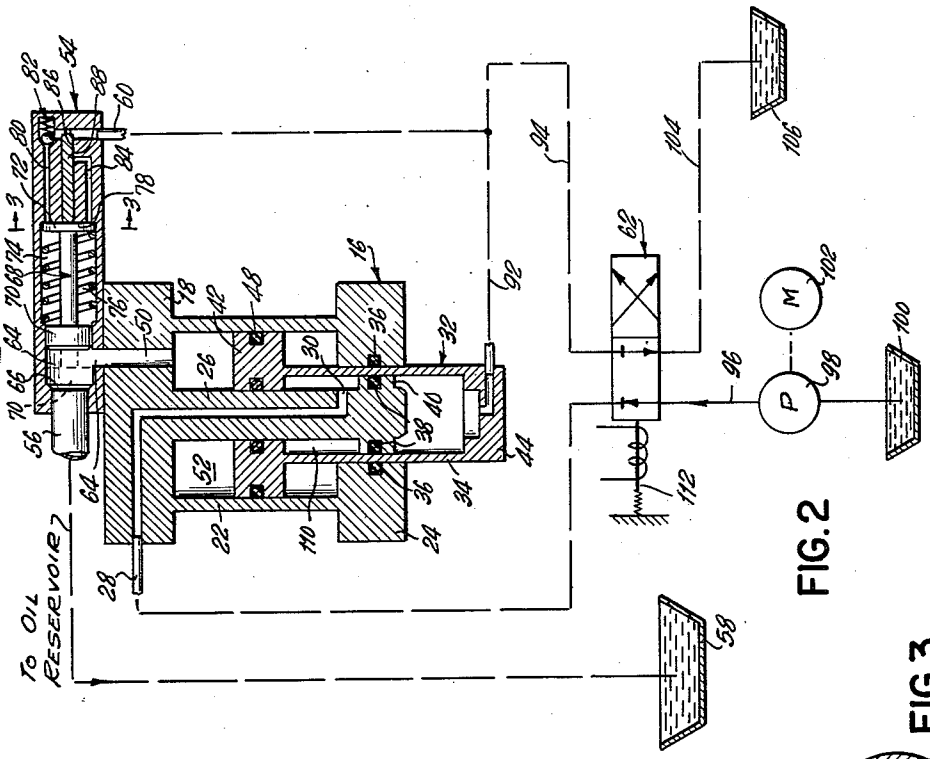


FIG. 2

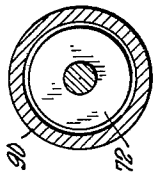


FIG. 3

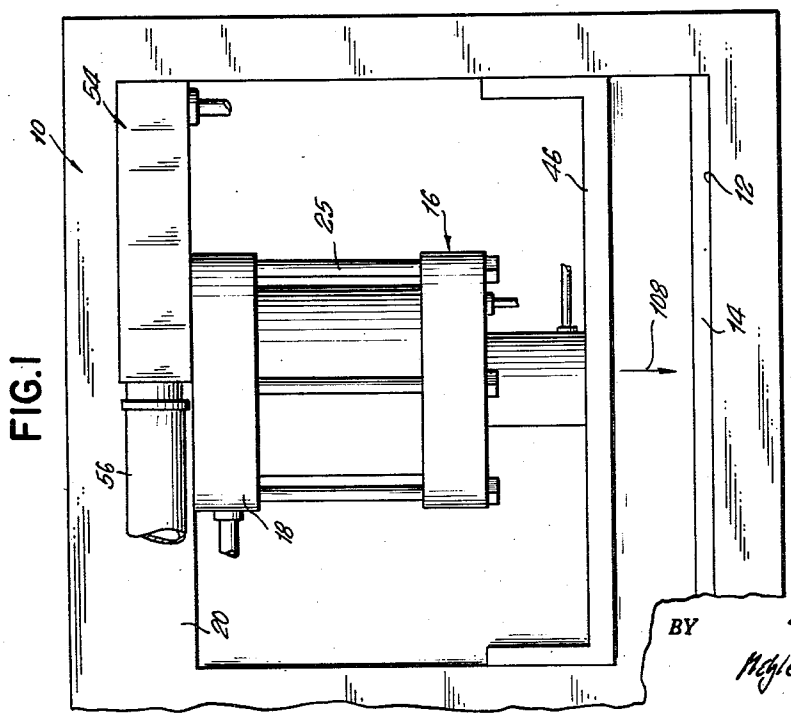


FIG. 1

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HYDRAULIC PRESSURE SYSTEM

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This invention relates in general to a hydraulic pressure system and in particular to a new and useful hydraulic press including an automatic arrangement for rapidly advancing a ram toward a workpiece under low power and low pumping volume requirements and for effecting full force against the workpiece after the ram is positioned in contact therewith.

At the present time, hydraulic presses include, in most instances, a single cylinder construction for advancing the ram under the force of fluid to pressurize one side of a piston connected to the ram. A disadvantage in a single cylinder construction is that a large horsepower requirement for pumping the fluid to advance the ram is required to act against the large area piston, even though the force of the ram is not being applied to a workpiece. The area of the piston must be designed sufficiently large to effect a large enough force for effecting sufficient pressing action on the workpiece, but the ram itself could be advanced by a smuch smaller sized piston area member while it is maneuvered to and from the workpiece.

In some instances, hydraulic pressure systems include a small sized so-called slave cylinder for the purposes of moving the ram backwardly and forwardly before it contacts the workpiece. Such systems include a control for switching to a large size piston for effecting a large force on the workpiece by the ram. Such systems have the obvious disadvantage that they require a duplication of the hydraulic pressure lines and there is a difficulty in locating the slave cylinder so that the force which it exerts on the ram will act in a uniform axial direction so that the ram will not be misaligned during its movement. A very important disadvantage of the use of a master piston for effecting ram force on the workpiece and the slave piston for advancing the ram is that the control valving to switch from the pressurizing of the slave cylinder to the pressurizing of the master piston must be sufficiently large to accommodate the displaced fluid from the master cylinder. This, of course, results in a large expenditure for valving and associate piping and the requirement for large horsepower motor to operate the pump, since it is necessary to handle at least some portion of the liquid of the master cylinder even though a small size slave cylinder is operating to maneuver the ram into position.

In accordance with the present invention there is provided a combination master and slave cylinder construction which includes a relatively small diameter slave cylinder having side walls which are slidable in an end wall of the main or master cylinder and which forms at its inner end the master piston which reciprocates within the master cylinder. The center of the master cylinder includes a cylindrical portion in which there is drilled a passage for conducting fluid under pressure to a location between the interior face of the master piston and an interior slave cylinder dividing wall formed as an extension of the end wall of the master cylinder and within the hollow slave piston. The pressure which is built up within the interior of the hollow pressure slave system causes movement of a ram attached to the end of the piston by the pumping of a relatively small quantity of fluid which acts against the relatively small area which is exposed within the hollow slave piston and which acts against the end wall of the master cylinder and the interior wall of the master piston to advance the hollow slave piston and the ram.

The invention includes an arrangement in which the actuating fluid is sucked into the master cylinder by movement of the master piston by the pressure of the fluid acting on the hollow slave piston. Thus a small quantity of fluid and small pumping capacity is required to maneuver the ram into an operating position while the master piston is actually sucking large quantities of fluid through a suitable connection through the one end of the master cylinder to the fluid reservoir.

A feature of the invention is that the ram may be operated automatically to advance the ram and upon the ram encountering a major resistance force such as the workpiece to be operated upon, the fluid pressure is automatically directed into the master cylinder and against the master piston to effect the exertion of a large compression force by the ram.

A further feature of the construction is that a low capacity control valve may be employed to effect both the advancing and the reversing movements of the ram. This control valve is not required to handle the fluid which is displaced by the master piston during its movements. Instead, the valving arrangement includes means to connect the master piston to a reservoir upon initiation of return movement of the ram by directing pressurized fluid into the hollow slave piston at a location between the end wall of the master cylinder and the interior wall of the master piston. The only electrical or manual control required is one four-way valve which permits pressurizing of the interior of the slave piston at one side of the master piston end wall and the simultaneous pressurizing of one side of the master piston after the force of the workpiece has been encountered, and for alternatively directing the pressure to the interior of the slave piston on the opposite side of the end wall of the master cylinder for the return movement of the ram. The valve also includes means for connecting the side of the slave piston which is not pressurized to a reservoir when the other side is pressurized and vice versa.

Thus, the invention provides an unusual hydraulic pressure system for a ram which makes it possible to manipulate the ram by displacing a very small quantity of control fluid and by expending a very small amount of horsepower in pumping such fluid. Besides the fact that it is not necessary to pump a large quantity of fluid in the manipulation of the master cylinder which exerts the major pressure force on a workpiece, the invention provides a system which is much simpler from prior art constructions, particularly in respect to the amount of parts and conduits required and in respect to the control valves which are necessary.

Accordingly, it is an object of this invention to provide an improved hydraulic pressure system.

A further object of the invention is to provide a hydraulic press including a combination master cylinder and piston construction in which the slave piston is made hollow and has its walls in an end wall of the master cylinder for reciprocation therein, and including improved means for manipulating the ram under the control of the slave piston and for automatically switching to actuation of the master piston upon contact by the ram of the workpiece or load.

A further object of the invention is to provide an improved hydraulic control system for a hydraulic press including means for rapidly advancing the ram by the displacement of a small quantity of control fluid.

A further object of the invention is to provide a high speed hydraulic press including means for advancing the ram thereof by the displacement of a small quantity of control fluid and the expenditure of a relatively small amount of power, and further including automatic means for increasing the pressure force applied on the ram after it contacts a workpiece.

A further object of the invention is to provide a hydraulic press which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawing and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a top plan view of a hydraulic press constructed in accordance with the invention;

FIG. 2 is a somewhat schematic transverse horizontal section through the combination master and slave cylinder and control valve indicated in FIG. 1 and showing the various hydraulic conduit connections; and

FIG. 3 is a vertical section taken on the line 3—3 of FIG. 2 on a somewhat exaggerated scale.

Referring to the drawings in particular, the invention embodied therein includes a hydraulic press comprising a rigid rectangular frame generally designated 10 which includes a front wall 12 against which is rigidly fastened a clamping jaw 14 of the hydraulic press.

A combination master and slave cylinder construction generally designated 16 is provided with a reinforced end wall or head 18 which is rigidly fastened to an end wall 20 of the frame 10. In accordance with the invention, the combination master and slave cylinder and piston member 16 includes a relatively large diameter master cylinder 22 formed as an extension of the head 18 and terminating in an opposite end wall or head 24 which is secured to the wall 18 by means of elongated stud or bolt members 25. The head 18 includes a central elongated cylindrical extension 26 which extends from the head 18 in the direction of end wall 24. The end wall or head 18 and the cylindrical extension 26 are provided with a passage 28 for conducting control fluid through an opening 30 which is located approximately in the same plane as the end wall 24.

The construction includes a combination hollow slave piston and master piston assembly generally designated 32 which includes a cylindrical wall portion 34 which is slidable between suitable seals 36 and 38 in the end wall 24 and lateral annular extension 40 of the cylindrical extension 26, respectively.

The cylindrical walls 34 define a slave hollow piston or cylinder member which has one wall closed by a master piston 42 in an opposite end closed by a wall 44 which is connected to a ram 46. The ram 46 is adapted to be displaced by the hydraulic fluid in directions toward and away from the clamping jaws for operation on a workpiece positioned between the clamping jaws and the ram. In the embodiment shown, the press is a bookbinding press.

The master piston 42 is of a larger diameter than the cylindrical walls 34 and includes a sealing ring 48 to maintain a fluid tight seal during the reciprocation of the piston 42 in the cylinder 22. A conduit 50 is provided for directing fluid into the space 52 between the end wall 18 and the master piston 42. The conduit 50 also provides a passage for relieving the pressure during the return movement of the piston 42.

A feature of the invention is the provision of a novel valve member generally designated 52 which is provided with an opening at one end 56 which is connected to an oil reservoir 58 and a small size opening 60 which is connected to a four-way solenoid control valve generally designated 62. An intermediate opening 64 is provided in the control valve member 54 in alignment with the opening 50 in the end wall 18. The interior of the valve control member 54 is provided with a bore portion 64 of larger internal diameter than the conduit 56 and a beveled portion 66 connecting conduit 56 and portion 64.

A combination plunger and piston member generally designated 68 includes a plunger portion 70 which is slidable in the portion 64 and a piston portion 72 which is slidable within a slightly larger diameter portion 74. The diameter of the piston portion 72 is larger than the plunger diameter 70 for the purpose to be set forth more fully hereinafter.

The piston is biased by means of a spring 76 against an end wall 78 which is provided with openings which lead to passages 80 which connect via a check valve 82 to the conduit 60 and a passage 84 which connects to a central passage 86 in which a pilot rod member 88 is slidable. There is a clearance between the piston portion 72 and the cylindrical walls 90 of the control valve member 54 for the purpose of permitting the passage of pressurized control fluid therearound as will be described more fully hereinafter (see FIG. 3).

The conduit 60 joins to a flexible conduit 92 which connects into the hollow slave piston 32 between the exterior end of the cylindrical extension 26 and the end wall 44 thereof. Each of the conduits 92 and 60 leads to a combined conduit 94 which connects to the four-way solenoid actuated valve 62. The conduit 28 also connects to the four-way solenoid actuated valve 62.

The opposite side of the valve 62 is connected through a conduit 96 which leads to a pump 98 which takes suction in a fluid reservoir 100. A pump motor 102 is provided to rotate the pump 98 to pressurize the conduit 96 and the pressure of the fluid delivered by the pump through the conduit 96 may be selectively connected to the conduit 28 or to the conduit 94. Four-way valve 62 is also connected by way of a conduit 104 to a fluid reservoir 106. It should be appreciated that the reservoirs indicated as 58, 100 and 106 may be and normally are one and the same reservoir.

The operation of the device is as follows: When it is desired to advance the ram 46 in a direction of the arrow 108 a solenoid plunger 112 is actuated by a suitable electrical control to cause the pressurized conduit 96 to be communicated to the conduit 94 and to simultaneously connect the conduit 28 to the reservoir 106 via the conduit 104.

After the valve is thus positioned, pressure is admitted through conduit 92 to the hollow slave piston 32 at the location between the widened end 40 of the cylindrical extension 26 and the end wall 44 to cause a buildup of pressure therein and movement of the wall 44 away from the extension 26 to displace the ram 46 in the direction of the arrow 108. During this time, conduit 28 is exposed through the opening 30 to the interior of the slave piston 32 to a chamber 110 on the opposite side of the widened portion 40 of the cylindrical extension 26 and the fluid pressure is relieved in the chamber 110. This permits the control fluid to be bled through the passage 28 to the valve 62 and conduit 104 to the reservoir 106. Thus rapid advance of the ram 46 is accomplished by means of the displacement of a small quantity of fluid in a hollow slave piston 32.

It should be appreciated that when the ram 46 is displaced by the pressurizing of the slave piston 32 in the chamber formed between the end of the cylindrical extension 26 and the walls 44, the master piston 42 is also moved within the cylindrical walls 22. This movement of the master piston 42 causes the sucking in of fluid from the reservoir 58 through the conduit 56 into the chamber 64 of the control valve 54 and through conduit 50 to the chamber 52. Thus, a large quantity of liquid is displaced by the movement of the master piston 42 but this liquid does not have to be separately pumped and it does not pass through the control valve 62.

When the ram 46 meets resistance such as by contacting a workpiece, the pressure in conduits 92, 94 and 60 builds up to a value sufficient to push the pilot rod 88 in the control valve 54 to the left as indicated in FIG. 2. This causes movement of the plunger 70 to the left as

viewed in the drawings until the whole plunger and piston assembly 68 moves sufficiently to close the opening 50. At this time pilot rod 88 has moved sufficiently to the left to uncover the passage 84. The pressurized fluid from the conduit 60 passes through the passage 84 and around the piston 72 to a space within the valve between the piston 72 and the plunger 70, while it continues to urge the combination piston and plunger member 68 to the left to close thus preventing any escape of fluid.

The plunger portion 70 moves sufficiently to uncover the passage 50 and permit it to communicate with the passage 60 through the passage 84 to cause the fluid to enter the chamber 52 and displace the master piston 42 to cause the exertion of a large amount of force by the ram 46 on the workpiece. Once the fluid pressure within the chamber 52 is increased, the plunger 70 is urged against the beveled portion 66 with an increasing force to tightly close off the conduit 56 and prevent leakage of oil to the reservoir 58.

When it is desired to retract the ram 46 the plunger 112 of the valve 62 is actuated to connect the conduit 28 to the pressure line 96 and the conduit 94 to the reservoir 106. The pump 98 therefore directs fluid through the conduit 28 and out the opening 30 to pressurize the chamber 110. Since the cylindrical extension 26 and its flange portions 40 are stationary, the master piston 42 is displaced by the action of the fluid within the smaller annular area defined at one end of the chamber 110. Since the conduit 92 and the conduit 60 are connected to the reservoir, the pressure is relieved on the other side of the cylindrical extension in the slave hollow piston 32 and return movement may be accomplished. However, as long as the plunger 70 closes the opening to the conduit 56, the oil in the chamber 52 is forced to flow through the chamber within the walls of the cylindrical valve 54 between the plunger 70 and the piston 72, around the piston and through the check valve 82 to the conduit 60. The clearance between the piston 72 and the cylindrical walls 90 is arranged to offer some resistance to the large flow of oil from the chamber 52. Some pressure will therefore be maintained in the chamber 52 which will push back the combination plunger and piston rods 68 and to first close and thereafter open the port 64. This occurs because the piston 72 is of a larger diameter than the plunger 70 and the pressure acting against the face of the piston overcomes the pressure acting against the face of the plunger. The spring 76 aids in moving the combination plunger and piston member 68 to the right but it is gradual until the plunger 70 uncovers the port 64. After the port 64 is partly opened, the pressure in the chamber 52 immediately drops as the conduit 50 communicates with the conduit 56 and the spring 76 is therefore able to return the combination piston and plunger member 68 to the position indicated in FIG. 2.

Thus, it can be seen that the ram 46 may be moved or manipulated into a position by the displacement of a small quantity of fluid requiring a pump of much smaller horsepower than if the master piston 42 had to be displaced by directing fluid against its face during the manipulation stage of the ram. The invention includes means for automatically causing the pressurizing of the master piston 42 when the load is encountered by the ram, causing a raising of the pressure in the conduits which feed the slave portion. Since the operation of the device depends on the pressures within the connecting conduits and the associated portions of the control valve, the equipment requires very little maintenance and very little attention in its operation. The device may be operated with a single electrically actuated four-way control valve for effecting forward or reverse movement of the ram 46 as desired. The overall construction is very inexpensive to manufacture and the saving in horsepower requirements is considerable. Due to the fact that the four-way solenoid control valve only handles a small quantity of liquid and not the full quantity of liquid displaced by the piston 42, it may be of much smaller and less costly construction than similar valves in prior art hydraulic systems of this character. The advancing and retracting movement by the slave hollow piston is very rapid.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A hydraulic system comprising a supporting frame, a master cylinder having end walls of relatively large diameter and being supported on said frame, a combination slave cylinder and master piston member including a hollow cylindrical wall portion of smaller diameter than the internal diameter of said master cylinder slidable in an end wall of said master cylinder, said master cylinder including end wall means dividing the interior of said slave cylinder portion, a master piston formed at one end of said slave cylinder of substantially the same diameter as the internal diameter of said master cylinder, and means to selectively pressurize said slave cylinder on alternate sides of said dividing wall means without pressurizing said master cylinder to cause relative movement of said slave cylinder in respect to said end wall means in accordance with the side thereof which is pressurized.

2. A hydraulic system for a press and the like comprising a master cylinder of relatively large diameter, said master cylinder having spaced end walls, one of said end walls having a central extension extending outwardly therefrom toward the opposite end wall, a combination master piston and slave cylinder member slidable in an end wall of said master cylinder and extending around the extension portion of the opposite end wall, said extension portion including a widened portion substantially dividing the interior of said slave cylinder, and pressure conduit means connected directly to said slave cylinder on each side of said widened portion without communicating with said master cylinder, whereby said cylinder is movable relatively to said end wall of said master cylinder in accordance with which side of the interior of said slave cylinder in respect to said widened portion is pressurized.

3. A hydraulic system for a press and the like according to claim 2, wherein said extension portion of said one end wall includes an internal conduit for directing fluid to the interior of said slave cylinder on one side of the widened portion which divides said slave cylinder.

4. A hydraulic system for a press according to claim 2, including a second conduit connected to said master cylinder on the opposite side of said master piston from said slave cylinder, means to selectively pressurize the conduits on alternate sides of said widened portion, and means connected to said pressurizing means and responsive upon the buildup of pressure to a predetermined amount to connect said second conduit to said pressurized means.

5. A hydraulic system for a press according to claim 2, wherein said means to connect said second conduit to said pressurizing means includes a control valve, said control valve having an intermediate conduit connected to said second conduit, reservoir means connecting one end of said control valve, pressurized fluid means connecting the opposite end of said control valve, said control valve having a displaceable valve member therein movable upon increase of pressure in said pressure conduit means to close said reservoir means from communication with said second conduit.

6. In a hydraulic system including a master cylinder of relatively large diameter having closing head portions at each end, one of said head portions having a central opening, a central portion extending interiorly of the other of said head portions to said central opening, including a widened outer end, a combination master piston and slave cylinder member slidable on said central portion in

sealing engagemnt with the end head of said master cylinder and the widened outer end of said central portion, a first conduit defined in said central portion and extending through the connected head and in communication with the interior of said slave cylinder on the interior side of said widened end portion, a second conduit connected to said slave cylinder on the opposite side of said widened end portion, a liquid reservoir, a liquid pressure line, and valve means for selectively connecting said pressure line to said first conduit and connecting said second conduit to said liquid reservoir and for thereafter connecting said second conduit to said liquid pressure means and said first conduit to said liquid reservoir.

7. A hydraulic system according to claim 6, wherein said valve means is a four-way solenoid actuated valve.

8. A hydaulic system according to claim 6, including means connecting said master cylinder on the opposite side of said master piston from said slave cylinder portion to said liquid reservoir, and valve means in said connection including means automatically operable to connect said master cylinder to said liquid reservoir upon the pressurizing of said first conduit.

9. A hydraulic system according to claim 8, wherein said valve means includes means to connect said master cylinder to said liquid pressure line upon the building up of pressure within said second conduit to a predetermined amount.

10. A hydraulic system according to claim 9, wherein said valve means includes a third conduit connection to said master cylinder between said master piston and the adjacent head, and a plunger displaceable between a position closing said third conduit and to a position connecting said third conduit to said fluid pressure means.

11. A hydraulic system according to claim 6, including a third conduit connected to said master cylinder between said master piston and the adjacent head and connected to said second conduit, a control valve disposed in said third conduit, said liquid reservoir being connected to said valve means at one end thereof, said connection to said liquid reservoir being in communication with said third conduit through the interior of one end of said valve, said third conduit and second conduit being in communication at the opposite end of said valve, and a plunger member slidable to close the communication between said third conduit and said reservoir in one extreme position and in an opposite extreme position to close the communication between said third conduit and second conduit and to open the communication between said third conduit and said reservoir.

12. A hydraulic system according to claim 11, wherein said plunger means includes a slidable member having a plunger at one end movable against a seat to close said connection to said reservoir and having a cylindrical skirt portion simultaneously uncovering said third conduit for communication with said second conduit.

13. A hydraulic system according to claim 12, wherein said combination plunger and piston member includes a piston formed at one end having a larger diameter than said plunger member but being of less diameter than the interior walls of said valve.

14. A hydraulic system according to claim 13, wherein said valve has walls having a port extending from a location adjacent said third conduit connection to a location intermediate the ends of said valve, said piston portion being disposed in a chamber at the end of said passage, and a pilot rod adjacent said piston portion and displaceable upon increase in pressure in said second conduit to shift said combination plunger and piston member to cover the connection to said reservoir.

15. A hydraulic system according to claim 14, including a second passage formed in said valve wall and connected to said second conduit and the intermediate chamber of said valve, said second passage having a check valve therein.

16. A control valve for a fluid system comprising a valve body having an opening at one end, a hollow interior chamber portion in alignment with said opening, a first connection intermediate the length of said body to said central chamber, a second connection connecting the opposite end of said separate chamber, a combination plunger and piston member slidable in said chamber and including a plunger portion, a piston portion and a pilot rod disposed adjacent said piston portion extending to said second connection, said pilot rod being displaceable upon increase in pressure in said second connection to displace said combination plunger and piston rod member, said plunger portion being of a size to close said opening and having a skirt portion movable to open and close said first connection, said plunger being moved to an extreme position to completely close said opening and the communication of said first and second connections on the interior of said valve.

17. A control valve for the fluid system according to claim 16, wherein said piston portion is of larger diameter than said plunger portion but is not as large in diameter as the bore of the interior walls of said valve body whereby fluid may bypass annularly around said piston from said first connection to said second connection.

18. A control valve for a fluid system according to claim 17, including a passage defined in said valve body connected between said second connection and the interior chamber of said valve, said passage having a check valve therein.

19. A control valve for a fluid system according to claim 18, including a passage defined between said second connection and central chamber of said valve body.

20. A control valve for a fluid system according to claim 16, wherein said valve body includes a central passage for said pilot rod, a first passage communicating with said second connection and said central chamber, a second passage communicating with said passage for said pilot rod and said central chamber, said pilot rod being displaceable to uncover said first passage to permit fluid connection between said second connection and said central chamber whereby to displace said plunger to initially cover said first connection and thereafter to cover said opening.

21. A control valve for a fluid system according to claim 16, wherein the annular clearance between said piston portion of the bore of the interior walls of said valve body is of an amount to create sufficient resistance to the flow of fluid to cause a back pressure sufficient to force said plunger portion to open the connection between the chamber of the master cylinder and the liquid reservoir, said plunger portion being of a smaller effective area than said piston portion.

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