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(19)

(54) AN HYDRAULIC SYSTEM SAFEGUARDING THE SUPPLY OF FLUID TO A PRIORITY LOAD

(71) We, ROBERT BOSCH GmbH, a German company of Postfach 50, 7000 Stuttgart 1, Germany, do hereby declare

the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement—:

This invention relates to an hydraulic system in which a priority load can still be provided with hydraulic fluid despite a low level of fluid in the supply reservoir due, for example, to leakage in the system or too high a demand for fluid by a non-priority load.

In one such proposed system in which a vehicle steering device represents the priority load, the steering device can no longer be supplied with hydraulic fluid under pressure when external leakages occur and the reservoir is sucked dry as a result. This can lead to serious operational breakdowns of the vehicle.

An hydraulic system in accordance with the invention comprises a reservoir for pressure medium, first and second suction openings arranged in the reservoir and a pump arranged to withdraw pressure medium from the reservoir through the suction openings and to deliver the withdrawn pressure medium to a priority load and to a secondary load through a regulating valve, the first suction opening being controlled by a float valve and the second suction opening being of smaller cross-section than the first suction opening, and being arranged below the level of the first suction opening, the flow regulating valve being arranged to operate in such a manner that, when pressure medium is withdrawn from the reservoir through both suction openings, the flow regulating valve delivers pressure medium to both loads whereas, when pressure medium is withdrawn from the reservoir solely through the second suction opening, the flow regulating valve only delivers pressure medium to the priority load.

Such an hydraulic system has the advantage that low levels in the reservoir can be detected promptly, and the priority load can continue to be supplied, albeit at a lower rate, long enough for operational breakdown to be prevented.

Preferably a third suction opening is arranged in the reservoir, below the level of the second suction opening, and through which the priority load can withdraw pressure medium direct from the reservoir.

The system may also comprise a fourth suction opening and a second pump arranged to withdraw pressure medium from the reservoir through the said fourth suction opening and deliver the withdrawn pressure medium to an auxiliary load. Generally, the fourth suction opening will be arranged above the level of the first suction opening.

If desired, a second pump may be arranged to withdraw pressure medium from the reservoir through the first and second suction openings and to deliver the withdrawn pressure medium to an auxiliary load. The two pumps may be arranged to withdraw pressure medium from the reservoir through a common suction line.

In order that the invention may be clearly understood and readily carried into effect, two embodiments of the system in accordance with the invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows one form of hydraulic system for safeguarding the operation of a priority load, and

Figure 2 shows a modification of the system of Figure 1.

In the embodiment according to Figure 1, two pumps 12 and 13 are driven by a motor 10 through a common driving shaft

11. A suction line 14 leads from the pump 12 to a suction tube 15 which is arranged in an hydraulic pressure medium reservoir 16 so that the pump 12 can withdraw pressure medium from the reservoir 16 through the tube 15. The suction tube 15 has a suction opening located at the height H_1 providing a third suction opening in the reservoir the lowest safe permissible presure medium or oil level of which is referenced H. The pump 12 supplies an auxiliary load with hydraulic fluid through a line 22*a*.

A suction line 17 leads from the pump 13 to a suction tube 18 which is likewise arranged in the pressure medium reservoir and through which the pump 13 withdraws pressure medium from the reservoir 16. The suction tube 18 is shorter than the suction tube 15 and has a first suction opening located at the height H_3 in the reservoir.

A transverse bore 30 formed in the suction tube 18 provides a second suction opening at the height H_2. The height H_2 is greater than the height H_4 but less than the height H_3. At the upper end of the suction tube 18 there is arranged a float valve 31 which consists simply of a spherical valve member 32 the diameter of which is greater than the diameter of the first suction opening at H_3 in the tube 18 and a stirrup 33 which prevents the valve member 32 being removed from the suction tube.

Furthermore, there is fixed in the reservoir 16, a suction tube 19 with a fourth suction opening at the height H_4 which is substantially lower than the opening at the height H_3 and a line 20 leads from the tube 19 to the handpump 21 of an hydrostatic steering device. This device represents the priority load.

An hydraulic line 22 leads from the pump 13 to the inlet 24 of a multiway flow regulating valve 25, from one outlet 26 of which a line 27 leads to the handpump 21 of the hydrostatic steering device. From a second outlet 28 of the flow regulating valve, a line 29 leads to a secondary load.

The flow regulating valve 25 is of known construction. It has a longitudinal bore 35 in which a control slide 36 is sealingly slidingly guided. The control slide has a blind longitudinal bore 37 in which is arranged a calibrated orifice 38. The forward edge 39 of the control slide 36 controls the supply to the outlet 28. Transverse bores 40 which can be brought into communication with the outlet 26, are formed in the control slide at the end of the longitudinal bore 37. The control slide is loaded from the rear end by a control spring 41 which seeks to push the control slide against the flow of pressure medium entering the inlet 24.

According to the setting of the spring 41, the regulating valve 25 supplies a constant flow of pressure medium to the steering device 21 and any residual flow to the secondary load 29.

If the level of pressure medium in the reservoir 16 has fallen below the lowest safe permissible level H then on reaching the height of the third suction opening H_1, the pump 12 can no longer supply its auxiliary load with pressure medium, that is to say, on the occurrence of external leakage in the load circuit of the pump 12 further lowering of the level of pressure medium in the reservoir is prevented but the supply of pressure medium to the priority load circuit by the pump 13 is ensured.

If the level of the pressure medium in the reservoir falls further, for example due to external leakage in the secondary load circuit connected to the line 29, then the supply to the priority load, that is to say the steering device, could also be in danger.

In order to ensure that, even with different pressure medium volumes in the steering cylinder for right-hand and left-hand lock, the steering system remains filled, the height at H_4 of the fourth suction opening in the suction tube 19 must be lower by the amount of this difference in pressure volumes than the height at H_2 of the second suction opening in the suction tube for the pump 13.

So as to prevent failure in the steering, even with external leakages in the secondary load circuit, the float valve 31 and the bore 30 are provided at the suction tube 18. Of course, if the fluid level falls to the height H_3 due to external leakage in the secondary load circuit 29, then the valve member 32 settles over the first suction opening to the suction tube. The pump 13 can then only draw pressure medium through the second suction opening formed by the bore 30. The cross-section of this bore is so calculated that only a pressure medium flow insignificantly smaller than the set constant flow to the steering device 21 through the regulating valve 25 can be withdrawn by the pump 13. That means that the control slide 36 in the flow regulating valve 25 is brought into its initial position by the control spring 41, whereby the forward edge 39 arrives right at the bottom and the control slides and blocks the communication to the outlet 28. Therewith, the supply to the secondary load is also interrupted. However, pressure medium can still flow through the control slide, its transverse bores 40 and the outlet 26 as well as the line 27 to the handpump for the hydraulic steering device. This occurs until the pressure medium level has

fallen to the level of the fourth suction opening at height H_4 due to the relatively small leakage loss at the control slide 36 in the flow regulating valve and then only manual steering is possible. Due to this, the occurrence of dangerous driving conditions is excluded and the possibility afforded of removing the vehicle from the traffic stream more safely.

The load 21 need not be a steering device but can be any other kind of especially important load.

The embodiment according to Figure 2 differs from that according to Figure 1 essentially by the fact that in this instance both pumps 12 and 13 are connected to a common suction line 43 connected to a suction tube 44 which corresponds to the suction tube 18 in the embodiment according to Figure 1. Furthermore, like parts in the embodiment according to Figures 1 and 2 are referenced with the same numerals. However, in the latter embodiment, only two suction tubes are provided in the reservoir 16', namely the suction tube 44 and the suction tube 19. The first suction opening height H_1 is located at the upper end of the suction tube 44 and the second suction opening represented by the transverse bore 30' is situated at height H_2.

A line 60 leads from the pump 13 to the flow regulating valve 25 from whence a line 27 leads to the steering device 21 and a further line 29 leads to a secondary load. Once again, a suction tube 19 has a fourth suction opening at height H_4 and a line 20 leads directly from the tube 19 to the steering device 21. The suction opening at height H_4 is arranged at a level with respect to the suction opening at H_2 so that the relationship between the heights and the volumes of the left and right steering cylinders are the same as in the embodiment of Figure 1. There is no suction tube in the embodiment of Figure 2 which corresponds to the tube 15 in Figure 1, thus, there is no suction opening at height H_3.

A suction line 43, through which the pumps 12 and 13 withdraw pressure medium from the reservoir 16, leads to a relief valve 45 in the housing 46 of which is formed a bore 47 provided with a shoulder 48. The shoulder 48 serves as a valve seat for a valve member 49 which is slidingly guided in the bore 47. At its outer periphery, the valve member has two longitudinal recesses 50 and 51 having the respective cross-sections of F_1 and F_2. These recesses do not extend up to the shoulder 48 so that when the valve member 49 abuts against the shoulder 48 no pressure medium can discharge through the valve. The position of the valve member 49 is determined by a control line 52. If there is pressure in the line 52 then the valve member 49 engages the shoulder 48. To ensure this, a spring 53 having a very low pre-tension is also provided.

Two bores 54 and 55 which penetrate into the bore 47 are formed in the housing 46. The outlets from these bores lie opposite one another and are completely covered by the valve member 49 when it engages the shoulder 48. A suction line 56 which leads to the suction side of the pump 13 is connected to the bore 54. A line 57 which issues into the line 43 branches off from the suction line 56. The line 43 itself is connected to the bore 55. In the line 43 there is provided a non-return valve 58 which can open in a direction away from the suction tube 44 towards the relief valve 45. The point at which the line 57 issues into the line 43 lies between the suction tube 44 and the non-return valve 58. A line 59 which leads to the suction side of the pump 12, branches off from a point between the non-return valve and the point where the line 43 issues into the bore 55.

A line 62 which leads through the non-return valve 63 to a secondary load circuit, is connected to the outlet bore 61 from the relief valve 45. The pressure line 64 from the pump 12 issues into the line 62 and indeed at a point between the non-return valve 63 and the relief valve 45.

Thus, it can be seen that the relief valve 45 is arranged between the delivery line 64 from the second pump 12 and the suction lines 59 and 56 of both pumps 12 and 13.

The hydraulic system is so designed that, in operation, the delivery rate from the pump 12 is substantially greater than that from the pump 13. Furthermore, the pump 13 supplies the priority load circuit whilst the pump 12 supplies the auxiliary load circuit. If there is no pressure in the control line 52, then pressure medium delivered by the pump 12 flows through the two recesses 50 and 51 with the valve member 49 raised from the shoulder 48, in accordance with the cross-sections F_1 and F_2, to the bores 54 and 55 and to the suction line branches 56 and 59 for the pumps 13 and 12. The cross-sections F_1 and F_2 are so calculated that a somewhat greater quantity of pressure medium flows to the suction line 56 of the pump 13 than the latter can withdraw so that a residual flow flows through the branch line 57 into the common suction line 43 and from there arrives at the suction side of the pump 12 through the line 59. Thus, the quantity of pressure medium flowing to the suction line 56 of the pump 13 must be withdrawn by the pump 12 through the common suction line 43. In this manner, cooled pressure medium always flows to the pump 12.

If the control line 52 is put under

pressure, then the valve member 49 engages the shoulder 48. The valve member 49 then interrupts the communication between the bores 54 and 55 so that the pressure side 64 and the two suction line branches 59 and 56 to the pumps are separated from one another. Then, the pressure medium delivered by the pump 12 flows through the non-return valve 63 to the auxiliary load circuit. The pump 13 withdraws pressure medium through the branch line 57 and delivers it to the flow regulating valve.

If, apart from the priority load circuit 27, an external leak occurs in the hydraulic system, then the pressure medium level in the reservoir 16′ falls below the lowest safe admissible level till it reaches the height H_1 and the suction tube 44 is blocked by the float valve 31. Then the quantity of pressure medium required for supplying the priority circuit (steering) can only be withdrawn through the bore 30′. This reduced quantity of pressure medium is withdrawn by the pump 13 through the suction line branch 57 because the spring loaded non-return valve 58 prevents withdrawal of pressure medium into the suction line 59 of the pump 12. If the pump 13 delivers only insignificantly less pressure medium than the quantity set at the flow regulating valve 25 to be delivered to the steering device 21, then the control slide 36 closes the connection to the secondary load 29 once again.

The quantity of pressure medium then remaining in the reservoir 16′ is available exclusively to the priority load 27. Then external leaks in the hydraulic system — other than in the priority load circuit — can only become effective at leakage points in the blocking members. However, these leaks are so small that the unlimited actuation of the priority load can still be maintained for quite a long period.

WHAT WE CLAIM IS:—

1. An hydraulic system comprising a reservoir for pressure medium, first and second suction openings arranged in the reservoir and a pump arranged to withdraw pressure medium from the reservoir through the suction openings and to deliver the withdrawn pressure medium to a priority load and to a secondary load through a regulating valve, the first suction opening being controlled by a float valve and the second suction opening being of smaller cross-section than the first suction opening, and being arranged below the level of the first suction opening, the flow regulating valve being arranged to operate in such a manner that, when pressure medium is withdrawn from the reservoir through both suction openings, the flow regulating valve delivers pressure medium to both loads whereas, when pressure medium is withdrawn from the reservoir solely through the second suction opening, the flow regulating valve only delivers pressure medium to the priority load.

2. An hydraulic system according to claim 1, comprising a third suction opening, arranged in the reservoir, below the level of the second suction opening, and through which the priority load can withdraw pressure medium direct from the reservoir.

3. An hydraulic system according to claim 1 or claim 2, comprising a fourth suction opening and a second pump arranged to withdraw pressure medium from the reservoir through the said fourth suction opening and deliver the withdrawn pressure medium to an auxiliary load.

4. An hydraulic system according to claim 3, in which the fourth suction opening is arranged above the level of the first suction opening.

5. An hydraulic system according to claim 1 or claim 2, comprising a second pump arranged to withdraw pressure medium from the reservoir through the first and second suction openings and to deliver the withdrawn pressure medium to an auxiliary load.

6. An hydraulic system according to claim 5, in which the two pumps are arranged to withdraw pressure medium from the reservoir through a common suction line.

7. An hydraulic system according to claim 6, in which a relief valve is arranged between the delivery side of the second pump and the suction sides of both pumps.

8. An hydraulic system substantially as herein described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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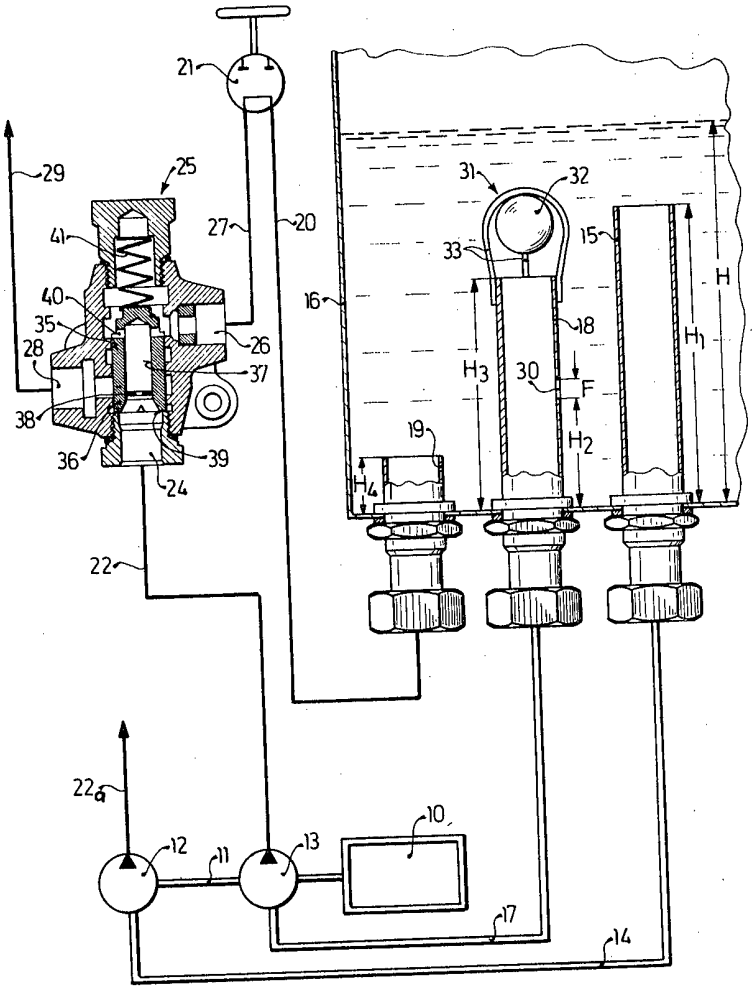
Fig. 1



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Sheet 2

Fig. 2