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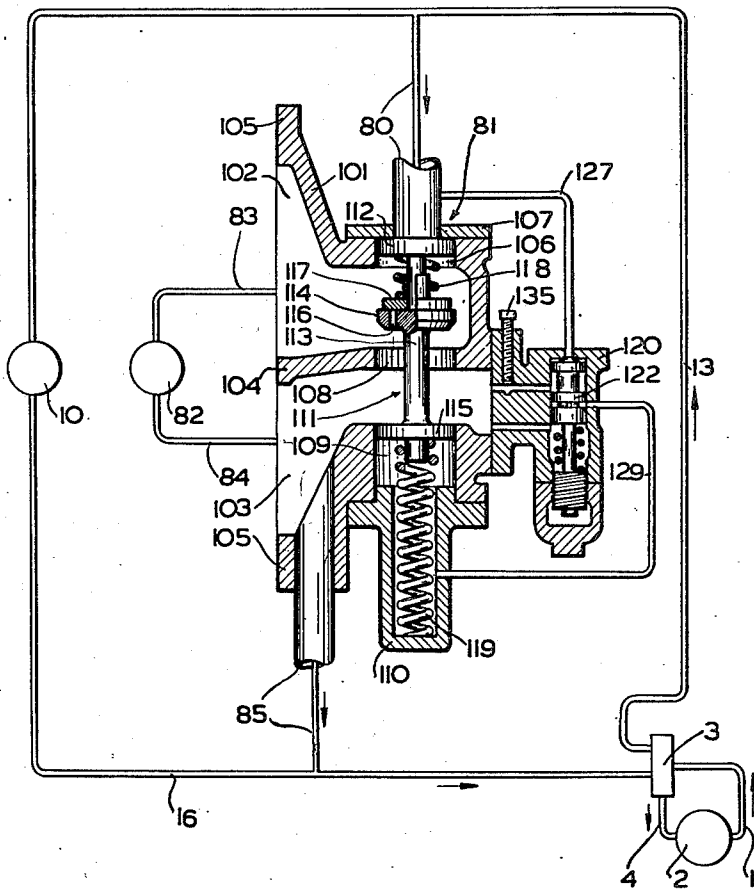
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PRESSURE RESPONSIVE CONTROL DEVICE FOR HYDRAULIC SYSTEMS

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2 Sheets-Sheet 1

FIG. 1.



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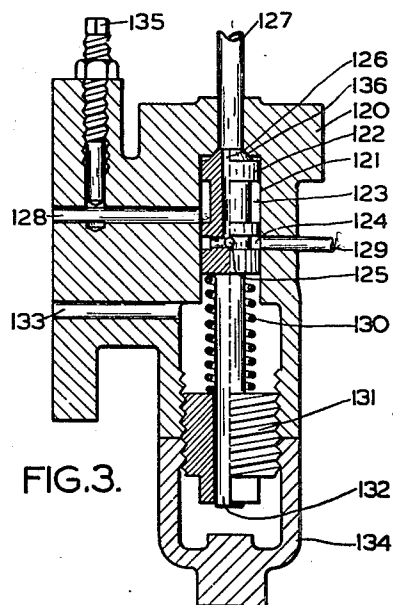
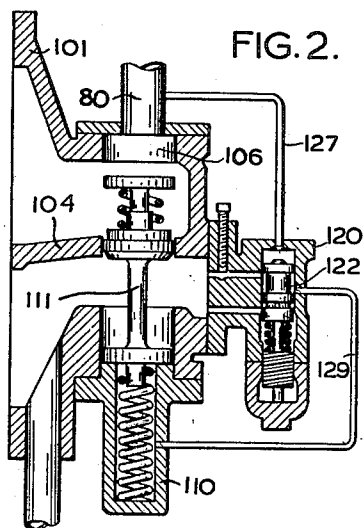
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2 Sheets-Sheet 2



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PRESSURE RESPONSIVE CONTROL DEVICE FOR HYDRAULIC SYSTEMS

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4 Claims. (Cl. 137—112)

This invention relates to a pressure responsive control device for hydraulic systems.

In such systems comprising at least two hydraulic motor circuits connected in aiding mechanical relation to the same shaft, it is sometimes desired to maintain one hydraulic motor circuit in an idling position disconnected from the main supply of pressure fluid, while the remaining motor circuit received all the pressure fluid, until a given pressure differential occurs in the system. In that event, the idling motor circuit is driven as a pump by the working motor circuit, and the inlet of the idling circuit must be connected to the discharge side of the system in order to reduce the circulation resistance in the idling motor circuit as much as possible.

It is an object of the present invention to obtain a pressure responsive control device for effecting such disconnection and short circuiting of a hydraulic motor circuit when the pressure differential between the supply side and the discharge side of the hydraulic system is below a given value, and to effect connection of the inlet of the motor circuit to the pressure side and simultaneously disconnection of the short circuit as soon as the pressure exceeds said given value.

A further object of the present invention is to obtain a pressure responsive control device of the kind aforesaid, in which the valve member will not assume intermediate positions at pressure lying in the neighbourhood of the desired change over pressure for the device.

The invention accordingly consists of a pressure responsive control device for hydraulic systems, comprising a hollow casing, a chamber within said casing having an outlet and two axially aligned inlets, a valve member carrying means for alternatively and selectively closing said inlets, a cylinder within said casing arranged in axial alignment with said inlets, a piston integral with said valve member and received within said cylinder, and pressure responsive means for controlling supply of pressure fluid to the interior of said cylinder.

In order that the invention may be more clearly understood one particular embodiment thereof will now be described, by way of example, with reference to the accompanying drawings wherein:

Figure 1 represents a pressure responsive control device and a hydraulic system.

Figure 2 shows a different operating position of the device as compared with Figure 1.

Figure 3 shows a part of the device according to Figures 1 and 2, drawn to a larger scale and shown in the same position as Figure 1.

Referring particularly to Figure 1, the hydraulic system in which the control device according to the present invention is embodied will first be described. This system comprises a main supply line 1 continuously supplying hydraulic pressure fluid, preferably oil, in a single direction from a non reversible pump 2 to a manually adjustable control-valve 3. By manually adjusting said control valve

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3 to different positions the fluid may either be led back to the pump 2 through a main return line 4, or may be supplied to a motor circuit 10 connected by a feed conduit 13 to the control valve 3. The discharge from said motor circuit 10 is by means of a discharge conduit 16 conducted back to the pump 2, through the main return line 4.

A branch conduit 80 is branched off from the feed conduit 13 and leads to a pressure responsive control device generally designated with the reference numeral 81. This device controls the feed of hydraulic fluid to a motor circuit 82 by being connected to the inlet 83 of said motor circuit.

In the hydraulic system shown in Figure 1, the outlet of the motor circuit 82 is connected by means of a conduit 84 to the main discharge, as represented by a branch 85 from the discharge conduit 16 to the control device. This, however, should be regarded as only an example, as the outlet may be conducted to the control valve 3 or directly connected to the main return line 4.

The control device 81 will now be described in greater detail, referring first to Figures 1 and 2. The device has a main casing 101 the interior of which is divided into an upper chamber 102 and a lower chamber 103, by means of a partition 104. The casing 101 is provided with flanges 105 by means of which the control device 81 may be flanged to the housing of a motor forming the motor circuit 82 controlled by the corresponding device 81. A partition in the interior of the motor housing is then adapted to cooperate with the partition 104 so that the upper chamber 102 communicates with the inlet 83 of the motor and the lower chamber 103 communicates with the outlet 84 of the motor. The discharge branch 85 is in constant communication with the lower chamber 103.

The branch conduit 80 is led axially into the upper end wall of an upper cylinder 106 which opens at its lower end into the upper chamber 102. The upper end wall is formed by an annular cover plate 107 to which the pipe forming the branch conduit 80 may be welded or otherwise secured.

A cylindrical opening or bore 108 is arranged in the partition 104 in direct axial alignment with the upper cylinder 106 and having slightly greater diameter than said cylinder 106.

A lower cylinder 109 is arranged in the bottom of the lower chamber 103 in direct axial alignment with the cylinder 106 and the opening 108 and of the same diameter as such opening 108. The lower cylinder 109 is terminated downwardly by a spring casing 110 at its lower end.

A valve member 111 cooperates with the upper cylinder 106, the opening 108 and the lower cylinder 109 by having an upper piston flange 112 secured to the upper end of a valve stem 113 and cooperating with the upper cylinder 106, an intermediate piston flange 114 cooperating with the cylinder opening 108, and a lower piston flange 115 secured to the lower end of the valve stem 113 and cooperating with the lower cylinder 109. All three piston flanges are snugly fitted within their respective cylinders and openings.

In the present embodiment the intermediate piston flange 114 is provided with a plurality of holes 116 extending through the flange and allowing communication between the opposite sides of said flange 114. The holes 116 are covered by a disc 117 which surrounds and is axially slidable on the valve stem 113 and is urged into closing position against the upper end of said holes 116 by a low compression return spring 118 which is compressed between the upper piston flange 112 and the disc 117. The holes 116 and the disc 117 form together a check valve opening under a slight suction in the upper

chamber 102 and seating under a pressure within said chamber.

When comparing Figure 1 and Figure 2 it will be seen that the valve member 111 may assume an upper position with the upper piston flange 112 positioned in the upper end of the cylinder 106, while the intermediate flange 114 is positioned remote from the opening 108 in the partition 104 and allows free and unthrottled communication between the upper chamber and the lower chamber. The piston flange 115 is then positioned in the upper end of the lower cylinder 109 (Figure 1).

It will be seen that the valve member 111 also may assume a lower position wherein the upper piston flange 112 is positioned remote from the upper cylinder 106 and allows free and unthrottled communication between the branch 80 and the upper chamber, while the intermediate flange is received within the opening 108 and prevents communication between the two chambers through this opening 108. The piston flange 115 in this position is pressed down to the end of the lower cylinder 109.

The distance from the upper end of the upper piston flange 112 to the lower end of the intermediate piston flange 114 is greater than the distance from the lower end of the cylinder 106 to the opening 108, so that the intermediate piston flange 114 closes the opening 108 before the upper piston flange 112 allows any communication between the branch conduit 80 and the upper chamber.

Normally the valve member 111 is kept in its uppermost position of Figure 1 by a lightly loaded return spring 119 arranged within the spring casing 110.

The position of the valve member 111 is controlled by a control valve arranged in an auxiliary valve housing 120 secured to the main casing 101. For the sake of convenience, the auxiliary valve housing 120 with its different parts is shown on an enlarged scale in Figure 3 in the same position as shown in Figure 1.

A cylindrical bore 121 is arranged within the housing 120. A control slide member 122 is snugly fitted for axially slidable movement within the bore 121 and comprises two portions 123, 124 of reduced diameter. The axial dimension of the upper reduced portion 123 is greater than the axial dimension of the lower reduced portion 124. The lower reduced portion 124 communicates by means of radial passages 125 with an axial passage 126 in the slide member 122, said axial passage 126 extending from the upper end face of the slide member 122 down to and terminating at the radial passages 125.

A supply pipe 127 is led axially into the upper end wall of the bore 121. Said supply pipe 127 supplies pressure fluid from the branch conduit 80 to the axial passage within the slide member 122, whereby the lower reduced portion 124 is supplied with pressure fluid through said axial passage 126 and the radial passages 125 in all positions of the slide member 122.

The upper reduced portion 123 is supplied with discharge fluid from the lower chamber 103 in all positions of the slide member 122 by means of a passage 128 in the housing 120. The term "in all positions" in this connection designates the extreme positions as shown in Figure 1 and Figure 2, the axial dimension of said reduced portion 123 allowing communication with the port of the passage 128 in both positions.

The port of a pipe 129 opens into the bore 121 in a height corresponding to the position of the lower reduced portion 124 in Figure 1. The pipe 129 leads to the interior of the spring casing 110.

The axial dimension of the upper reduced portion 123 is such as to allow the passage 128 to communicate with the port of the pipe 129 when the slide member 122 is in its lowermost position of Figure 2, by means of the upper reduced portion 123. The port of the pipe 129 is then situated at the lower end of said reduced portion, while

the port of the passage 128 is situated at the upper end of the reduced portion 123.

The slide member 122 is normally urged towards its uppermost position as shown in Figures 1 and 3 by means of a control spring 130 compressed between the lower end face of the slide member 122 and a control screw 131 by means of which the load of the control spring 130 may be adjusted.

The lower end of the control slide member is provided with a stem 132 which extends axially through the middle of the control spring 130 and through the control screw 131. By means of said stem distortion of the control spring is prevented and the axial displacement of the slide member suitably guided.

A second passage 133 is arranged in the housing 120 for supplying fluid from the lower chamber 103 to the lower end of the bore 121 below the slide member 122, in order to permit the slide member to be subjected to a pressure differential between the supply pressure applied from above and the discharge pressure applied from below. As it is preferred to use oil as the driving fluid in the system, the stem 132 is also lubricated by the supply of fluid through this passage. Any leakage is prevented by covering the control screw 131 with a cap which also limits the downward movement of the slide member. The bottom of said cap 134 receives the end of the stem 132 in the position of Figure 2 and prevents further downward movement of the slide member, whereby it is ensured that the upper reduced portion 123 is correctly located in the lowermost position. The cap 134 is threaded to the end of the control screw 131 and may easily be removed when it is desired to adjust the position of said screw.

The rate of flow through the passage 128 may be adjusted, if desired, by means of a throttling screw 135 arranged for throttling said passage to any desired extent.

At its upper end the slide member 122 is provided with an annular head arranged around the axial passage 126, and seated against the port of the pipe 127. Said head, which may be seen at 136, acts to restrict the area against which the pressure fluid exerts its pressure in the position of Figure 3 to substantially the cross section of the pipe 127. As will be seen this cross section is considerably smaller than the entire end area of the slide member 122.

The mode of operation of the present device will now be explained. As mentioned above, the slide member is urged upwardly by the force of the control spring 130, and as long as the pressure differential between the supply pressure in the branch conduit 80 and its associated pipe 127 and the discharge pressure within the lower chamber 103 is insignificant, the slide member 122 remains in its upper position as seen in Figures 1 and 3. The interior of the lower cylinder 109 is supplied with pressure fluid from the main supply through the pipe 127, the axial passage 126, the lower reduced portion 124 and the pipe 129. The valve member 111 is thus subjected to pressure of exactly the same magnitude against its upper and lower end faces. But as the upper piston flange has a slightly smaller diameter than the lower piston flange 115, as explained in the preceding, the resulting upward force is slightly greater. As the force from the return spring 119 also acts upwardly, the valve member 111 is kept in its uppermost position of Figure 1 as long as pressure fluid is supplied to the interior of the lower cylinder 109.

If the pressure in the main supply increases due to an increase in load, the downward force upon the slide member 122 resulting from the pressure fluid acting against the area of the end head 136 increases accordingly. As soon as said downward force exceeds the upward force from the control spring 130, the annular head 136 is urged away from its seat in the port of the pipe 127, whereby the entire upper end face of the slide member 122 receives the pressure from the hydraulic fluid supply.

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The downwardly directed force upon the slide member increases accordingly. Said increase is preferably arranged to be of such magnitude that the control slide member 122 at once is pressed to its lower position of Figure 2, whereby the passage 128 by means of the upper reduced portion 123 is brought to communicate with the port of the pipe 129.

The interior of the lower cylinder 109 is now in communication with the lower chamber 103 and consequently with the discharge side of the system through the pipe 129, the upper reduced portion 123, the passage 128, the lower chamber 103 and the branch conduit 85. The lower piston flange 115 no longer receives supply pressure against its lower end face, so that the valve member 111 is urged downwardly with a considerable force.

Excess fluid is then forced out of the lower cylinder 109. If desired, the rate of flow may be regulated by means of the throttling screw 135, whereby a slower response time may be obtained. If so, it should be noted that the intermediate piston flange 114 closes its opening 108 before the upper piston flange 112 allows access for pressure fluid to the upper chamber 102. But for the disc 117 with its associated holes 116, the corresponding motor circuit 82 might have been blocked, the disc 117 is however lifted by the suction from the inlet of the motor circuit and gives access for fluid through the holes 116, until the pressure fluid is supplied to the upper chamber 102 by the upper piston flange 112 being moved fully outside its cylinder 106. Thereby, the suction in the chamber 102 is substituted by high pressure from the main supply through the branch conduit 80, so that the disc 117 closes the opening of the holes 116 and prevents communication between the upper and lower chambers therethrough.

If no such delay in the response time is desired, the throttling screw 135 as well as the disc and holes may be omitted.

As soon as pressure fluid is admitted to the upper chamber 102, the pressure acts against the upper side of the intermediate piston flange 114, whereby an increase in downwardly directed force against the valve member 111 is obtained, because of the somewhat increased area of this flange. Consequently, the valve member 111 is urged down to its lowermost position of Figure 2, without assuming intermediate positions. The force of the return spring 119 is preferably chosen quite small in order to let said spring act merely as a return spring enabling easier return of the valve member to its uppermost position.

The valve member remains in its lowermost position until the slide member 122 has again moved so far upwardly that the lower reduced portion 124 is brought into communication with the port of the pipe 129. The pressure differential at which such communication is brought about, depends upon the downward force resulting from pressure fluid acting against the entire area of the upper end face of the slide member, in relation to the upward force from the control spring 130. It is easy to construct the different parts so that return is obtained at a given value. Generally, it is preferred to maintain the motor circuit 82 connected even when the load drops below the load corresponding to the change over pressure, i. e. that the ratio between the entire area of the slide member at its upper end and the area of the annular head 136 is great.

It will be clear that even if the slide member is moved upwardly due to any decrease in pressure, this will not bring about any return of the valve member 111 to its uppermost or even an intermediate position. The port of the pipe 129 is only blocked by the slide member in such intermediate position, and no pressure fluid is admitted to the interior of the lower cylinder 109.

It should also be noted that the upper cylinder 106 as the opening 108 allows the valve member a certain

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movement back or forth without any opening for communication. Thereby, a further prevention of undesired change over is obtained. Should, for instance, the system for any reason be subjected to a sudden pressure wave, whereupon the system returns to a lower pressure status, the valve member 111 may be moved a short distance without transfer into the opposite position.

When it is necessary to reset or adjust the change over pressure of the device, the cap 134 is moved, and the force from the spring 130 adjusted by turning the control screw 131.

As many possible embodiments may be made in the invention and as many changes may be made in the embodiment hereinbefore set forth, it will be understood that all matter described herein is to be interpreted as illustrative and not as a limitation.

What is claimed is:

1. A pressure responsive control device for a hydraulic system operating on a pressure differential between a pressure fluid and a discharge fluid, comprising a hollow casing, a partition within said casing dividing the interior into an upper chamber and a lower chamber, an outlet for fluid from the upper chamber, a first inlet for pressure fluid into the upper chamber, a second inlet for discharge fluid into the lower chamber, said partition defining an opening for communication between said upper and lower chambers, a cylinder in the wall of the lower chamber in axial alignment with said first inlet and closed at one end, a valve member having on its upper end a first face for closing said first inlet, a second face intermediate its ends for closing said opening and a piston flange integral with said valve member with a third face received within said cylinder so as to face towards the closed end of said cylinder and being disposed at an end of said valve member opposing said first face, and pressure responsive means for supplying pressure fluid to the interior of said cylinder at pressure differentials below a given value and discharge fluid at pressure differentials above said value while closing off the supply of pressure fluid to the interior of said cylinder.

2. A pressure responsive device according to claim 1, wherein check valve means are arranged for allowing a flow from said lower chamber to said upper chamber and blocking a flow from said upper chamber to said lower chamber.

3. A pressure responsive control device for a hydraulic system operating on a pressure differential between a pressure fluid and a discharge fluid comprising a hollow casing, a chamber within said casing having an outlet and a first inlet for supplying pressure fluid to said chamber, a second inlet for supplying discharge fluid into said chamber, a cylinder within said casing arranged in axial alignment with said first inlet and having one end closed in opposition to said first inlet, a valve member having a piston flange received within said cylinder and further having a first face diametrically opposing said piston flange and a second face intermediate said piston flange and said first face, said valve member having a first position in which said first face engages said first inlet to close same and said second face is spaced from said second inlet to allow discharge fluid therethrough, said valve member further having a second position in which said first face is spaced from said first inlet to allow pressure fluid therethrough and the second face engages said second inlet to close same, a conduit leading to the interior of said cylinder to supply hydraulic fluid to the end face of said piston face so as to balance said valve member between the pressure differential between the supplied pressure fluid of said first inlet acting towards said first face and the hydraulic fluid of said conduit acting in opposition thereto against the piston face within said cylinder, said conduit leading to an auxiliary housing having a cylindrical bore, a slide member axially displaceable within said bore and subjected at one end face to the pressure of hydraulic pressure fluid and at its oppo-

site end face to the pressure of hydraulic discharge fluid, said slide member having a first position in which hydraulic pressure fluid is supplied to said conduit, and a second position in which hydraulic discharge fluid is supplied to said conduit, and a spring having adjustable spring force and urging said slide member towards said first position in addition to the pressure of the discharge fluid.

4. A device according to claim 3, wherein throttling means are arranged in the communication line between the interior of said cylinder and the discharge fluid in said second position of the slide member.

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