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WARNING VALVE FOR A DUAL FLUID PRESSURE SYSTEM

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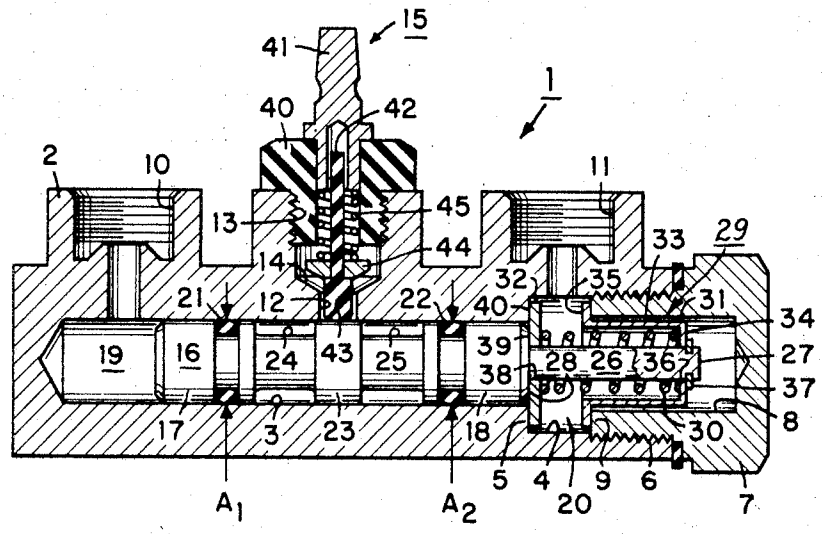

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WARNING VALVE FOR A DUAL FLUID PRESSURE SYSTEM

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ABSTRACT OF THE DISCLOSURE

In a control or driver warning valve, a switch operating piston reciprocally mounted in the control valve housing for movement from a normal position toward opposed translated positions in response to predetermined differentials between the magnitudes of separately applied fluid pressures acting thereacross, and resilient means contained on said piston for engagement with said control valve housing to impede piston movement toward the translated positions.

This invention relates to control valves for split or dual fluid pressure systems and in particular to control valves for warning a vehicle operator of an impending failure in said system.

In the past or known control or driver warning valves for use between split or dual fluid pressure braking systems, a switch operating piston was reciprocally mounted for translatory movement in one and opposite directions from a substantially normal operating position in response to differentials in excess of a predetermined value between the magnitudes of separate fluid pressures applied in the split system and acting on the opposed ends of said piston, and a pair of springs were respectively contained in the housing of said control valve for engagement with the opposed ends of said piston to impede the translatory movement thereof in response to differentials less than the predetermined value between the magnitudes of the separately applied fluid pressures. One of the undesirable or disadvantageous features of such past control valves was that the spring rates of the pair of springs were not identical; therefore, the translatory movement of the piston in one direction against one of the spring rates was effected by a differential between the magnitudes of the separately applied fluid pressures which was different than that necessary to effect the translatory movement of said piston in the other direction against the other of the spring rates. Another undesirable or disadvantageous feature of the past control valves was manifested in an attempt to overcome the aforementioned undesirable feature wherein means were provided to adjust the spring rates of the pair of springs; however, such adjustment means have proven to be ineffective and inaccurate while also adding cost not only to the valve per se but also to the assembly thereof.

The principal object of the present invention is to provide a novel control valve which overcomes the aforementioned undesirable or disadvantageous features, as well as others, and this and other advantageous features and concepts of the present invention will become apparent hereinafter.

Briefly, the present invention includes a control valve having means for comparing the magnitudes of separate fluid pressures applied thereto and movable toward opposed translated positions in response to differentials in excess of a predetermined value between the magnitudes of the separately applied fluid pressures, and resilient means contained on said first named means for impeding movement thereof toward its translated positions.

In the drawing wherein like numerals refer to like parts wherever they occur, a sectional view of a control valve embodying the present invention is provided in partial cross-section.

Referring now to the drawing in detail, a control or driver warning valve, indicated generally at **1**, is provided with a housing **2** having an axially aligned bore and counterbore **3**, **4** therein, and an annular shoulder **5** is defined in said housing at the juncture of said bore and counterbore. The counterbore **4** is threaded at its outer or open end **6** to threadedly receive a closure member or end plug **7**, said end plug having a blind bore **8** in axial alignment with the housing bore and counterbore **3**, **4**, and an interior end defining an annular shoulder or abutment **9** about said end plug bore and opposed to the housing shoulder **5**. Ports **10**, **11** are provided in the housing **2** for respective connection with the fluid pressure generating chambers of a dual or split matter cylinder (not shown) of a type well known to the art, and the port **10** intersects the housing bore **3** adjacent the leftward end thereof while the port **11** intersects the counterbore **4** between the housing shoulder **5** and the end plug shoulder **9**. A cross-bore and cross-counterbore **12**, **13** having a beveled shoulder or contact seat **14** therebetween is provided in the housing **2**, and the contact seat **14** is electrically connected to ground through said housing (not shown), as well known in the art. The cross-bore **12** intersects the housing bore **3** adjacent the mid-portion thereof, and the cross-counterbore **13** is threaded at its open end to threadedly receive an electrical switch, indicated generally at **15** (to be discussed in detail hereinafter).

A reciprocal switch actuating member or piston, indicated generally at **16**, shown in its normal operating or centered position in the housing bore **3** being slidably received therein, and spaced opposed annular flanges or end portions **17**, **18** are provided on said switch piston defining with the housing **2** opposed fluid pressure chambers **19**, **20** respectively connected in pressure fluid communication with the ports **10**, **11**. Seals **21**, **22** are carried in the flanges **17**, **18** in sealing engagement between the piston **16** and the housing bore **3**, and it should be noted that the sealing engagement of said seals between said piston and housing bore respectively define opposed, substantially equal, effective areas A_1, A_2 on said piston which are subjected to the respective fluid pressures applied at the ports **10**, **11**. The piston **16** is provided with a central switch positioning land **23** between the opposed flanges **17**, **18** thereof which is slidable in the housing bore **3** and positioned beneath the housing cross-bore **12** when said piston is in its centered or normal operating position (as shown), and peripheral switch locking grooves **24**, **25** are provided in said piston on opposite sides of said land. The piston **16** is also provided wth an extension **26** which is integrally formed with the piston flange **18** and having a free end **27** extending coaxially into the end plug bore **8**, and an annular shoulder or abutment **28** is defined on the piston flange **18** about the extension **26**.

A yieldable connection, indicated generally at **29**, is provided between the piston **16** and the housing **2** including a motion impeding or centering spring **30** contained on the piston **16** between retainers or abutment members **31**, **32** to impede movement of said piston from its centered position toward opposed translated or displaced positions, as will be discussed hereinafter. The retainer **31** is provided with a cylindrical or sleeve portion **33** which extends coaxially between the piston extension **26** and the side wall of the end plug bore **8**, and opposed annular flanges or abutments **34**, **35** are integrally formed on the opposed ends of said sleeve portion extending radially inwardly and outwardly therefrom, respectively. An aperture **36** is provided through the retainer flange

34 in sliding engagement with the peripheral surface of the piston extension 26, and a snap ring and groove assembly 37 defining an extension abutment is provided in said piston extension adjacent to the free end 27 thereof for displacement preventing engagement with said retainer flange 34. Another aperture 38 is provided in the retainer 32 in sliding engagement with the peripheral surface of the piston extension 26, and radially spaced abutment portions 39, 40 are also provided on the retainer 32 for respective abutting engagement with the piston shoulder 28 and housing shoulder 5. The spring 30 is precompressed between the retainers 31, 32 urging the abutments 34, 35 of the retainer 31 into abutting engagement with the extension snap ring or abutment 37 and end plug shoulder 9, respectively, and also urging the abutment portions 39, 40 of the retainer 32 into abutting engagement with the piston shoulder 28 and housing shoulder 5, respectively. In this manner, the yieldable connection 29 maintains the piston 16 in its normal or centered position with the land 23 beneath the housing cross-bore 12, as shown.

The electrical switch 15, as mentioned hereinbefore, includes a closure or plug member 40 of suitable insulating material which is threadedly received in the housing cross-counterbore 13, and a metal terminal 41 is provided through the switch plug member having an exterior end for connection in an electrical circuit for energizing a driver or warning dash lamp, as well known in the art (not shown). A switch operating member 42 of suitable insulating material has a lower end or follower portion 43 slidably and guidably received in the housing crossbore 12, and an electrical contact 44 is carried on said switch operating member for electrical contact or engagement with the housing shoulder or contact seat 14. To complete the description of the control valve 1, a spring 45 having a current carrying capacity is conductively biased between the interior end of the switch terminal 41 and the switch contact 45 urging the switch operating member follower end 43 into abutting or positioning engagement with the piston land 23 and urging said contact toward engagement with the housing shoulder 14, said contact being normally spaced from said housing shoulder in its circuit interrupting position when said switch operating member lower end is engaged with said piston land.

In the operation with the component parts of the control valve 1 positioned as shown in the drawing and as described hereinabove, independent or separately applied fluid pressures P_1, P_2 normally having substantially equal magnitudes are supplied upon operator actuation of the split master cylinder (not shown) to the ports 10, 11, respectively, of the control valve 1 and act on the areas A_1, A_2 of the piston 16, respectively. Since the areas A_1, A_2 have previously been defined as substantially equal and since the fluid pressures P_1, P_2 are also substantially equal, it is obvious that substantially equal and opposite forces $P_1 A_1$ and $P_2 A_2$ are established across the piston 16; therefore, since the forces $P_1 A_1$ and $P_2 A_2$ are substantially self-cancelling, the piston 16 is relatively unaffected by the separately applied fluid pressures P_1, P_2 and will remain substantially in its centered position.

In the event that a sustained differential is established between the separately applied fluid pressure P_1, P_2 due to a malfunction of the split master cylinder, leaks or the like, wherein the magnitude of the applied fluid pressure P_1 exceeds that of the applied fluid pressure P_2 by a predetermined value, the force $P_1 A_1$ acting on the piston 16 will, of course, overcome the opposing force $P_2 A_2$ acting thereon and displace said piston from its centered position rightwardly toward its rightward displaced or translated position since the reduction of the applied fluid pressure P_2 effects a corresponding reduction in the force $P_2 A_2$. This rightward movement of the piston 16 toward its rightward displaced position is impeded by the yieldable connection 29. In other words, the rightward movement of the piston 16 drivingly engages the shoulder 38 of the piston flange 18 with the abutment portion 39 of the retainer 32 to disengage the abutment portion 40 of said retainer 32 from the housing shoulder 5 and concertedly drive said retainer rightwardly against the compressive force of the contained spring 30. The compressive force of the spring 30 maintains the abutment 35 of the retainer 31 in engagement with the shoulder 9 of the end plug 7 to prevent the rightward displacement of said retainer 31, and the piston extension 26 moves rightwardly through the aperture 36 in said retainer 31, wherein the extension abutment 37 is disengaged from the abutment flange 34 of said retainer 31. When the retainer 32 is driven into engagement with the abutment flange 35 of the retainer 31, further rightward displacement movement of the piston 16 is, of course, obviated, and such engagement between the retainers 31, 32 defines the rightward translated position of said piston.

In the event that a sustained differential is established between the separately applid fluid pressures P_1, P_2 wherein the magnitude of the applied fluid pressure P_2 exceeds that of the applied fluid pressure P_1 by a predetermined value, the force $P_2 A_2$ acting on the piston 16 will, of course, overcome the opposing force $P_1 A_1$ acting thereon and displace said piston from its centered position leftwardly toward its leftward displaced or translated position since the reduction of the applied fluid pressure P_1 effects a corresponding reduction in the force $P_1 A_1$. This leftward displacement movement of the piston 16 toward its leftward displaced position is also impeded by the yieldable connection 29. In other words, the leftward movement of the piston 16 drivingly engages the extension abutment 37 with the abutment flange 34 of the retainer 31 to disengage the abutment flange 35 of said retainer 31 from the end plug shoulder 9 and concertedly drive said retainer 31 leftwardly against the compressive force of the contained spring 30. The compressive force of the spring 30 maintains the abutment portion 40 of the retainer 32 in abutting engagement with the housing shoulder 5 obviating leftward displacement of said retainer 32, and the piston extension 26 moves leftwardly through the aperture 38 of said retainer 32 wherein the shoulder 28 of the piston flange 18 is disengaged from the abutment portion 39 of said retainer 32. When the abutment flange 35 of the retainer 31 is driven into engagement with the retainer 32, further leftward displacement movement of the piston 16 is, of course, obviated, and such engagement between the retainers 31, 32 defines the leftward translated position of said piston.

When the piston 16 is displaced from its normal centered position into its leftward or rightward displaced positions, as described above, the piston land 23 is, of course, concertedly moved from beneath the housing cross-bore 12, and the force of the switch spring 45 drives the switch member follower end 43 into the housing bore 3 into locking engagement with either the locking groove 24 or 25 to positively maintain said piston in its rightward or leftward displaced positions, respectively, and also moves the switch contact 44 into electrical engagement with the housing contact 14 to complete the electrical circuit and energize the driver warning or dash lamp thereof (not shown). The locking engagement between the switch member follower end 43 and the locking groove 24 or 25 prevents the return of the piston 16 to its centered position in response to the compressive force of the centering spring 30 acting thereon until the switch 15 is removed from the control valve 1. Upon the manual removal of the switch 15, the switch member follower end 43 is manually removed from locking engagement with the piston locking groove 24 or 25, and the compressive force of the centering spring 30 acts through the retainers 31, 32 to return the piston 16 to its centered position in the housing 2.

It should be noted that the yieldable connection 29 acts in the same manner as previously described to prevent displacement of the piston 16 into its opposed displaced positions in response to differentials between the magni-

tudes of the applied fluid pressures P_1, P_2 less than the aforementioned predetermined value.

From the foregoing, it is apparent that the identical spring rate of the contained recentering spring **30** is utilized to oppose or impede translatory movement of the piston **16** from its centered position toward its opposed translated positions, and in this manner, the differential between the magnitudes of the applied fluid pressures P_1, P_2 necessary to effect such translatory movement of said piston can be accurately predetermined.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A control valve comprising a housing adapted to receive separate fluid pressures applied thereto, means movable in said housing including opposed portions respectively subjected to the separately applied fluid pressures for comparing the magnitudes thereof, said means being movable in said housing from a normal operating position in opposite directions toward opposed translated positions in response to differentials in excess of a predetermined value between the magnitudes of the separately applied fluid pressures acting on said opposed portions, and yieldable means contained on only one of said opposed portions for engagement with said housing to impede movement of said first named means in the opposite directions toward its opposed translated positions.

2. The control valve according to claim **1**, wherein said one opposed portion includes extension means, said yieldable means being contained on said extension means.

3. The control valve according to claim **2**, comprising a pair of spaced abutments on said extension means, another pair of spaced abutments on said housing, and said yieldable means including a pair of resiliently urged means movable on said extension means, each of said resiliently urged means having first and second abutment portions respectively urged toward engagement with one of said first named and other pairs of abutments.

4. The control valve according to claim **2**, comprising spaced abutments on said housing, abutment means on said extension means and spaced from said one opposed portion, said yieldable means including first and second retainer means movable on said extension means, and spring means on said extension means contained between said first and second retainer means and urging said first and second retainer means toward engagement with said one opposed portion and abutment means and with said spaced housing abutments, respectively.

5. The control valve according to claim **4**, comprising first and second aperture means in said first and second retainer means, said extension means being slidably received in said first and second aperture means, first and second abutment portions on said first and second retainers adjacent to said first and second aperture means for engagement with said one opposed portion and said abutment means, and third and fourth abutment portions on said first and second retainer means spaced from said first and second abutment portions for engagement with said pair of spaced housing abutments, respectively.

6. A control valve comprising a housing, a pair of chambers in said housing for respective subjection to separate fluid pressures applied thereto, means movable in said housing and between said chambers from a normal operating position toward opposed translated positions including opposed end portions respectively subjected to the separately applied fluid pressures in said chambers, said means being movable toward its opposed translated positions in response to oppositely directed differentials in excess of a predetermined value between the magnitudes of the separately applied fluid pressures acting on said opposed end portions, respectively, a pair of opposed abutment means on said housing in one of said chambers, extension means on one of said end portions extending into said one chamber, another abutment means on said extension means opposed to and spaced from said one end portion, and other means for impeding movement of said first named means toward its translated positions including a pair of retainer means movable on said extension means between said one end portion and said other abutment means and each having abutment portions between said pair of housing abutment means, and resilient means urging said pair of retainer means into abutting engagement with said one end portion and said other abutment means and urging the abutment portion of said pair of retainer means into abutting engagement with said pair of housing abutment means, respectively.

7. A control valve comprising a housing having an aligned bore and counterbore therein, a first annular shoulder on said housing at the jucture of said bore and counterbore, a pair of ports in said housing connected with said bore and counterbore, a second annular shoulder on said housing in said counterbore and opposed to said first shoulder, piston means slidable in said bore between said ports, first and second opposed ends on said piston means respectively subjected to separately established fluid pressures at said ports, said piston means being movable toward one and the other of said pair of ports in response to oppositely directed differentials in excess of a predetermined value between the magnitudes of the established fluid pressures at said one and other ports acting on said first and second opposed ends, respectively, extension means on one of said first and second opposed ends and extending through said first and second shoulders, abutment means on said extension means spaced from said one of said first and second opposed ends, and means for impeding movement of said piston means toward said one and other ports including a first retainer slidable on said extension means and having first and second abutment portions for engagement with said one of said first and second opposed ends and said first shoulder, a second retainer slidable on said extension means and opposed to said first retainer, said second retainer having third and fourth abutment portions for engagement with said extension abutment means and said second shoulder, and spring means on said extension means having opposed ends pre-compressed between said first and second retainers to concertedly urge said first and second abutment portions into engagement with said one of said first and second opposed ends and said first shoulder and said third and fourth abutment portions into engagement with said extension abutment means and said second shoulder.

8. A control valve comprising a housing having an aligned bore and counterbore therein, a first annular shoulder on said housing at the juncture of said bore and counterbore, a closure member connected with said housing to close the open end of said counterbore, another bore in said closure member aligned with said housing bore and counterbore, a second annular shoulder on said closure member in said counterbore and opposed to said first shoulder, a pair of ports in said housing connected with said housing bore and counterbore for receiving separately applied fluid pressure from a split master cylinder, respectively, a cross-bore in said housing having one end intersecting with said housing bore adjacent to the mid-portion thereof, a cross-counterbore in said housing aligned with said cross-bore and connected with the other end thereof, piston means slidable in said housing bore between normally substantially centered position and opposed translated positions toward said pair of ports, a pair of opposed ends on said piston means respectively subjected to the separately applied fluid pressures at said ports, land means on said piston means between said opposed ends slidable in said housing bore and aligned with said cross-bore when said piston means is in its centered position, a pair of opposed locking grooves in said piston means between said land means and said opposed ends, respectively, for alignment with said cross-bore when said piston means is in one of its translated positions, said piston means being movable

from its centered position toward one of its translated positions in response to a differential in excess of a predetermined value between the magnitudes of the separately applied fluid pressures respectively acting on said opposed ends of said piston means, an electrical switch for an electrical circuit removably secured in said cross-counterbore, an operating member reciprocally movable in said switch, said member having a follower end thereon movable in said cross-counterbore for positioning engagement with said land means and for locking engagement with said pair of groove means, first contact means disposed in said cross-counterbore, second contact means on said member for circuit making engagement with said first contact means, electrical connection means in said switch having one end electrically connected with one of said first and second contact means and the other end thereof for connection in said circuit, spring means in said cross-counterbore engaged with said operating member to urge said second contact means toward said first contact means and said follower means into positioning engagement with said land means when said piston means is in its centered position, said member being movable in response to the compressive force of said spring means to move said second contact means into circuit making engagement with said first contact means and to also move said follower end through said cross-bore into said housing bore and into locking engagement with one of said groove means when said piston means is in its one translated position disengaging said land means from said follower end, extension means on one of said opposed ends of said piston means extending coaxially through said housing counterbore into said closure member bore, a free end portion on said extension means in said closure member bore, abutment means on said extension means adjacent to the free end portion thereof and opposed to said one opposed end of said piston means, first retainer means having first aperture means therein slidably received on said extension means, first and second abutment portions on said first retainer means for engagement with said one opposed end of said piston means and said first shoulder, second retainer means including an annular sleeve portion substantially coaxial with said extension means, a radially inwardly extending first flange connected with the end of said sleeve portion for abutting engagement with said abutment means on said extension means, second aperture means in said first flange slidably received on said extension means, and a radially outwardly extending second flange connected with the other end of said sleeve portion for abutting engagement with said second shoulder, and other spring means for opposing movement of said piston means from its centered position toward its opposed translated positions, said other spring means being precompressed between said first and second retainer means to concertedly urge said first and second abutment portions of said first retainer means into abutting engagement with said one end portion of said piston means and said first shoulder and to concertedly urge said first and second flanges of said second retainer means into abutting engagement with said abutment means on said extension means and said second shoulder, respectively.

9. The control valve according to claim **1**, comprising a pair of spaced abutment means on said housing adjacent to said one opposed portion, said yieldable means being respectively engageable with said abutment means to impede the movement of said first named means in the opposite directions toward its opposed translated positions.

10. The control valve according to claim **9** comprising another pair of spaced abutment means on said one opposed portion, said yieldable means being contained on said one opposed portion between said other abutment means.

11. The control valve according to claim **10**, wherein said yieldable means includes a pair of retainer means movable on said one opposed portion, and resilient means urging said pair of retainer means toward engagement with said first named and other pairs of abutment means, respectively.

12. The control valve according to claim **11**, comprising a pair of aperture means in said retainer means, said one opposed portion being movable through said aperture means, a pair of abutment portions on said retainer means adjacent to said aperture means for engagement with said other abutments means, and another pair of abutment portions on said retainer means spaced from said first named abutment portions for engagement with said first named abutment means, respectively.

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