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[54] **HYDRAULIC FLOW CONTROL VALVE ASSEMBLIES**


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[52] **U.S. Cl.** ..... **60/413,** 137/110, 137/494

[51] **Int. Cl.** ..... **F15b 1/02**

[58] **Field of Search** ..... 137/110, 494, 568, 599.1; 60/403, 404, 409, 410, 413



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[57] **ABSTRACT**

In an hydraulic flow control valve assembly a valve is normally urged into a closed position by a return spring, and movement of the valve into an open position in opposition to the force in the return spring is effected by a differential piston working in a stepped bore. The end of the piston which is of smaller area acts on the second valve, and the end of greater area is exposed to the pressure in an inlet passage. The differential piston is operative to open the valve when the force applied to the piston by the pressure in a first outlet passage overcomes at least the force of the return spring.


**6 Claims, 2 Drawing Figures**

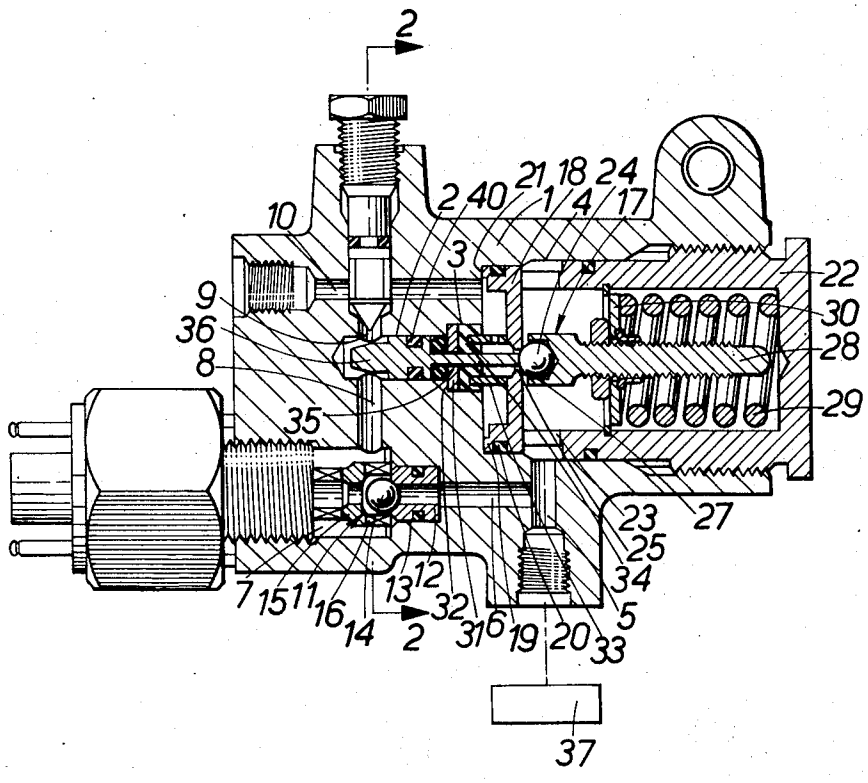
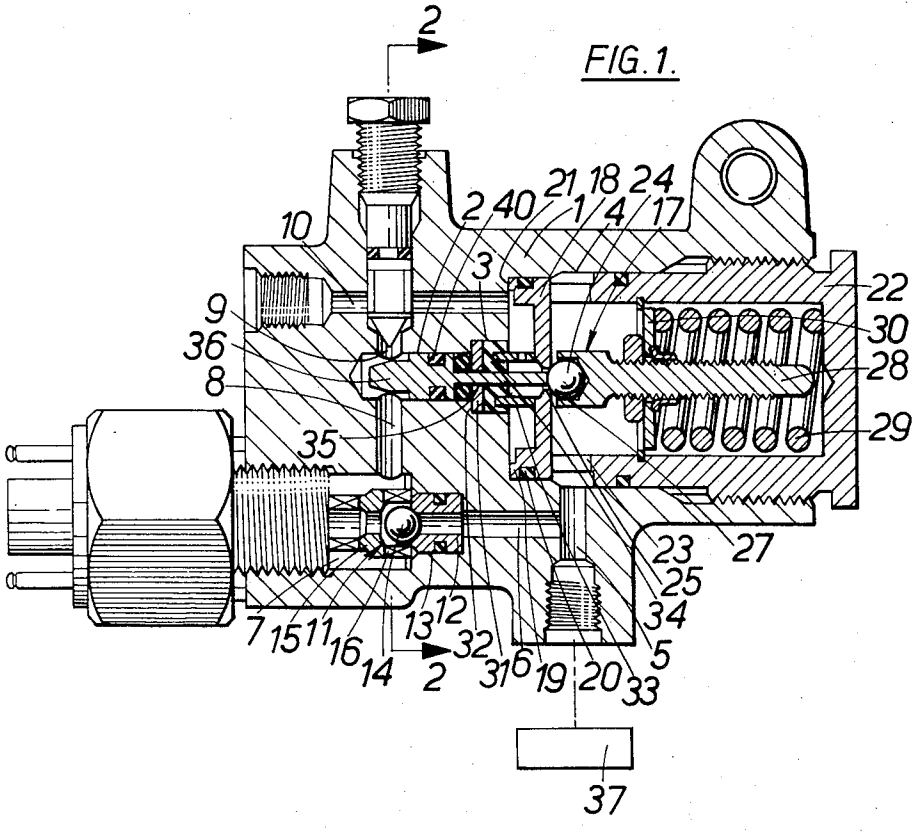


FIG. 1.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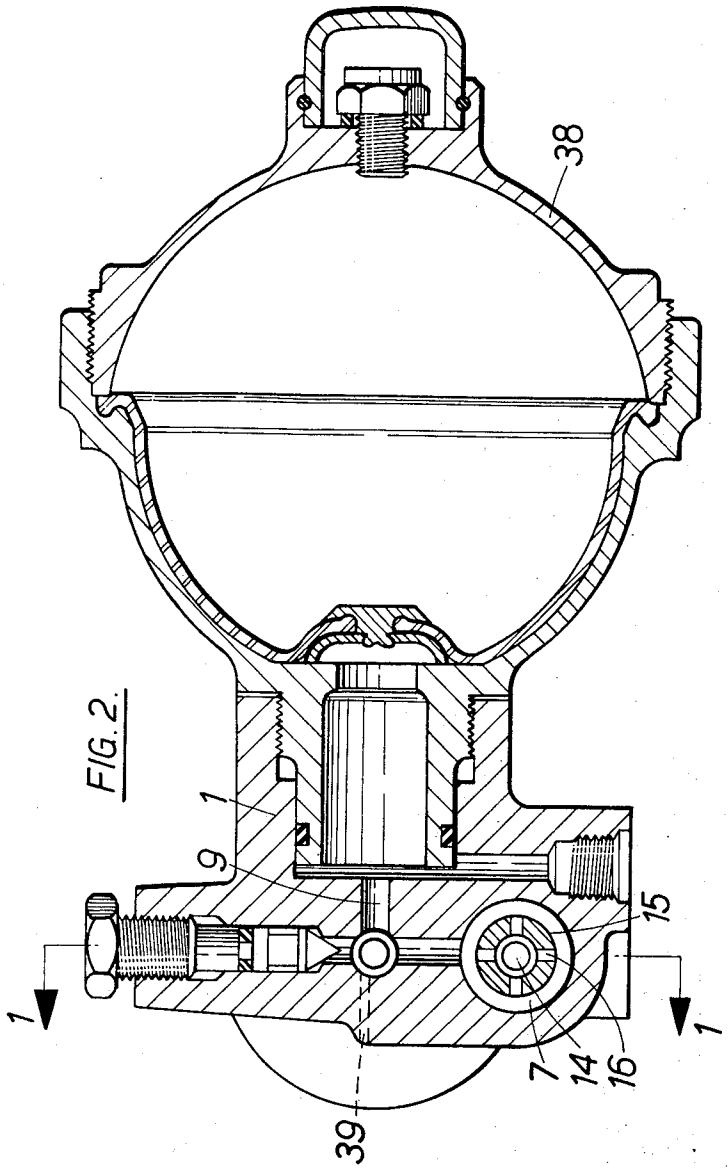


FIG. 2.

# HYDRAULIC FLOW CONTROL VALVE ASSEMBLIES

## SPECIFIC DESCRIPTION

This invention relates to improvements in hydraulic flow control valve assemblies of the kind comprising a housing having an inlet passage for connection to a source of hydraulic fluid under pressure, a first outlet passage for connection to pressure storage means, a first normally closed one-way valve for controlling communication between the inlet passage and the first outlet passage, the first one-way valve being adapted to open when the pressure in the inlet passage exceeds a first predetermined value and being adapted to close when that pressure exceeds a second predetermined value greater than the first, a second outlet passage for connection to pressure operable means, and a second normally closed valve for controlling communication between the inlet passage and the second outlet passage and adapted to open when the pressure in the second outlet passage attains at least said second predetermined value.

According to our invention in an hydraulic flow control valve of the kind set forth the second valve is normally urged into its closed position by a return spring, and movement of the second valve into an open position in opposition to the force in the return spring is effected by a differential piston working in a stepped bore of which the end of smaller area acts on the second valve and the end of greater area is exposed to the pressure in the inlet passage, the differential piston being operative to open the second valve when the force applied to the differential piston by the pressure in the first outlet passage overcomes at least the force of the return spring.

When pressure is present in the second outlet passage, that pressure acts on the end of the differential piston which is of smaller area. Thus the differential piston is operative to open the second valve only when the force applied to it by the pressure in the first outlet passage is sufficient to overcome the combined force of the return spring and the force applied thereto from the pressure in the second outlet passage.

When the differential piston moves in a direction to open the second valve the inlet passage is placed in communication with the second outlet passage. As a consequence the pressure operable means is adapted to be actuated by a supply of hydraulic fluid under pressure from source of hydraulic fluid under pressure.

Conveniently the hydraulic flow control valve assembly may be incorporated into a vehicle hydraulic braking system in which fluid under pressure for operating the braking system is stored in an hydraulic accumulator connected to the first outlet passage. A reservoir for supplying hydraulic fluid to the source of hydraulic fluid, conveniently a high pressure pump, is connected to the second outlet passage, and a connection for a power steering line of the vehicle is interposed between the second outlet passage and the reservoir.

Thus, after the hydraulic accumulator is fully charged, at which pressure the first valve closes, fluid under pressure from the source is supplied through the second valve to the power steering line.

One embodiment of our invention is illustrated in the accompanying drawings in which:



FIG. 1 is a longitudinal section through an hydraulic flow control valve on the line 1—1 of FIG. 2; and

FIG. 2 is a section on the line 2—2 of FIG. 1.

In the control valve assembly illustrated in the drawings a housing 1 is provided with a longitudinal stepped bore comprising an inner portion 2 of smallest diameter, a intermediate portion 3 of greater diameter, and an outer portion 4 of greatest diameter.

A radial inlet passage 5 communicates with the outer bore portion 4, and a passage 6 in the housing parallel with the stepped bore leads from the radial passage 5 to a chamber 7 of enlarged diameter which is connected to the bore portion 2 through a radial passage 8. The bore portion 2 is also connected to a first radial outlet passage 9. The housing 1 is also provided with a further longitudinal bore 10 which defines a second outlet passage communicating at its innermost end with the bore portion 4 of greater diameter.

Communication between the inlet passage 5 and the first outlet passage 9 is controlled by a first valve 11 which is located in the chamber 7. The valve 11 comprises an annular valve seating 12 housed in a counterbored recess 13 at an adjacent end of the passage 6, and a valve member 14 for engagement with the seating 12 and guided for movement relative to the seating within a guide 15 provided with a plurality of radial outlet ports 16.

Communication between the inlet passage 5 and the second outlet passage 10 is controlled by a second valve 17. The valve 17 comprises an annular valve seating member 18 having an axially extending flange 19 which carries a radial seal 20 for sealing engagement with the wall of the bore portion 4. The free end of the flange 19 is clamped against a shoulder 21 at a step in the change in diameter between the bore portions 3 and 4 by means of a sleeve nut 22 screwed into the open end of the bore portion 4. The inner free end of the sleeve nut 22 is provided with at least a pair of radial openings 23 through which the inlet passage 5 communicates with the interior of the sleeve nut 22.

A valve member 24 comprising a ball for engagement with a seating 25 surrounding a central opening in the seating member 18 is located in a recess 27 in the inner end of a push-rod 28. Normally the ball 24 is urged into engagement with the seating 25 by a helical spring 29 acting between a radial abutment plate 30 on the push-rod 28 and the closed outer end of the sleeve nut 22.

An annular plate 31 is clamped against a shoulder 32 at a step at the change in diameter between the bore portions 2 and 3 by means of an axially extending radially apertured sleeve 33 which engages between the seating member 18 and an annular seal 34 engaging with the plate 31. The bore portion 2 and the wall of a central opening 35 in the plate 31, which is of a diameter smaller than that of the bore portion 2, together define a stepped bore in which works a differential piston 36. The end of the differential piston 36 which is of greater diameter is exposed to hydraulic pressure in the radial passage 8. The portion of the differential piston 36 is of smaller diameter projects through the plate 31 and the seal 34 and is adapted to engage at its free end with the ball 24 to move the ball 24 away from its seating 25 when the pressure to which the end of the piston 36 of greater diameter is exposed is sufficient to apply to the piston 36 a force greater than that applied thereto in the opposite closing direction comprising the

force in the spring **29** and a force from the pressure in the outlet passage **10** acting on the portion of the differential piston which is of smaller diameter and which engages with the ball **24.**

The control valve assembly is adapted to be incorporated in a vehicle power operated hydraulic braking system. In such an installation the inlet passage **5** is connected to a source of hydraulic fluid under pressure, for example a high pressure pump **37** driven by the prime mover of the vehicle or another motor and the first outlet passage **9** is connected to an hydraulic accumulator **38** which is screwed into the outer end of an enlarged bore continuous with the passage **9.** The second outlet passage **10** is connected to a connection for a power steering line of the vehicle interposed between the second outlet passage **10** and a reservoir for fluid.

Normally the second valve **17** is closed and the first valve **11** opens when subjected to a first predetermined pressure in the inlet passage **5.** Thus, fluid from the pump is supplied through the passages **5, 6, 8** and **9** to the hydraulic accumulator **38.** When the hydraulic accumulator **38** is fully charged, at a second predetermined pressure, the first valve **11** closes automatically and cuts-off communication between the inlet passage **5** and the first outlet passage **9.**

The pressure of fluid in the hydraulic accumulator **38** and in the first outlet passage **9** acts on the end of the differential piston **36** which is of greater diameter and applies to the piston **36** a force greater than that of the helical spring **29** and the pressure in the outlet passage **10** acting on the portion of the piston **36** which is of smaller diameter. Thus the differential piston **36** moves to the right in FIG. **1** of the drawings towards the end of the stepped bore in which it works, thereby opening the second valve **17.** Fluid under pressure from the pump is then supplied to the second outlet **10** through the seating **25** and the apertures in the sleeve **34** with the result that fluid under pressure is supplied to the power steering line.

When the second valve **17** is opened, fluid in the inlet passage **5** acts on the end of the differential piston **36** which is of smaller diameter to augment the force already applied to the valve member **24** in a closing direction from the helical spring **29** and the pressure in the outlet passage **10.** The relative diameters of opposite ends of the differential piston **36** are therefore chosen to ensure that, under such conditions, the force applied to the ball **24** by the differential piston **36** is sufficient to hold it out of engagement with its seating **25.**

Should the pressure in the hydraulic accumulator **38** drop below the said second predetermined value, the pressure acting on the end of the differential piston **36** which is of greater area is reduced and the second valve **17** closes to cut-off communication between the inlet passage **5** and the second outlet passage **10.** Thereafter the first valve **11** opens so that the hydraulic accumulator **38** is re-charged to its said second predetermined value, whereafter the first valve **11** again closes and the second valve **17** opens as described above.

A volume of the bore portion **2** defined between a shoulder on the differential piston **36** and the plate **31** is at all times vented to atmosphere through a passage **39.** This ensures that there is no pressure trapped between the seal **34** and a seal **40** in the piston **36** during assembly, and that a vacuum is not produced during operation.

I claim:

**1.** An hydraulic flow control valve assembly comprising a housing having an inlet passage for connection to a source of hydraulic fluid under pressure, a first outlet passage for connection to pressure storage means and a second outlet passage for connection to pressure operable means, a first normally closed one-way valve for controlling communication between said inlet passage and said first outlet passage, said first one-way valve being adapted to open when pressure in said inlet passage exceeds a first predetermined value and being adapted to close when said pressure exceeds a second predetermined value greater than the first, and a second normally closed valve for controlling communication between said inlet passage and said second outlet passage and adapted to open when pressure in the second outlet passage attains at least said second predetermined value, a spring for urging said second valve into a closed position, and a differential piston working in a stepped bore and having a first end of greater area exposed to pressure in said inlet passage and a second end of smaller area exposed to pressure in said second outlet passage and adapted to open said second valve when the force applied to said differential piston by pressure in said first outlet passage overcomes at least the force of said return spring.

**2.** A valve assembly as claimed in claim **1,** wherein said differential piston is adapted to open said second valve only when the force applied to said second valve by the pressure in said first outlet passage acting on said first end of said differential piston is sufficient to overcome the combined force of said return spring and said force applied to the second valve from the pressure in said second outlet passage acting on said second end of said differential piston.

**3.** A valve assembly as claimed in claim **1** wherein a valve seating is disposed between said inlet passage and said second outlet passage, and said second end of said piston projects through said seating, and said return spring comprises a compression spring for urging said valve member towards said seating, said compression spring acting between said valve member and an abutment in said housing on the side of said seating remote from said stepped bore.

**4.** A valve assembly as claimed in claim **3,** including a push-rod, wherein said valve member is located in a recess in one end of said push-rod, and said compression spring acts between an abutment on said push-rod and said abutment on said housing.

**5.** An hydraulic system for a vehicle comprising a housing having an inlet passage for connection to a source of hydraulic fluid under pressure, a first outlet passage for connection to pressure storage means, and a second outlet passage for connection to pressure operable means, a first normally closed one-way valve for controlling communication between said inlet passage and said first outlet passage, said first one-way valve being adapted to open when pressure in said inlet passage exceeds a first predetermined value and being adapted to close when said pressure exceeds a second predetermined value greater than the first, and a second normally closed valve for controlling communication between said inlet passage and said second outlet passage and adapted to open when pressure in the second outlet passage attains at least said second predeter-

mined value, a spring for urging said second valve into a closed position, and a differential piston working in a stepped bore and having a first end of greater area and exposed to pressure in said inlet passage and a second end of smaller area adapted to open said second valve when the force applied to said differential piston by pressure in said first outlet passage overcomes at least the force of said return spring, wherein a source of high pressure fluid is connected to said inlet passage, an hydraulic accumulator for operating a braking system is connected to said first outlet passage, and power steering means is connected to said second outlet passage whereby when said hydraulic accumulator is fully charged said first valve closes and, thereafter, fluid under pressure from said source is supplied through said second valve to said power steering means.

**6.** An hydraulic system for a vehicle as claimed in claim **5,** wherein said power steering means is interposed between said second outlet passage and a reservoir from which the source receives fluid.

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