PATENT SPECIFICATION (11) 1 567 046

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(21) Application No. 45250/76 (22) Filed 30 Oct. 1976
(23) Complete Specification Filed 19 Oct. 1977
(44) Complete Specification Published 8 May 1980
(51) INT. CL. [3] B60T 8/24
(52) Index at Acceptance
F2F 647 686 C

(54) VALVE FOR VEHICLE FLUID PRESSURE BRAKING SYSTEM

(71) We, AUTOMOTIVE PRODUCTS LIMITED, a British Company of Tachbrook Road, Leamington Spa, Warwickshire, CV31 3ER 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:-

The invention relates to valves for vehicle fluid pressure braking systems of the kind in which a valve is controlled by the vehicle suspension system and operates only during vehicle cornering to reduce the fluid pressure supplied to a brake or group of brakes on the side of the vehicle nearer the centre of the corner.

Fluid suspension systems for vehicles are well known. A suspension strut interposed between a suspension component which moves with vertical movement of a road wheel and a vehicle body component supports the weight of the vehicle transmitted through to the road wheel such that the fluid pressure in the strut is substantially proportional to the direct load carried by the strut. Usually the mass of fluid is varied to provide a self-levelling suspension system. If the fluid is air or some other gas, then this acts as the suspension spring. If the fluid is oil or some other liquid, then an accumulator, usually a gas spring type, is incorporated into the strut or connected to it to provide the suspension spring.

An object of the invention is to provide a valve for a vehicle fluid pressure braking system of the kind described which can be controlled by a fluid suspension system.

According to the invention a valve for a vehicle fluid pressure braking system comprises:-

a housing;

first and second inlet ports for connection to a driver-controlled source of fluid pressure;

a first outlet port for connection to a brake or group of brakes on one side of the vehicle;

a second outlet port for connection to a brake or group of brakes on the other side of the vehicle;

a first non-return valve capable of blocking communication from the first inlet port to the first outlet port;

a second non-return valve capable of blocking communication from the second inlet port to the second outlet port;

a first chamber within the housing connected to the first inlet port through the first non-return valve and to the first outlet port;

a second chamber within the housing connected to the second inlet port through the second non-return valve and the second outlet port;

a first plunger comprising a first movable wall of the first chamber and being guided for movement in the housing in a direction which causes the first plunger to unseat the first non-return valve and in the opposite direction to allow the first non-return valve to seat and increase the volume of the first chamber;

a second plunger, (operably connected to the first plunger), comprising a second movable wall of the second chamber and being guided for movement in the housing in a direction which causes the second plunger to unseat the second non-return valve and in the opposite direction to allow the second non-return valve to seat and increase the volume of the second chamber;

a first control port for connection to a first fluid suspension strut on said one side of the vehicle, the first suspension strut producing a fluid pressure at the first control port which is substantially proportional to the load supported by a road wheel on said one side of vehicle;

a second control port for connection to a second fluid suspension strut on said other side of the vehicle, the second suspension strut producing a fluid pressure at the second control port which is substantially proportional to the load supported by the corresponding road wheel on said other side of the vehicle;

a third movable wall operably connected to the first plunger and subjected to pressure at the first control port to bias the first plunger in the direction which causes the first non-return valve to unseat;

and a fourth movable wall operably connected to the second plunger and subjected to pressure at the second control port to bias the second plunger in the direction which causes the second non-return valve to unseat, the arrangement being such that, when the pressures at the control ports are the same, both plungers are in a normal position in which the first and second non-return valves are both unseated, but when the pressure at the second control port exceeds the pressure at the first control port the first plunger moves to allow the first non-return valve to seat and to increase the volume of the first chamber and when the pressure at the first control port exceeds the pressure at the second control port the second plunger moves to allow the second non-return valve to seat and to increase the volume of the second chamber.

In certain installations, particularly where the brake operating fluid is air, or some other gas, a first exhaust valve may be provided such that further movement of the first plunger beyond the position where the first non-return valve seats in the direction which caused the first non-return valve to seat operates the first exhaust valve to reduce the brake operating pressure in the first chamber and a second exhaust valve may be provided such that further movement of the second plunger beyond the position where the second non-return valve seats in the direction which caused the second non-return valve to seat operates the second exhaust valve to reduce the brake operating pressure in the second chamber. When the brake operating fluid is a liquid the overall compressibility of the brakes and the pipes and hoses connecting them to the valve is such that relatively small movements of the first and second movable walls increase the volumes of the first and second chambers sufficiently to effect the required reductions in the brake operating pressures without a need for exhaust valves.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawing, which shows a cross-section through a valve according to the invention.

The valve 11 comprises a housing including two castings 12, 13 each having a stepped through-bore closed at the outer end by a respective end plug 14, 15. End plug 14 incorporates a first inlet port 16 and a first non-return valve 17 and end plug 15 incorporates a second inlet port 18 and a second non-return valve 19.

The end plug 14 forms one end wall of a first cylindrical chamber 21 which connects with the first inlet port 16 through the first non-return valve 17 and with a first outlet port 22. Similarly, the end plug 15 forms an end wall of a second cylindrical chamber 23 which connects with the second inlet port 18 through the second non-return valve 19 and with a second outlet port 24.

A first stepped plunger 25 slidable in the stepped bore of casting 12 has a projecting snout 26 at the end nearer the end plug 14 for unseating the ball of the first non-return valve 17. Similarly, a second stepped plunger 27 is slidable in the stepped bore of casting 13 and has a projecting snout 28 at the end nearer the end plug 15 for unseating the ball of the second non-return valve 19. The end of the first stepped plunger 25 which includes the snout 26 acts as a first movable wall of the first chamber 21 and similarly the end of the second stepped plunger 27 which includes the snout 28 acts as a second movable wall of the second chamber 23.

Each stepped plunger 25, 27 has two effective diameters, the smaller diameter being sealed by ring seals 29, 31 (on plunger 25) and 32, 33 (on plunger 27) and the larger diameter being sealed by seals 34 (on plunger 25) and 35 (on plunger 27). The annular area formed by the step between the smaller and larger effective diameters of the second stepped plunger 27 acts as a third movable wall which is open to pressure at a first control port 36 in the casting 13. Pressure on the third movable wall biasses the second stepped plunger 27 away from the end plug 15 and, by virtue of its abutment with the first stepped plunger 25 is operably connected to the first stepped plunger to bias it in the same direction. Similarly a fourth movable wall is formed by the area of the step between the smaller and larger effective diameters of the first stepped plunger 25 and is open to pressure at a second control port 37. Pressure on the fourth movable wall biasses the first stepped plunger away from end plug 14 and, by virture of its abutment with the second stepped plunger 27, is operably connected to the second stepped plunger 27 to bias it in the same direction.

The plungers 25, 27 are dimensioned so

that when in a normal, centralised, position both non-return valves 17, 19 are unseated. Centralising is aided by preloaded springs 38, 39 in the first chamber 21 and second chamber 23 respectively which each act on washers 41 such that if plunger 25 moves beyond the central position towards end plug 14 is compresses spring 38 and if plunger 27 moves beyond the central position towards end plug 15 is compresses the other spring 39.

When the valve 11 is installed in a motor vehicle, both inlet ports 16, 18 are connected to a driver's brake hydraulic master cylinder, or equivalent device, outlet port 22 is connected to a front brake on one side of the vehicle and outlet port 24 is connected to a front brake on the other side of the vehicle. Control port 36 is for connection to a hydro-pneumatic suspension strut 42 (shown diagrammatically) which supports the weight acting on a wheel on the same side of the vehicle as the brake served by the first outlet port 22. Similarly, control port 37 is for connection to a hydro-pneumatic suspension strut 43 (also shown diagrammatically) which supports the weight acting on the corresponding wheel on the opposite side of the vehicle. Each suspension strut 42, 43 produces a pressure at the respective control port 36, 37 which is proportional to the weight supported by the respective wheel.

When the pressures at the control ports 36, 37 are the same, i.e. when the vehicle is stationary or travelling in a straight line, the plungers 25, 27 remain centralised since the biassing loads on each plunger 25, 27 are equal and opposite. Hence brake pressure at the inlet ports 16, 18 is transmitted to the outlet ports 22, 24 unimpeded and since the pressures in chambers 21, 23 remain equal the plungers 25, 27 remain centralised for all brake pressures.

If the vehicle corners such that strut 43 compresses and strut 42 extends, then the wheel associated with the brake served by port 22 will be less heavily laden and the wheel associated with the brake served by port 24 will be more heavily laden. If the brakes are not applied when the vehicle enters the corner, the relative increase in pressure at control port 37 over the pressure at control port 36 causes the plungers 25, 27 to be moved away from end plug 14, allowing non-return valve 17 to seat and prevent communication from the first inlet port 16 to the first outlet port 22 and increases the volume of the first chamber 21. If the driver now applies the brakes, the immediate effect is for pressure to be communicated from the second inlet port 18 to the second outlet port 24 but not from the first inlet port 16 to the first outlet port 22.

This condition continues until the bias on the plungers 25, 27 caused by the imbalance of suspension pressure at the control ports 36, 37 is counteracted by an opposite bias caused by the imbalance of brake pressures in the chambers 21, 23, whereupon the first non-return valve 17 is unseated to allow a quantity of fluid through to the first outlet port 22. The subsequent rise in pressure in the first chamber 21 tends to bias the plungers 25, 27 away from the end plug 14 to re-seat non-return valve 17 so that with further steadily increasing master cylinder pressure at the inlet ports 16, 18 the plungers 25, 27 shuttle to and fro, seating and unseating the first non-return valve 17 and maintaining a balance of forces.

If the brakes are applied before the vehicle enters the corner, the increase in pressure at control port 37 over that at control port 36 causes the plungers 25, 27 to move away from the end plug 14 as before. However, after the first non-return valve 17 has seated, the plunger 25 continues to move away from end plug 14 to increase the volume of the first chamber 21 and so reduce the brake pressure at the first outlet port 22. This continues until the force balance on the plungers is restored.

The valve 11 is symmetrical so that operation when cornering in the opposite direction is directly similar to that described above for cornering in the one direction.

In the embodiment described above the first and second plungers 25 and 27 are separate components for ease of manufacture and assembly, but they may be fastened together or made as one component if desirable.

WHAT WE CLAIM IS:-

1. A valve for a vehicle fluid pressure braking system comprising:-

a housing;

first and second inlet ports for connection to a driver-controlled source of fluid pressure;

a first outlet port for connection to a brake or group of brakes on one side of the vehicle;

a second outlet port for connection to a brake or group of brakes on the other side of the vehicle;

a first non-return valve capable of blocking communication from the first inlet port to the first outlet port 22;

a second non-return valve capable of blocking communication from the second inlet port to the second outlet port;

a first chamber within the housing connected to the first inlet port through the

first non-return valve and to the first outlet port;

a second chamber within the housing connected to the second inlet port through the second non-return valve and the second outlet port;

a first plunger comprising a first movable wall of the first chamber and being guided for movement in the housing in a direction which causes the first plunger to unseat the first non-return valve and in the opposite direction to allow the first non-return valve to seat and increase the volume of the first chamber;

a second plunger, (operably connected to the first plunger), comprising a second movable wall of the second chamber and being guided for movement in the housing in a direction which causes the second plunger to unseat the second non-return valve and in the opposite direction to allow the second non-return valve to seat and increase the volume of the second chamber;

a first control port for connection to a first fluid suspension strut on said one side of the vehicle, the first suspension strut producing a fluid pressure at the first control port which is substantially proportional to the load supported by a road wheel on said one side of the vehicle;

a second control port for connection to a second fluid suspension strut on said other side of the vehicle, the second suspension strut producing a fluid pressure at the second control port which is substantially proportional to the load supported by the corresponding road wheel on said other side of the vehicle;

a third movable wall operably connected to the first plunger and subjected to pressure at the first control port to bias the first plunger in the direction which causes the first non-return valve to unseat;

and a fourth movable wall operably connected to the second plunger and subjected to pressure at the second control port to bias the second plunger in the direction which causes the second non-return valve to unseat, the arrangement being such that, when the pressures at the control ports are the same, both plungers are in a normal position in which the first and second non-return valves are both unseated, but when the pressure at the second control port exceeds the pressure at the first control port the first plunger moves to allow the first non-return valve to seat and to increase the volume of the first chamber and when the pressure at the first control port exceeds the pressure at the second control port the second plunger moves to allow the second non-return valve to seat and to increase the volume of the second chamber.

2. A valve according to Claim 1 wherein a first exhaust valve is provided such that further movement of the first plunger beyond the position where the first non-return valve seats in the direction which caused the first non-return valve to seat operates the first exhaust valve to reduce the brake operating pressure in the first chamber and a second exhaust valve is provided such that further movement of the second plunger beyond the position where the second non-return valve seats in the direction which caused the second non-return valve to seat operates the second exhaust valve to reduce the brake operating pressure in the second chamber.

3. A valve according to Claim 1 or Claim 2 wherein the second plunger is stepped to provide the third movable wall and the first plunger is stepped to provide the fourth movable wall, the arrangement being such that in use the first plunger is biassed by suspension pressure at the second control port into abutment with the second plunger which is biassed in the other direction by suspension pressure at the first control port.

4. A valve according to any preceding claim wherein the first plunger has a projecting snout for unseating the first non-return valve and the second plunger has a second projecting snout for unseating the second non-return valve.

5. A valve according to any preceding claim wherein a centering spring is provided in each of the first and second chambers, only one of the centering springs being exercised when the plungers are moved from said normal position.

6. A valve for a vehicle fluid pressure braking system substantially as described herein with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1980.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*