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(71) Applicant
Alfred Teves GmbH

(Incorporated in FR Germany)

7 Guerickestrasse, 6000 Franfurt am Main, Federal Republic of Germany

(72) Inventors
Juergen Schonlau
Alfred Birkenbach
Ralf Harth

(74) Agent and/or Address for Service
Ruffhead & Vaufrouard
Maidstone Road, (STC Site) Foots Cray, Sidcup, Kent, DA14 5HT

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(54) Hydraulic pressure regulator

(57) A hydraulic pressure regulator, particularly for a vehicle brake system, comprises a housing (1) provided with at least one pressure fluid inlet (2) and one pressure fluid outlet (3), the connection between which is respectively controlled by a valve unit (10, 11) biassed by a driving force in proportion to an application force, the pressure regulator being substantially located in the interior of a suspension spring (25). To attain a vehicle load-sensitive pressure regulator of utmost precision, a fluid enclosed by a membrane (22) serves for the transformation of suspension spring seat application force to driving force, with force being applied to the pressure regulator (10, 11) through a partial face (B) (Fig. 1) of the membrane (22) in the opening direction.

FIG.2

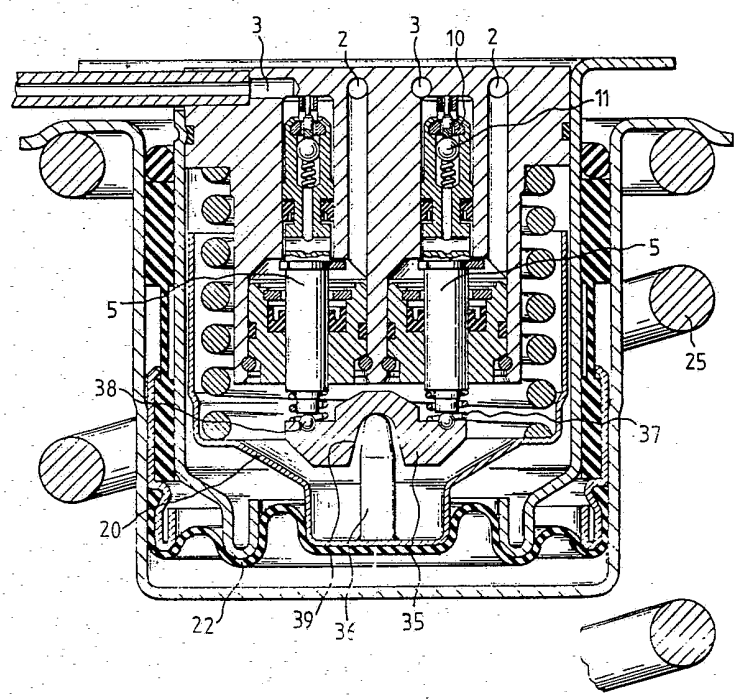

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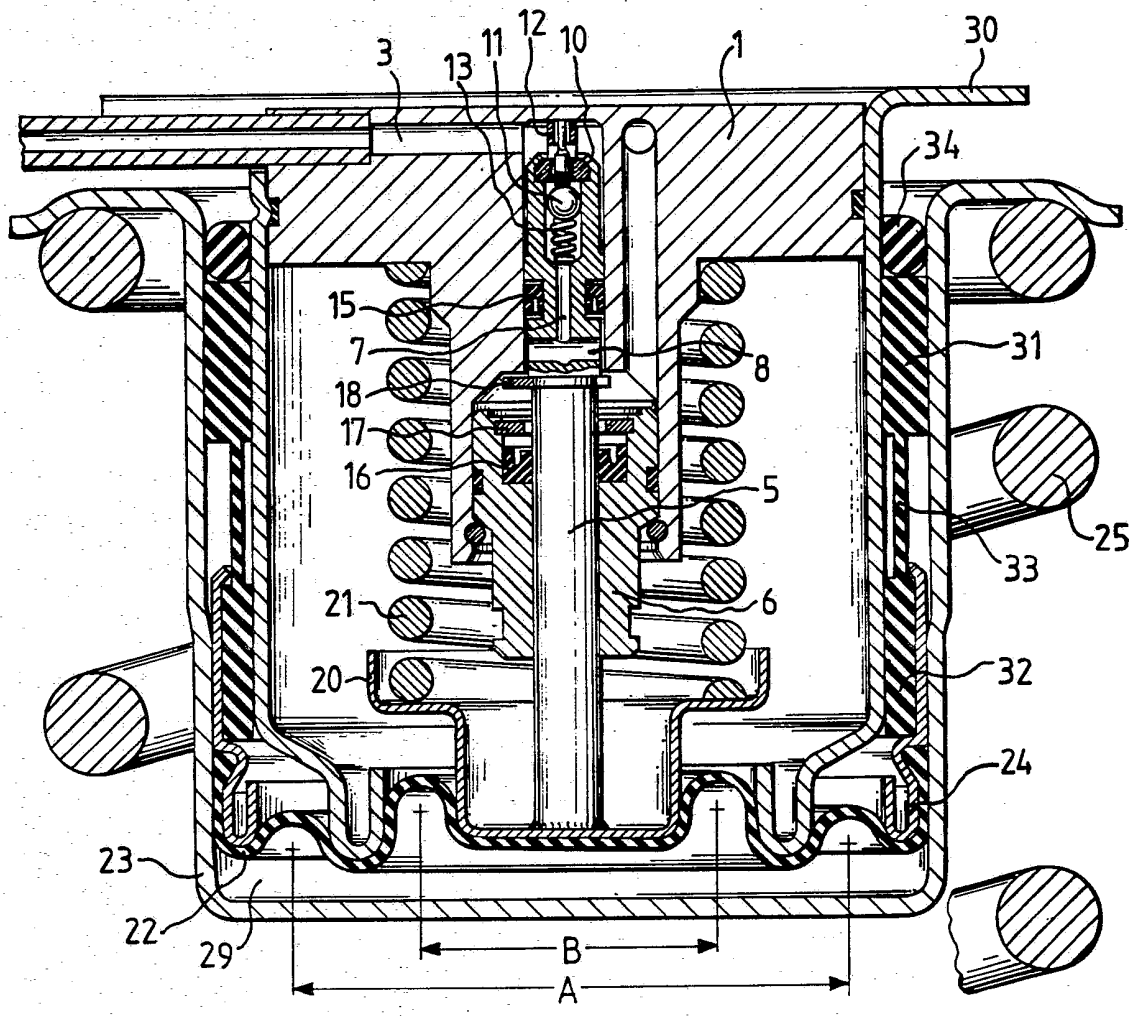
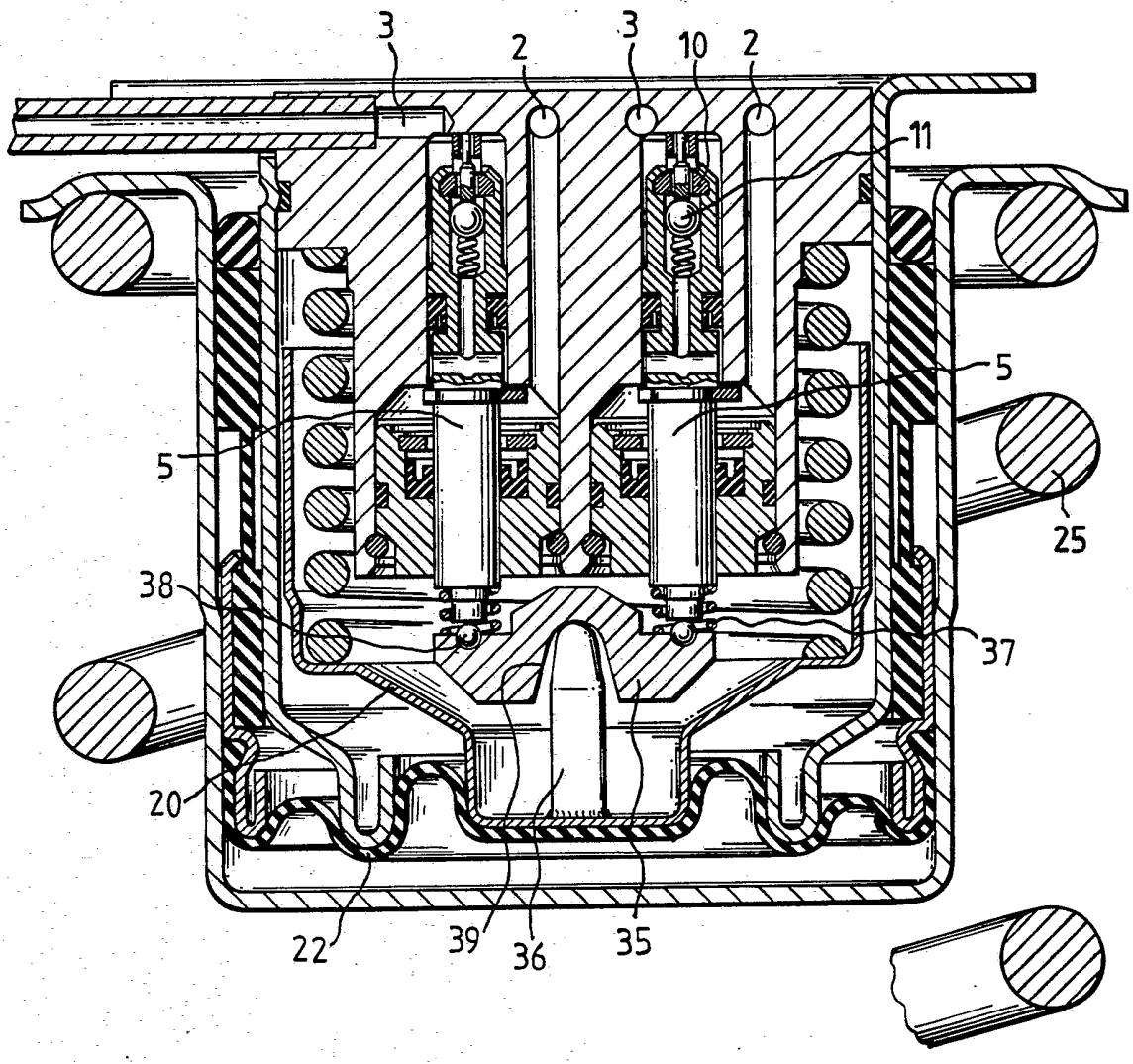
FIG.1



J. Schonlau - 41
A. Birkenbach - 15
R. Harth - 4

FIG.2



J. Schonlau - 41
A. Birkenbach - 15
R. Harth - 4

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PRESSURE REGULATOR

The present invention is concerned with a pressure regulator, in particular, for use with a pressure fluid-operable brake system of an automotive vehicle, of the kind comprising a housing provided with at least one pressure fluid inlet and one pressure fluid outlet, the connection between which is controlled by a valve unit driven by a driving force in proportion to an application force, the pressure regulator being located substantially in the interior of a suspension spring.

Pressure regulators of the afore-mentioned kind are employed, for example, with automotive vehicles to distribute the brake pressure between front and rear axles in response to load. DE-OS 30 01 415 discloses a load-sensitive brake force regulator of this kind, wherein a reduction in force from the gear cushion is to be achieved through an enclosed rubber element which, with a predetermined proportion of its surface, applies force to a transmission member to actuate, in turn, the valve in the opening direction. The disadvantage involved therewith resides in that, thanks to the load exerted on the suspension spring, the rubber element, admittedly, moves the valve means in the opening direction; however, no return movement for closing the

valve is any longer possible as the enclosed rubber element is not capable of performing a passing movement. In addition it is disadvantageous that the rubber element, in the course of time, changes its characteristic, thereby precluding a precise regulation.

It is, therefore, an object of the present invention to improve the regulating precision of a pressure regulator of the kind referred to.

According to the invention there is provided a pressure regulator, in particular, for use with a pressure fluid-operable brake system of an automotive vehicle, of the kind comprising a housing provided with at least one pressure fluid inlet and one pressure fluid outlet, the connection between which is controlled by a valve unit driven by a driving force in proportion to an application force, the pressure regulator being located substantially in the interior of a suspension spring, characterised in that a fluid enclosed by a membrane serves to transform application force to driving force, driving force being applied to the valve means by a partial face of the membrane in the opening direction.

The solution provided by the invention enables the valve means always to be driven by a driving force exactly in proportiron to the force of admission. Moreover, during the pressure decrease, an almost hysterisis-free characteristic is permitted.

Also, the fact that the valve unit is composed of a valve seat located in a regulating piston and comprising

a spring-loaded valve closing member associated therewith, will contribute to high-precision regulation.

According to a particularly favorable embodiment of the invention, the membrane is in the form of a roll-type membrance comprising radially circumferential bulgings between all parts relatively displaceable with respect to one another and applying force to the membrance, such as a spring seat, a supporting ring and a piston support plate, wherein the roll-type membrane is of such a configuration as to permit satisfactory rolling movements thereby precluding deformation of or even damage to the membrane.

To enable switch-over pressures to be adjusted precisely to different requirements, a regulating spring is provided between the housing and the piston support plate. This will enable the load-sensitive switch-over pressure, when using the pressure regulator as a brake force regulator in an automotive vehicle, to be adjusted precisely to the specific data of the automotive vehicle.

Any disturbing frictional influence exerted on the regulating behaviour is minimised in that a slide ring is provided between spring seat and supporting ring.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 shows a longitudinal section through one form of embodiment of the invention in the form of a single-type regulator and

Figure 2 shows a longitudinal section through one

form of embodiment of the invention in the form of a twin-type regulator.

The pressure regulator as shown in Figure 1 comprises a housing 1 of a stepped outer contour, which is provided with an equally stepped central port and a connecting bore for the inlet 2 and a connecting bore for the outlet 3. Housing 1 is in communication with the resilient vehicle body. Located in the axial centre port of the housing is the major part of the regulating piston 5 which is axially displaceable and, on the one hand, is sealingly disposed in the section of the central port of smaller diameter while, on the other hand, it is guided through a closure member 6 which, in the central port step of larger diameter is fixed, in pressure-tight manner, to a snap ring. The end of the regulating piston 5 facing the outlet is provided with an axial bore 7 in communication with a transverse bore 8; communication between inlet and outlet is established through these two ports.

At the end of the stepped axial port 7, facing the connecting port for the outlet 3, a valve seat 10 is conventianlly caulked in a pressure-tight manner. Through the valve seat 10, a valve closure member 11 preloaded toward the valve seat through the valve spring 13, is enclosed within the central step of the axial bore 7.

The valve seat 10, in part, protrudes from the control piston, with a transverse port being provided in

the protruding section, which transverse port is in communication with the axial passage port of the valve seat in which is located an actuating pin 12. The axial passage port of the valve seat 10 and the actuating pin 12, respectively at the ends thereof facing the valve closure member 11, comprise a cross-sectional enlargement locking the actuating pin against dropping.

Provided between the transverse bore 8 and the end of the regulating piston facing the outlet is a groove ring 15 disposed in a corresponding annular groove of the cylindrical surface of the regulating piston 5 against the housing 1. Within the closure member 6, the regulating piston 5 is sealed by another groove ring 16 protected through a locking ring 17 against dropping. The locking ring 17 cooperates with the stop ring 18 limiting the return stroke of the regulating piston 5 and provided between the lock ring 17 and the transverse port 8 on the regulating piston 5.

The end of the regulating piston 5 protruding from the housing 1, through a welding seam, is in communication with the piston support plate 20 constituting a sheet metal part formed as a hat and partly enclosing the regulating piston end protruding from the housing; disposed in the cup-shaped radially outer marginal area thereof is a regulating spring 21. The regulating spring 21 is supported, with its other end, on an outer step and is of a helical compression spring configuration. The piston support plate 20 with

the outer bottom side thereof applies force to a membrane 22 configured as a roll-type membrane which, at the edge thereof, is provided with a bead through which it is fixed to the spring seat 23 by means of a holding ring 24. The cup-shaped spring seat 23 largely surrounds the complete regulator, and force is applied to the externally bent flange-type edge in the axial direction through the suspension spring 25, the other end of which is supported on a non-resilient suspension part (not shown).

A supporting sleeve 30 caulked at one end thereof to the housing 1 is axially guided into the spring seat 23 and comprises, at the other end thereof, a U-shaped closing curve turned back in collar-type manner and applying force to the membrane 22 conforming to the closing curve. Trapped in the closed chamber 29 formed by the membrane 22 and the bottom of the spring seat 23 is a suitable fluid medium, for example, a silicone oil. The membrane 22 between the U-shaped end pieces of the holding ring 24 applying force to the membrane 22, and the support sleeve 30, and between the piston support plate 20 and the U-shaped end section of the support sleeve 30 surrounding the piston support plate 20, curvilinearly, is directionally bulged out from the bottom of the spring seat 23, thereby enabling the membrane to perform a roll-off movement in the case of a relative movement between the afore-mentioned parts. The annular face of the membrane 22 between the cylindrical

section of the spring seat 23 and the end section of the support sleeve 30 can, by a corresponding tapering of the support sleeve in this area be freely selected within a predetermined range so as to vary the relation of the driving force exerted on the valve means to the admission force from the suspension spring 25.

The cylindrical surface of the support sleeve 30 is, in part, surrounded by a slide ring 31 disposed between the support sleeve 30 and the spring seat 23 to reduce the friction in the case of a movement of the spring seat relative to the support sleeve. The slide ring 31 comprises a second section 32 of a reduced wall strength to which the holding ring 24 surrounding the section 32 is caulked. A central area 33 of the slide ring 31 is of the lowest wall thickness and is provided with circumferentially distributed recesses.

To preclude ingress of water or dirt, the annular gap between the spring seat 23 and the support sleeve 30 is sealed by a gasket 34.

In the non-pressurised condition of the brake system, the pressure regulator holds the position shown in the drawing. If the brake circuit is pressurised by a pressure fluid source through the connecting port for the inlet 2, the pressure fluid, through transverse bore 8, the axial bore 7 and the valve means 10,11 opened through the actuating pin 12, is passed to the connecting port for the outlet 3 and into the brakes in communication therewith, respectively. Through the pressure exerted on

the front face of the regulating piston, a force is generated tending to force the regulating piston from the central port of the housing. Once a predetermined distance is covered by the regulating piston 5, the actuating pin 12 is lifted off housing 1 and is thus no longer able to keep the valve 10,11 open. The valve closure member 11, through the force of the valve spring 13, is forced onto the valve seat 10 thereby blocking the passage between the inlet and the outlet. The regulating piston, in its area between piston support plate 20 and stop ring 18, is of a smaller diameter than in the area between stop ring 18 and the end of the piston facing the outlet. In this manner, in the case of a further pressure build-up, through the connecting port for the inlet, a force is generatd on the regulating piston by way of which it is slightly forced back into the central port of the housing, with the actuating pin 12 reopening the valve 10,11. During the pressure build-up, the regulating piston 5, hence, in quick sequence, moves forth and back, with the valve means 10,11 permanently opening and closing, and with the outlet pressure being reduced over the inlet pressure at the ratio of the surfaces to which pressure is applied.

The spring seat 23 is forced toward the housing 1 to a more or less heavy degree, through the suspension spring 25, in response to the wheel load, with the fluid enclosed in the chamber 29 being pressurised in response to load. The pressure generated in chamber 29

corresponds to the quotient from the force admitted through the suspension spring 25, from the wheel load and the cross-sectional face A.

Thanks to this pressure, a reaction force is applied to the piston support plate and, hence, to the regulating piston, the reaction force corresponding to the product of the pressure and the cross-sectional face B. Consequently, a force reduction of the wheel load on the driving force of the regulating piston 5 will take place. Through the control force, force is applied to the regulating piston 5 in load-sensitive manner in the opening direction of the valve 10,11. This will result in an increase in the switch-over pressure which, through the selection of the spring rate of the regulating spring 21 and the relationship between the pressure applying surfaces, can be adapted to the conditions respectively required by a predetermined automotive vehicle.

In the case of a pressure drop in the inlet, first the regulating piston 5 is shifted from the central port of the housing 1 to a degree causing the stop ring 18 to abut against the lock ring 17 so that the outlet pressure is decreased by an increase in volume of the outlet chamber. Thereafter, the pressure decrease in the outlet is effected in that the excess pressure in the outlet displaces the valve closure member 11 against the force of the valve spring 13 thereby opening the valve 10,11 until the valve 10,11, through the actuating pin 12 then in abutment with housing 1, is held in the open position.

The twin regulator as shown in Figure 2 is, basically, of the same construction and exhibits the same way of operation so that, in the followng, reference will only be made to the differences between these two embodiments of the invention. In respect of parts corresponding to one another, identical reference characters have been selected in both Figures.

Housing 1, in this embodiment, comprises two main ports in each of which is respectively provided one regulating piston 5 and to which are respectively connected one connecting bore for the inlet 2 and one connecting bore for the outlet 3. The pressure application to the regulating piston 5 is not effected - as in Figure 1 - directly through the piston support plate 20, but rather through a distributor element 35 in the form of a hinged plate on a plunger 36.

The ends of the regulating piston 5 protruding from the housing 1, are stepped toward the distributor element 35, with a spring 37 being respectively supported on the step, the other end of which (spring) applies pressure to the distributor element 35.

The distributor element 35 serves to balance closure path tolerances; to permit a friction-free swing movement of the distributor element 35, respectively a ball 38 acting as an intermediate element is provided between the regulating piston end and the point of contact with the distributor element 35. The plunger 38 welded with one end to the piston support plate 20, is at the other end

shaped conically passing over into a curve. The appertaining cut 39 of its abutment on distributor element 35, in the conical area thereof, exhibits an elevated slope, which slope is so selected that, in the case of a failure of a brake circuit - in which case the regulating piston 5 of the circuit remains in its initial position while the other is moved into the closure position of the valve 10,11 - the two conical flanks of the plunger 36 and of the distributor element 35 strike one another and, as a result, the whole of the driving force of plunger 36 is transmitted to the circuit still intact thereby increasing the switch-over pressure of the intact circuit.

CLAIMS;

1. A pressure regulator, in particular, for use with a pressure fluid-operable brake system of an automotive vehicle, of the kind comprising a housing provided with at least one pressure fluid inlet and one pressure fluid outlet, the connection between which is controlled by a valve unit driven by a driving force in proportion to an application force, the pressure regulator being located substantially in the interior of a suspension spring, characterised in that a fluid enclosed by a membrane (22) serves to transform application force to driving force, driving force being applied to the valve means (10,11) by a partial face (B) of the membrane (22) in the opening direction.

2. A pressure regulator according to claim 1, characterised in that the valve unit comprises a valve seat (10) located in a regulating piston (5), and a spring-loaded valve closure member (11) associated with the valve seat (10).

3. A pressure regulator according to claim 1 or 2, characterised in that the membrane (22) is configured as a roll-type membrane and comprises radially circumferential bulgings between all parts that are relatively displaceable with respect to one another and that apply force to the membrane (22), such as spring seat (23), supporting sleeve (30), or piston support plate (20).

4. A pressure regulator according to claim 3,

characterised in that a regulating spring (21) is located between the housing (1) and the piston support plate (20).

5. A pressure regulator according to claim 3 or 4, characterised in that a slide ring (31) is provided between the spring seat (23) and the support sleeve (30).

6. A pressure regulator substantially as described with reference to the accompanying drawings.

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