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(71) Applicant
Boge GmbH (FR Germany),
Postfach 360, 5208 Eitorf (Sieg), Federal Republic of Germany

(72) Inventors
Dr. Theo Meller,
Heinz Knecht,
Werner Kuchheuser

(74) Agent and/or Address for Service
Barker Brettell & Duncan, 138 Hagley Road, Edgbaston, Birmingham B16 9PW

(54) Self-pumping self-levelling hydro-pneumatic strut

(57) A simple, reliable and rugged height level control mechanism of a self-pumping hydro-pneumatic spring strut is of such a form that on reaching the predetermined height a delayed flow back to the low pressure chamber is achieved. For this purpose, between the height control orifice 25 of the pump rod 19 and a suction valve installation 22 at the end of the pump rod there is inserted a sleeve 26 which provides a passage 27 and a throttle opening 28 which allows the fluid to flow in a delayed manner from the high pressure working chamber 16 through the control orifice 25 of the pump rod 19 to its bore and thence back to the low pressure chamber 10.

In operation, with the strut contracted below the mean height (and the control orifice 25 therefore covered by the piston), oscillations cause liquid to be pumped from low pressure chamber 10, through the bore in the pump rod 19, through suction valve 22 into the pump chamber 21, and thence via delivery valve 23 into the high pressure chamber 16 to extend the strut until height control orifice 25 is uncovered. Flow back to the low pressure chamber 10 then takes place in the throttled manner referred to above. Because the throttle opening is adjacent the suction valve 22, it is flushed each time the valve opens.

FIG. 1

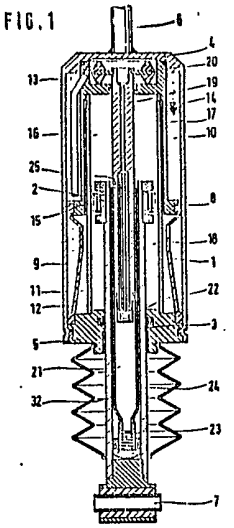

FIG. 2

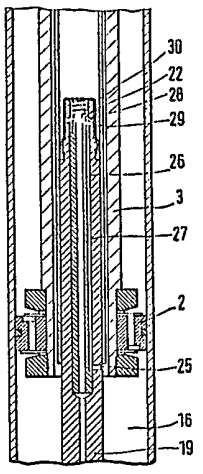

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FIG. 1

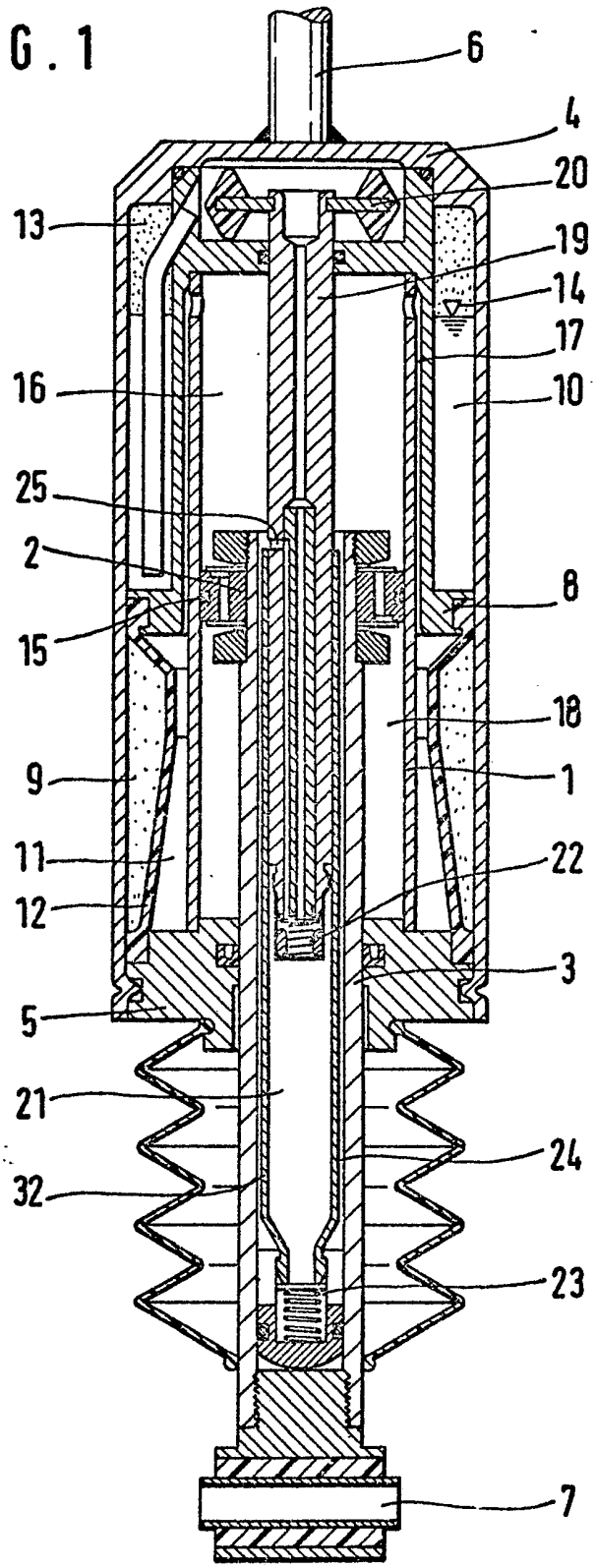


FIG. 2

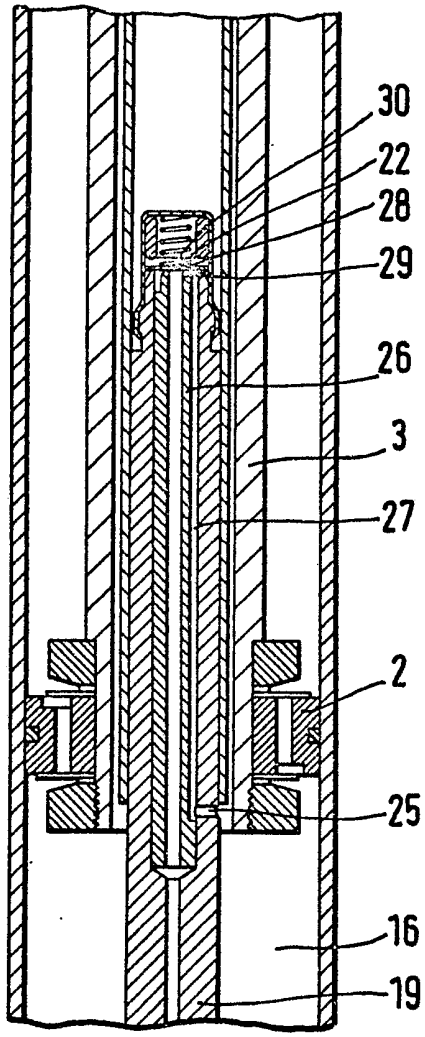
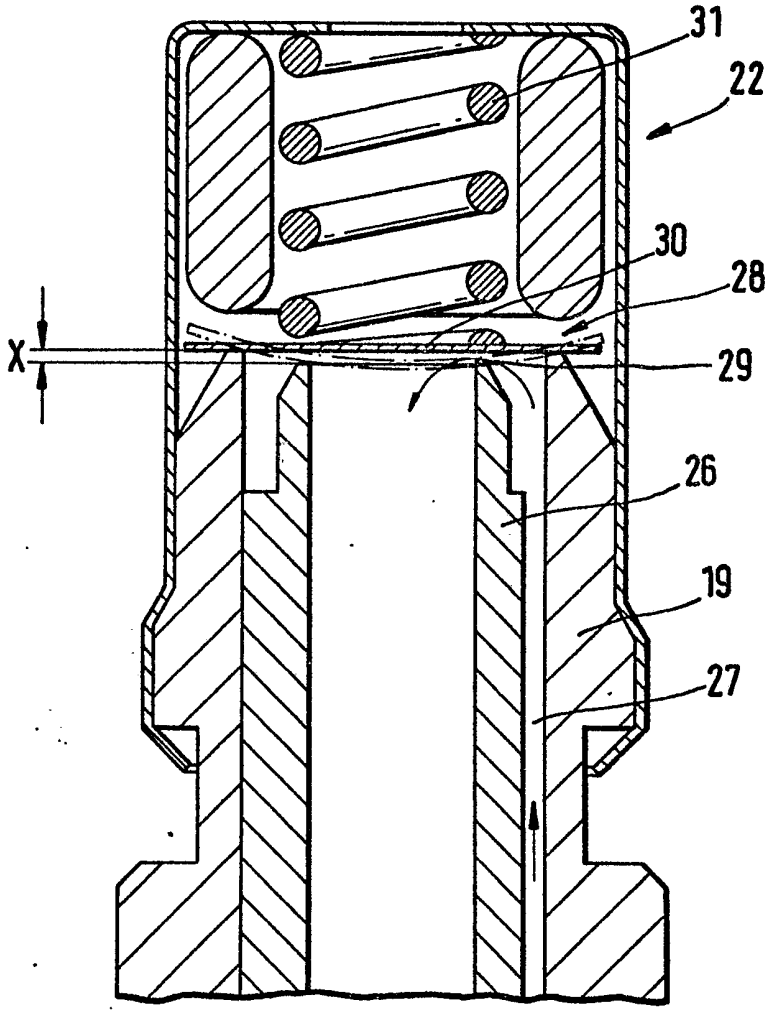


FIG. 3



SPECIFICATION

Self-pumping self-levelling hydro-pneumatic strut

The invention relates to a self-pumping self-levelling hydro-pneumatic strut for motor vehicles, comprising a fluid-filled working cylinder and a force-transmitting piston sliding in the cylinder on the end of a hollow piston rod, the interior of the piston rod serving as a pump cylinder for a pump rod secured to the working cylinder, the working piston dividing the working cylinder into two working chambers, a control orifice being uncovered in a predetermined working position to connect that working chamber under high pressure to a low pressure chamber, and a bore of the pump rod being provided at the end of the pump rod with a suction valve.

In some such known self-levelling struts (e.g. DE—PS 16 30 107), in a corresponding position of the working piston after uncovering of the control orifice by displacement of the piston rod, the fluid from the high pressure chamber can flow through the control orifice directly to the low pressure chamber. This has an unfavourable effect in that, after the control orifice has been uncovered for only a brief moment the pressure in the high pressure chamber falls in a very short time. Such short-period control arises for example after travel in a curved path at high speed or during sharp braking, which causes the rear end of the vehicle to rise. This unwanted change in the levelling gives rise to adverse effects on the ride characteristics of the vehicle.

Furthermore, self-levelling struts are known (e.g. DE—OS 30 20 050) in which a number of control orifices are employed, co-operating with a conical piston rod. In order to obtain an appropriate delay in the correction time, it is not possible to design these control orifices to be as small in diameter as is desired, since below a predetermined diameter there is the danger that impurities in the fluid become lodged in the control orifice and have a corresponding adverse effect on the levelling characteristics.

From this starting point it is the aim of the invention to provide a simple, reliable and rugged self-levelling device in which response time is extended so that even upon travel in a curved path and/or severe braking of the vehicle, unwanted changes in the vehicle height are avoided.

This problem is solved according to the invention in that a throttle member is mounted in the pump rod to connect the control orifice to the bore of the pump rod through a connecting passage and at least one throttle opening.

It is advantageous here that the throttle member provides a by-pass for the fluid emerging from the control orifice to the pump rod. The throttle member which causes the delay presents the fluid flowing directly from the high pressure chamber into the low pressure chamber so that the control orifice no longer acts as a throttle opening but on the contrary various forms of throttle can be employed as a time delay. In this way it is possible for the control orifice to be increased in diameter and for the danger of blockage by impurities in the oil to be reduced. On the one hand the control orifice is made less delicate, and instead a rugged component is provided for rough driving, and on the other hand a time delay in the levelling response has been achieved.

In a preferred embodiment, the or each throttle opening co-operates with the suction valve.

The or each throttle opening may be provided at the end portion of the throttle member and the remainder of the end portion of the throttle member may serve as a stop surface for the valve member of the suction valve. In this way the drawbacks of blockage of the orifice are eliminated since during a subsequent operation of the suction valve the member lifts away from the throttle member and the pump rod so that the fluid which flows past can wash away the potentially blocking particles. This feature results in a self-cleaning action, in which the blockage can only be of brief duration.

It is also possible with advantage for the or each throttle opening to be in the form of a wedge-shaped recess. Such a recess can be manufactured without difficulty by chipless forming.

In a preferred embodiment, the suction valve has a flexible pre-stressed valve member which abuts against the end portion of the pump rod and forms the or each throttle opening in conjunction with the end portion of the throttle member that is spaced from it.

In this embodiment a delay dependent on load or pressure is achieved by the provision of a throttle member of which the end portion is a predetermined measured distance below the working surface of the suction valve. As a consequence of different yielding of the resilient valve member at different pressures, a variable and pressure-dependent throttling cross-section is formed.

Furthermore, delays in the response can be achieved by arranging that the connecting passage is itself in the form of a throttle and has a corresponding throttling cross-section over at least part of its length. The required throttling cross-section is achieved by incorporation of an appropriate annular gap, to contribute connecting passage, between the inside diameter of the pump rod and the outside diameter of the sleeve.

In a further preferred embodiment the connecting passage forms a throttle opening and is in the form of a helix, extending over either surface of the sleeve or the inside surface of the pump rod. In this case the length and the cross-section of the passage determine the throttling cross-section, and hence the appropriate delay in the flow of fluid.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a section through a self-pump

hydro-pneumatic spring strut with self-levelling;

Figure 2 is a section through a portion of the piston rod together with the working cylinder and the pump rod of the strut shown in Figure 1; and

Figure 3 is a section through a throttle member and the suction valve shown in Figures 1 and 2, to a larger scale.

The spring strut for motor vehicles illustrated in Figure 1 comprises substantially a working cylinder 1 in which a piston 2 slides, mounted on the end of a piston rod 3. The working cylinder 1 is closed at the one end by a base cape 4 and at the other end by a cover 5, through which the piston rod 3 extends through a seal.

The base cap 4 is secured to the vehicle structure by an attachment pin 6 and the piston rod 3 is attached to the axle of the vehicle in a manner not shown by means of an attachment eye 7. The working cylinder 1 is surrounded by an annular compensating chamber filled partially with hydraulic fluid and partially with gas, this chamber being divided by a partition 8 into a high pressure chamber 9 and a low pressure chamber 10. A high pressure gas cushion or bag 9 is separated from a fluid space 11 by a diaphragm 12. In the low pressure chamber 10 the fluid and a low pressure gas cushion 13 are not kept separate from one another. The fluid level is indicated at 14. In the fully adjusted down, i.e. not pumped-up condition the same pressure prevails in the low pressure chamber 10 as in the high pressure chamber 11, 9.

The inner working chamber 16 in the end between the working piston 2 and the base cap 4 is in communication with the oil space 11 of the high working pressure chamber 9 through the passage 17. The working chamber 18 arranged in that end which is between the working piston 2 and the cover 5 co-operates through valves in the working piston 2 with the working chamber 16 in the end of the working cylinder 1.

Secured by a resilient mounting 20 to the base cap 4 is a pump rod 19 which, together with a pump cylinder 21 formed by a control tube 32 present in the hollow space of the piston rod 3, constitutes an oil pump. The movements of the vehicle axle and of the piston rod 3 attached to it, resulting from an uneven road surface, actuate this pump which continuously pumps fluid, controlled by the suction valve 22, from the low pressure chamber 10 through the delivery valve 23, through the passage 24 and into the working cylinder 1. In this way the working piston 2, the piston rod 3 and the control tube 32 are displaced outwards to a distance until one or more control orifices 25 in the pump rod 19 are uncovered to open a connection between the working cylinder 1, exposed to a high pressure, and the low pressure chamber 10. This effects the height-levelling function.

In Figure 2 there is shown a portion of the pump rod 19, the piston 2 and the piston rod 3 to a larger scale. The pump rod 19 has in its interior a throttle member in the form of sleeve 26, the end face of the rod 19 being engaged by a valve member 30 of suction valve 22. When the piston rod 3 is displaced in an outward direction far enough for it to take up the position shown in Figure 2, the control orifice 25 is uncovered and the levelling function takes place, in that fluid flows from the working cylinder 1, exposed to high pressure, through the control orifice 25, a connecting passage 27, a throttle opening 28 (best shown in Figure 3) and the interior of the pump rod 19 to reach the low pressure chamber 10.

The throttle opening 8 is provided at the end portion of sleeve 26 and, like the end face opening of the interior of the pump rod, is closed off by valve member 30 of the suction valve 22. In the event of blockage of the opening 28 then on the next suction stroke of the piston rod 3 the suction valve opens and accordingly the cross-section for flow is increased substantially and in this way any possible blockage of the opening is flushed clear.

Figure 3 shows an embodiment of a load-dependent or pressure-dependent throttle opening 28, with the pump rod 19 provided at its end face with the suction valve, 22 and the sleeve 26 spaced away from the end face of the pump rod 19 by the distance X. The face of the pump rod 19 serves as a stop surface for the valve member 30 of the suction valve 22 and forms, together with the end face of the sleeve 26, a throttle opening 28 by which the fluid passing through the connecting passage 27 is controlled, variable according to the pressure relationships. The valve member 30 is constructed in such a way that by flexing corresponding to the pressure acting upon it, it varies the throttling cross-section of opening 28 to allow a corresponding amount of flow.

CLAIMS

1. A self-pumping self-levelling hydro-pneumatic strut for motor vehicles, comprising a fluid-filled working cylinder and a force-transmitting piston slidable in the cylinder on the end of a hollow piston rod, the interior of the piston rod serving as a pump cylinder of a pump rod secured to the working cylinder, the working piston dividing the cylinder into two working chambers and a control orifice being uncovered in a predetermined working position to connect the working chamber under high pressure to a low pressure chamber, and a bore of the pump rod being provided at the end of the pump rod with a suction valve, in which a throttle member is arranged in the bore of the pump rod to connect the control orifice to the bore of the pump rod (19) through a connecting passage and at least one throttle opening.

2. A strut according to claim 1 in which the or each throttle opening co-operates with the suction valve.

3. A strut according to claim 1 or claim 2, in which the or each throttle opening is provided at the end portion of the throttle member and the remainder of the end portion of the throttle member serves as a stop surface for a valve member of the suction valve.

4. A strut according to claim 3 in which a wedge-shaped recess is provided as a throttle opening.

5. A strut according to claim 1 or claim 2 in which the suction valve has a flexible pre-stressed valve member which abuts against the end portion of the pump rod and defines the or each throttle opening in conjunction with the end portion of the throttle member, which is spaced from it.

6. A strut according to claim 1 in which the connecting passage forms a throttle opening and has a corresponding throttling cross-section over at least part of its length.

7. A strut according to claim 6 in which the required throttling cross-section is achieved by incorporation of an appropriate annular gap, to constitute to the connecting passage, between the inside diameter of the pump rod and the outside diameter of the sleeve.

8. A strut according to claim 1 in which the connecting passage forms a throttle opening and is of helical shape and arranged to extend over the outer surface of the sleeve or the inner surface of the pump rod.

9. A self-pumping self-levelling hydro-pneumatic strut substantially as described with reference to the accompanying drawings.

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