Dec. 27, 1955 G. W. CRABTREE 2,728,419

SPRING CONTROLLING UNIT

Filed Dec. 7, 1950 2 Sheets-Sheet 1

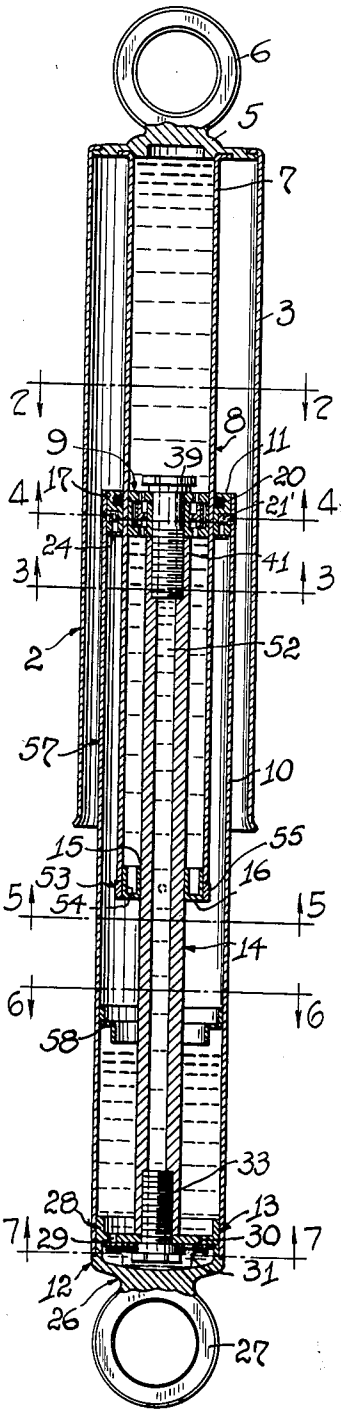


FIG. 1

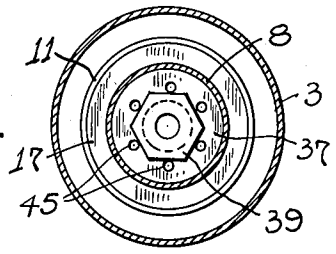


FIG. 2

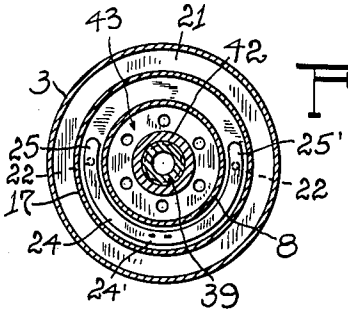
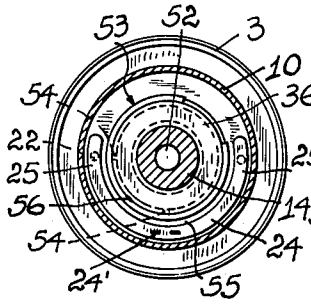


FIG. 3

FIG. 4



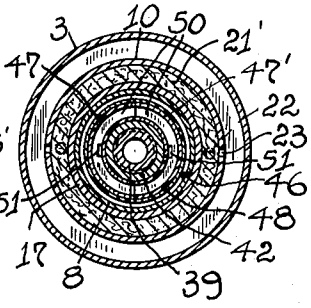


FIG. 5

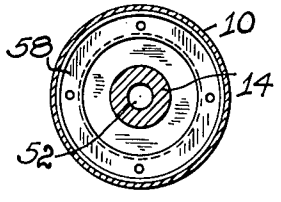


FIG. 6

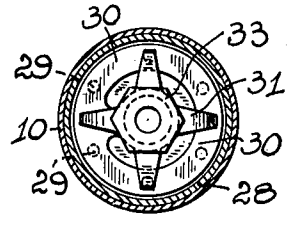


FIG. 7

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SPRING CONTROLLING UNIT

Filed Dec. 7, 1950 2 Sheets-Sheet 2

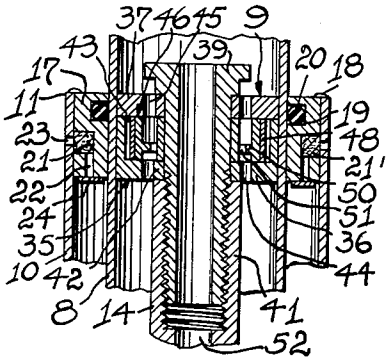


FIG. 8

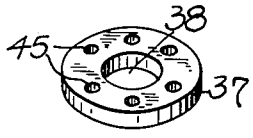


FIG. 9

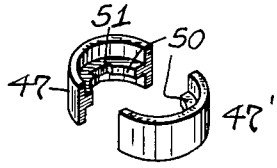


FIG. 10

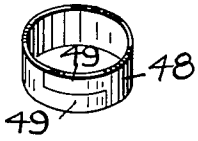


FIG. 11

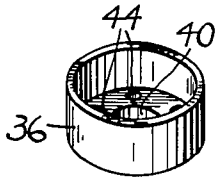


FIG. 12

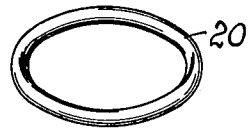


FIG. 13

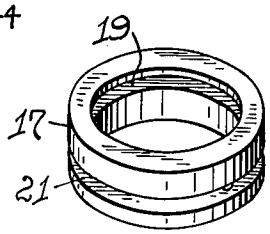


FIG 14

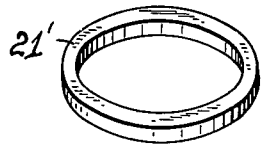


FIG. 15

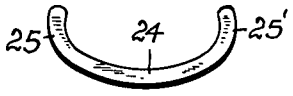


FIG. 16

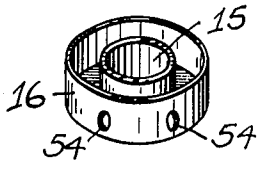


FIG. 17

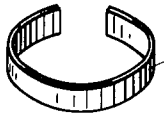


FIG. 18

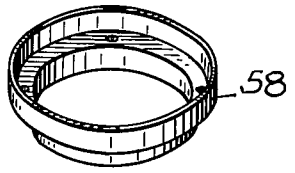


FIG. 19

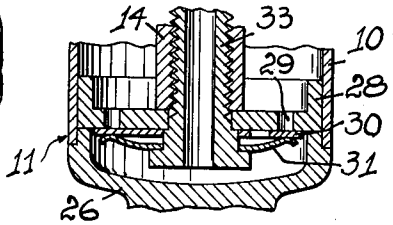


FIG. 20

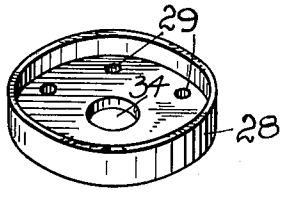


FIG. 21

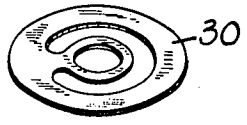


FIG. 22

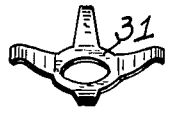


FIG. 23

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SPRING CONTROLLING UNIT

George W. Crabtree, Cleveland Heights, Ohio

Application December 7, 1950, Serial No. 199,681

7 Claims. (Cl. 188—88)

The present invention relates to double acting, hydraulic, spring-controlling units of the directly actuated type constructed to include a liquid-filled cylinder having slidably arranged therein a valved piston member adapted to effect check and retard movements of vehicle springs under compression and their reflex actions under rebound by forcible displacement of liquid through its valved portion from one end of the liquid-filled cylinder to its other end and vice versa.

Hydraulic spring-controlling units of this type generally differ at opposite sides of their piston members in the usable size of the cross section of their working or cylinder chamber. Therefore, it is difficult to keep the cylinder chamber properly filled with liquid, which condition is necessary to avoid forming of air and vapor bubbles in the chamber causing a decrease in the efficiency of the spring controlling unit.

The general object of this invention is the provision of a double-acting, hydraulic, spring-controlling unit of the type referred to above which includes means adapted to keep the cylinder chambers under all conditions properly filled by forcibly transferring liquid from a liquid reservoir into the cylinder chamber of the hydraulic spring controlling unit to properly keep such chamber filled with liquid so as to avoid forming of air or vapor bubbles in the cylinder chamber.

Such a general object is according to the invention attained by providing a hydraulic, spring-controlling unit with auxiliary, pneumatic cylinder piston and a liquid reservoir means arranged to cooperate to effect in shock absorbing operations of the unit forcible transfer of liquid from the reservoir into the cylinder chamber of the unit.

Another object of the invention, therefore, is the provision of a double-acting hydraulic spring controlling unit of the type referred to above constructed to include a liquid reservoir and pneumatic cylinder piston means associated with said reservoir and the cylinder piston arrangement of the spring-controlling unit to effect forcible transfer of liquid from the reservoir into the cylinder chamber of the unit to keep such chamber under all conditions properly filled with liquid.

With the above and other incidental objects in view, the invention has other marked improvements and superiorities which radically distinguish it from presently known structures. These improvements or superior characteristics embodying certain novel features of construction are clearly set forth in the appended claims, and a preferred form of embodiment of the invention is hereinafter shown with reference to the accompanying drawings forming part of the specification.

In the drawings:

Fig. 1 is a longitudinal sectional view partly in elevation of a double-acting, hydraulic, spring-controlling unit constructed according to the invention;

Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is a cross-sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a cross-sectional view taken on line 5—5 of Fig. 1;

Fig. 6 is a cross-sectional view taken on line 6—6 of Fig. 1; and

Fig. 7 is a cross-sectional view taken on line 7—7 of Fig. 1;

Fig. 8 is an enlarged fragmentary longitudinal sectional view showing in section the combined piston and control valve arrangement and the valve-controlled upper end portion of the cylindrical liquid reservoir arrangement;

Figs. 9 through 12 are perspective views of the individual elements of the control valve, thus:

Fig. 9 is a perspective view of the cover member of the valve housing;

Fig. 10 is a perspective view of the two valve sectors forming the valve;

Fig. 11 is a perspective view of the split spring member encircling the valve sectors when assembled, and

Fig. 12 is a perspective view of the bottom portion of the valve housing;

Figs. 13 through 16 are perspective views of the individual elements used to seal the cylindrical liquid reservoid at its upper end and provide same at this end with a check valve controlled air intake opening, thus:

Fig. 13 is a perspective view of an O-ring;

Fig. 14 is a perspective view of the collar-shaped housing and valve body for the check valve;

Fig. 15 is a perspective view of the felt ring, and

Fig. 16 is a perspective view of the valve member of the check valve.

Figs. 17 and 18 are perspective views of the individual elements used to seal the working or cylinder chamber at its lower end and provide same at this end with a relief valve, thus:

Fig. 17 is a perspective view of the cup-shaped closure member, and

Fig. 18 is a perspective view of a leaf spring valve member;

Fig. 19 is a perspective of a baffle ring member;

Fig. 20 is an enlarged fragmentary, longitudinal, sectional view of the valved bottom portion of the hydraulic spring controlling unit;

Figs. 21 through 23 are perspective views of the individual elements forming the valve element of the bottom portion of the unit, thus:

Fig. 21 is a perspective view of the cup-shaped valve body;

Fig. 22 is a perspective view of the valve, and

Fig. 23 is a perspective view of the valve spring.

Referring now in detail to the exemplified form of the spring-controlling unit shown in the drawings and embodying the invention, reference numeral 2 denotes a double-acting, hydraulic, spring-controlling unit which includes a tubular shielding sleeve 3 closed at its upper end by a head 5 provided with a ring 6. Head 5 has fluid-tightly secured thereto the upper end 7 of a tubular cylinder 8 which forms the working chamber of spring controlling unit 2 and slidably mounts therein a valved piston member 9. Tubular cylinder 8 is encircled by a tubular reservoir 10 fluid-tightly slidably engaged with its upper valved end 11 with the outer surface of cylinder 8 and coupled at its lower valved end 12 with valved piston member 9 by a tubular piston rod 14 extended from reservoir 10 into cylinder member 8 through an axial bore 15 in a valved cover member 16 closing the lower end of cylinder 8.

To this effect, tubular reservoir 10 mounts in its upper

end a collar member 17 welded to the upper edge of the reservoir as at 18 and provided with an internal circumferential groove 19 seating an O-ring 20. Collar member 17 which is dimensioned to provide fluid-tight sliding engagement of reservoir end 11 with cylinder 8, includes an external circumferential groove 21 communicating with reservoir 10 through valve controlled bores 22 and with the open atmosphere through bores 23 in the wall of said reservoir. A felt washer 21' in groove 21 effects filtering of air passing through bores 23, groove 21 and valved bores 22 into reservoir 10 and this passing of air into the reservoir is controlled by a leaf spring valve 24 welded at 24' to the bottom face of collar member 17, which spring valve covers with end portions 25, 25' the bores 22 and effects check valve action when the pressure in reservoir 10 is above atmospheric pressure, all for a purpose later to be described. The lower end of tubular reservoir 10 is closed by a member 26 including a ring 27 and mounts a valve 13 including a cup-shaped valve body 28 welded to the inner wall of said reservoir. Valve body 28 is provided with a plurality of bores 29 which are covered by a disk-shaped valve member 30 yieldingly forced by a soft spring 31 toward the valve body to close the bores 29. Valve body 28 furthermore mounts the lower end of tubular piston rod 14 which is secured to the valve body by a tubular screw member 33 extended through an axial bore 34 in said body. This screw member simultaneously effects holding of valve member 30 and spring 31 in proper working relation with respect to each other and to said valve body.

Tubular piston rod 14, extended from tubular reservoir 10 into cylinder 8, has its upper end rigidly attached to valved piston member 9 slidably arranged in said cylinder for reciprocating movements with respect thereto. This valved piston member embodies a housing 35 consisting of a cup-shaped, axially perforated body 36 and a perforated cover plate 37 having an axial bore 38. Cover plate 37 is seated on the edge of body 36 and held in alignment with respect thereto by a tubular screw member 39 which is extended through axial bore 38 and an axial bore 40 in body 36, and which is threadedly engaged with the internally threaded upper end 41 of tubular piston rod 14. A tubular spacer 42 sleeved on screw member 39 holds cover plate 37 in proper relation with respect to body 36.

The described construction of piston member 9 provides its housing 35 with a ring-shaped valve chamber 43 openly communicating with cylinder chamber 8 through perforations 44 in body 36 and perforations 45 in cover plate 37. This ring-shaped valve chamber shiftably supports a ring-shaped valve member 46 consisting of two symmetrically shaped valve elements 47, 47'. These valve elements are yieldingly held in proper position with respect to each other by a split ring 48 which encircles the valve elements and is split to provide such split ring with overlapping end portions 49 for proper seating effect when in shock-absorbing operations the split ring is expanded and contracted. The described arrangement permits differential opening up of valve member 46 against the tension of split ring 48 when, in operation of the hydraulic spring-controlling unit, liquid is forced by piston member 9 through its valve member 46 from one end of the cylinder into the other end thereof and vice versa. In this case liquid under pressure forces the elements 47, 47' against the tension of split ring 48 outwardly and increases the cross section of the liquid passing area of valve member 46. A decrease in the pressure of the working liquid reduces the cross section of the liquid passing area of valve member 46 as split ring 48 tends to shift the elements 47, 47' so as to reduce the cross section of the liquid passing area of the valve member.

Valve elements 47, 47' are shifted by liquid under pressure acting on either side of the valved piston member when in shock absorbing operations the piston member is reciprocated in cylinder 8; therefore, spring-controlling unit 2 permits control of both compression and reflex stresses of vehicle springs. The valve elements 47, 47' are identical in construction, each consisting of a half ring which has extended between its top and bottom edges a radial flange 50 giving the element T-shaped cross section. The location of this flange defines the size of the curved areas of these valve elements which in shock-absorbing operations are exposed to liquid pressure and affords a simple means to obtain differential shock-absorbing control of compression and reflex stresses of a vehicle spring. Each flange 50 includes a cut-out portion 51 arranged in the central area of said flange to provide the described ring-shaped valve member 46 with continuously open small passages permitting restricted passage of liquid from one side of valved piston member 9 to its other side.

Reciprocatory movement of valved piston member 9 in cylinder 8 forces liquid under pressure through ring-shaped valve member 46 from the cylinder portion above piston member 9 into the cylinder portion below such piston member and vice versa, and effects forced filling of cylinder 8 with liquid from reservoir 10. This is necessary as the volume of liquid forced from the portion of cylinder 8 above piston member 9 into the portion below piston member 9 is larger than the volume of liquid forced from the cylinder portion below piston member 9 to the portion above said piston member. The difference in the volume of thus forcibly displaced liquid is due to a difference in active cross section of the portions of cylinder 8 above and below piston member 9, the cylinder portion below piston member 9 having substantially smaller active cross section as the piston rod 14 is extended through such cylinder portion.

Proper action of the thus constructed spring controlling unit is made possible by providing cylinder 8 at its bottom end with a pressure relief valve 53 which is arranged in cover member 16 and consists of a plurality of bores 54 covered by a curved leaf spring 55 welded at 56 to cover member 6, and by a pneumatic plunger-type pump arrangement 57 formed by cylinder 8 and reservoir 10 fluid-tightly slidably encircling said cylinder, which plunger-type arrangement effects forcible feeding of liquid from reservoir 10 through axial passage 52 in piston rod 14 and axial passages in tubular screw members 33 and 39 into the cylinder portion above piston member 9.

In operation spring-controlling unit 2 forces on its downward stroke liquid from the upper portion of cylinder 8 through valve member 46 into the lower portion of the cylinder and discharges excess liquid from said lower portion of cylinder 8 through pressure relief valve 53 into tubular reservoir 10. Liquid forced from the upper portion of cylinder 8 passes through valve member 46, as passage of such liquid through tubular screw member 39, passage 52 in piston rod 14, and tubular screw member 33 is prevented by valve member 30 closing bores 29 of valve body 28. On the downward stroke of spring-controlling unit 2 pneumatic plunger-type pump arrangement 57 compresses the air in tubular reservoir 10, as in this case cylinder 8 is the plunger of arrangement 57 and is shifted into tubular reservoir 10 thereby subjecting the liquid in said reservoir to air pressure.

When, in operation of the spring-controlling unit, the direction of movement of cylinder 8 is reversed; that is, when spring-controlling unit is on its upward stroke, liquid from the lower portion of cylinder 8 is forced through valve member 46 into the upper portion of the cylinder and at the same time liquid from reservoir 10, by air pressure, is forced from said reservoir through bores 29 in valve body 28, tubular screw member 33, passage 52 in piston rod 14, and tubular screw member 39 into the upper portion of cylinder 8. The pneumatic plunger-type pump arrangement 57, therefore, insures continuous forcible filling of the upper portion of cylinder

8 with liquid and thus counteracts possibility of forming of air or vapor bubbles in cylinder 8.

The air pressure in tubular reservoir 10 differentiates in accordance with the relative position of cylinder 8 and tubular reservoir 10 with respect to each other. Should such pressure fall below atmospheric pressure, then leaf spring valve 24, by atmospheric pressure, is shifted to open up bores 23 and permit air to be sucked into the tubular reservoir 10, all for the purpose of providing in operation of the spring-controlling unit the necessary volume of air for forcing by air pressure above atmospheric pressure, during the upward stroke of the unit, proper amount of liquid from the reservoir into the upper portion of cylinder 8.

Excessive movement and foaming of liquid in tubular reservoir 10 is avoided by a ring-shaped baffle member 58 arranged within said reservoir above the liquid stored therein.

Having thus described my invention what I claim is:

1. In a double-acting, hydraulic spring-controlling unit, a hydraulic cylinder embodying a first cylinder closed at its opposite ends and valved controlling the flow of liquid in said first cylinder when the piston is reciprocating therein, a second cylinder open at its one end slidably and fluid-tightly sleeved with said open end on said first cylinder, said second cylinder forming with said first cylinder a plunger-type cylinder device, coupling means fluid-tightly extended from said second cylinder into said first cylinder through one end thereof coupling said second cylinder with said valved piston, inlet passage means for said second cylinder, valve means for said inlet passage means arranged to open the inlet passage means when the pressure in the second cylinder drops below atmospheric pressure, outlet passage means for said second cylinder including passage means extended through the valved piston and effecting communication of such second cylinder with the first cylinder in an area above the valved piston, and valve means controlling said outlet passage means, said second cylinder providing for said hydraulic cylinder sealed liquid reservoir means having through the valve means controlling the outlet passage means of the second cylinder valve-controlled communication with the first cylinder and through the valve means controlling the inlet passage means of the second cylinder valve-controlled communication with the open atmosphere.

2. A spring-controlling unit as described in claim 1 including pressure relief valve means at the lower end of the first cylinder adapted to effect at excessive pressure a direct discharge of liquid from said first cylinder into said second cylinder.

3. A spring-controlling unit as described in claim 1, wherein the inlet and outlet passage means controlling valve means of said second cylinder are check valves adapted to effect unidirectional discharge of liquid from said second cylinder into said first cylinder.

4. In a double-acting, spring-controlling unit a first cylinder closed at its top end, a second cylinder sealed at one end and fluid-tightly slidably engaged at its other end with the outer peripheral wall of said first cylinder, a valved piston slidably arranged within said first

cylinder subdividing same into two cylinder chamber portions, a tubular piston rod fluid-tightly slidably extended through the bottom end of said first cylinder and rigidly coupling said piston with the lower end portion of said second cylinder, said tubular piston rod communicating with said second cylinder and the cylinder chamber portion above the piston, and a check valve arranged in the lower portion of said second cylinder adapted to control communication of said second cylinder with the cylinder chamber portion above the piston, said check valve effecting unidirectional flow of liquid from said second cylinder through said piston rod into the said cylinder chamber portion above said piston when in the operation of the spring-controlling unit the first cylinder moves in the second cylinder in a direction away from the bottom portion thereof.

5. A spring-controlling unit as described in claim 4, wherein the second cylinder includes at its top portion an air intake passage and valve means controlling said air intake passage, said valve means adapted to be opened automatically when the pressure in the second cylinder falls below atmospheric pressure.

6. A spring-controlling unit as described in claim 4, wherein the first cylinder includes at its lower end portion a pressure relief valve adapted to permit at excessive pressures discharge of excessive liquid from the lower cylinder chamber portion of the first cylinder into the second cylinder.

7. In a double-acting, hydraulic spring-controlling unit a hydraulic cylinder device including a cylinder closed at opposite ends, a piston in said cylinder and valve means in said piston adapted to control in said hydraulic cylinder device the flow of liquid in opposite directions through the piston when reciprocated, and an auxiliary pneumatic plunger-type cylinder having a plunger piston formed by the cylinder of the cylinder device and including a cylinder member encircling the cylinder of the hydraulic cylinder in spaced relation, said cylinder member having its one end fluid-tightly slidably engaged with said hydraulic cylinder and its other end rigidly coupled with the piston of the hydraulic cylinder device by means fluid-tightly slidably extended into said hydraulic cylinder through one end thereof, and valve-controlled communicating means between said cylinder member and said hydraulic cylinder, said pneumatic cylinder device adapted to force by air pressure liquid from the cylinder member through the valve-controlled communicating means into the cylinder of the hydraulic cylinder device.

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