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(54) IMPROVEMENTS IN AND RELATING TO HYDRAULIC RESERVOIRS

(71) We, AISIN SEIKI KABUSHIKI KAISHA a Japanese body corporate of 2-1 Asahi-machi, Kariya-shi, Aichi-ken, Japan and TOYOTA JIDOSHA KOGYO KABUSHIKI KAISHA, a Japanese body corporate of 1 Toyota-cho, Toyota-shi, Aichi-ken, Japan, 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 present invention relates to liquid reservoirs for example the master cylinder of a vehicle brake system.

According to the invention, there is provided a liquid reservoir comprising a casing for storing liquid, a cap member detachably mounted on the upper, open, end of said casing, a resilient seal member, the outer peripheral portion thereof being secured between the casing and the cap member for sealing in the liquid stored in said casing, a first chamber within said casing and defined between the cap member and the seal member, said first chamber being in communication with the atmosphere through a vent provided in said cap member, a second chamber within said casing and defined between the seal member and the liquid surface of the liquid when housed in said casing, said second chamber being normally sealed by said seal member to maintain the pressure therein at the atmospheric level, a well in said cap member extending from a central portion of the cap member through the seal member into the second chamber, and check valve means including an annular lip formed by a central portion of said seal member to make sealing contact with the outside of said well and a lip-engaging portion on said outside of the well for co-operating with the lip whereby when the pressure in said second chamber rises above atmospheric level said annular lip is deformed by the pressure difference and is separated from the outside of the well thereby to allow air flow from the second chamber to the first chamber and when the pressure in said second chamber drops below the atmospheric level the annular lip is displaced into engagement with said lip-engaging portion of said annular projection thereby to allow air flow from the first chamber to the second chamber.

According to the invention, there is further provided a liquid reservoir comprising a casing closed by a cap, a membrane trapped between the cap and the casing to define two chambers, the cap having a well extending through the membrane to lie in both chambers, the inner, circumferential, portion of the membrane having a lip which is in sealing engagement with the outside of the well to make an acute angle with the outside of the well, release means on the outside of the well located within the acute angle and arranged to break the seal between the lip and the well when the lip is displaced towards the release means whereby when the pressure in one said chamber exceeds that of the other said chamber, the pressure difference will displace the membrane in a sense to cause the lip to co-operate with the release means and so equalise the pressure between the two chambers whereafter the membrane will resile to bring the lip into sealing engagement with the outside of the well again and, when the pressure in the other said chamber exceeds the pressure in said one chamber, the lip will be displaced by the pressure difference out of contact with the outer wall until the pressures have equalised again.

A vehicular braking system, embodying the invention, will now be described, by way of example, with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a vertical section through a master cylinder of the system;

Figure 2 is an enlarged fragmentary view of Fig. 1;

Figure 3 is a cross-section taken along the line 3—3 of Fig. 2;

Figure 4 is a cross-section taken along the line 4—4 of Fig. 2;

Figures 5 and 6 are scrap view of a part of the valve of the cylinder of Figure 1 in different operative positions;

Figure 7 is a vertical section through another master cylinder for use in the system in place of that shown in Figure 1; and

Figures 8 and 9 are scrap view of a part of the valve of the cylinder of Figure 1 in different operative positions.

The braking system shown in Figures 1 to 6, includes a casing 10 supporting a master brake cylinder 11 and a strainer to filter contaminants entering the casing 10.

A detachable cap member 20 closes the upper, open, end of the casing 10 to form a fluid-tight seal with the casing. The cap member 20 has a vent hole 22 in its side wall and an annular flange 23 extending radially outwardly from the side wall. The flange 23 has an annular groove 23*a* for receiving therein a portion of a diaphragm member 30. The cap member 20 has a central hollow cylindrical stepped well 21 extending downwardly within the casing 10. A reed switch 25 and a resistor 26 are housed in the well 21. The reed switch 25 and resistor 26 are connected to a liquid level warning indicator (not shown) through lead wires 24 extending up out of the well 21. The well 21 has a large diameter upper portion and a reduced or small diameter lower portion. An annular rib 21*a* extends radially outwardly from the upper portion of the well 21 (see Figs. 2 and 3). The annular rib 21*a* is of semicircular cross-section having a predetermined diameter. Four vertically extending equiangularly spaced grooves 21*b* are provided in the rib 21*a*. An annular float member 27 encircles the lower portion of the well and so is constrained for vertical sliding relative to the lower portion of the well. A permanent ring magnet 29 is located within the float member 27 and is arranged to magnetically couple the reed switch 25 to close the contacts thereof when the float member has risen to its highest point relative to the well. The downward movement of the float member 27 is limited by a stop secured to the lowermost portion of the well 21.

The diaphragm member 30 is made of a synthetic rubber or other flexible material capable of effecting a seal. The diaphragm member 30 has an annular rim 30*a* detachably but fluid-tightly secured to the open end of the casing 10, a sinuous intermediate portion 31 and an annular central valve body 32. As is shown in Figs. 2 and 4, the valve body 32 has an annular support 33 of a predetermined diameter and an annular lip 34 projecting upwardly and inwardly of the support 33 to make an acute angle with the outside of the well. The annular support 33 has eight vertical recesses 35 (see Fig. 4).

Within the casing 10 when closed by the cap member there are two chambers R_1 and R_2, the upper chamber R_1 is defined between the underside of the cap member 20 and the upper side of the diaphragm member 30 and the lower chamber R_2 is defined between the under side of the diaphragm member 30 and the surface of the brake fluid stored in the casing 10. The upper chamber R_1 is in communication with the atmosphere through the vent hole 22 in the cap member 20 while the lower chamber R_2 is normally sealed by the diaphragm member 30 to maintain the pressure at substantial atmospheric level. The valve body 32 of the diaphragm member 30 and the outer wall of the well 21 constitute a control valve means A between the upper and lower chambers R_1 and R_2 for controlling the air flow between them. The control valve A has two functions, one being to serve as an inlet valve allowing air flow only from the upper chamber R_1 to the lower chamber R_2 and the other being as an outlet valve to allow the air flow only from the lower chamber R_2 to the upper chamber R_1. Thus, when the pressure in the lower chamber R_2 is equal to that of the upper pressure (atmospheric level), the valve body 32 is in sealed contact with the large diameter portion of the well 21 through the elasticity of the valve body 32. When the pressure in the lower chamber R_2 rises above the atmospheric level, the annular lip 34 will bend outwardly about the support 33 due to the pressure difference between the two chambers R_1 and R_2, thereby allowing air flow from the lower chamber R_2 to the upper chamber R_1. When the pressure in the lower chamber R_2 drops below the atmospheric pressure (vacuum condition), as shown in Fig. 6, the annular support 33 will ride over the annular projection 21*a* due to the pressure difference between the two chambers R_1 and R_2, and so the lip 34 will be forced to extend outwardly by the projection 21*a* to allow air flow from the upper chamber R_1 to the lower chamber R_2.

While the liquid level in the casing 10 remains unchanged, entrance of water, dirt or exterior air into the lower chamber R_2 is prevented, due to the sealed contact between the lip 34 and the outer periphery of the well 21. Even when the liquid level changes slightly then so long as the variations in liquid level are within the extendable range of the diaphragm member 30, the pressure in the lower chamber R_2 can be maintained at the atmospheric level by the flexibility in the sinuous portion 31 of the diaphragm member 30.

If the liquid temperature in the casing 10 increases due to an increase in the environmental temperature, to cause the liquid to expand to a level exceeding the extendable range of the diaphragm member 30 then the pressure in the chamber R_2 will increase (i.e. due to the reduced volume of the chamber R_2). Then, the annular lip 34 will bend outwardly by the increased pressure in the chamber R_2, to allow the flow of air from the lower chamber R_2 to the upper chamber R_1 through grooves 21*b* and recesses 35. This valve operation is momentary and thereafter the lip 34 will again come in contact with the outer periphery of the well 21 by its own resilience to seal the lower chamber R_2 and maintain atmospheric pressure therein.

If the liquid level in the casing 10 falls by an amount which exceeds the extendable range of the diaphragm member 30, the pressure in the lower chamber R_2 will drop below the atmospheric level (vaccum condition). In this case, the valve body 32 is attracted downwardly by the pressure difference between the two chamber R_1 and R_2, as shown in Fig. 6 and the support 33 thereof will ride over the annular outward projection 21*a*. As a result the lip 34 is forced by the projection 21*a* to distend outwardly to allow the flow of air from the upper chamber R_1 to the lower chamber R_2. Simultaneously, the float member 27 is moved downwardly in response to the reduction in liquid level and so actuate the reed switch 25. The reed switch 25 when actuated triggers the warning indicator (not shown) to inform the driver of the vehicle of the deficiency of brake fluid.

As shown the lip 34 is integral with the support 33 which is provided for forcing the lip supported thereon to bend outwardly. However, the support 33 can be omitted if the lip 34 itself has sufficient rigidity for the top end of the lip to be outwardly displaced by a pressure rise in the lower chamber R_2.

The master brake cylinder shown in Figures 7 to 9 has a control valve B which corresponds to the control valve A in the previous embodiment. The control valve B includes an annular lip 134 formed at the radially inner periphery of a diaphragm member 130, an annular, downwardly-extending, projection 121*a* formed at the upper portion of a stepped well 121 and a vertically extending recess 121*c* in the outer wall of the intermediate portion of the stepped well 121.

Othere elements or parts of this master cylinder are substantially similar to the corresponding elements or parts of the cylinder of Figure 1 and have been referenced with the same reference numerals prefixed by 1.

In the operation when the liquid level remains unchanged or changes only slightly within the extendable range of the diaphragm member 130, the annular lip 134 is in sealed contact with the outer wall of the well 121 due to the resilience of the lip 134. This prevents fluid communication between the two chamber R_1 and R_2. When the liquid level rises to exceed the extendable range of the diaphragm member 130, the lip 134 will be bent outwardly by the pressure difference between the chambers R_1 and R_2 and so allow air flow from the lower to upper chambers R_1 and R_2 through the bore 121*b* provided in the annular downardly extending projection 121*a*. When the liquid level drop exceeds the extendable range of the diaphragm member 130, the annular lip 134 is displaced downwardly by the vacuum in the lower chamber R_2 thereby allowing an air flow from the upper chamber R_2 to the lower chamber R_1 through recess 121*c* of the well 121.

It should be noted that the projection 121*a* can be omitted if the annular lip 134 itself has sufficient rigidity so that the top end of the lip 134 can be bent outwardly by a pressure increase in the lower chamber R_2.

Although the two master cylinders described show the cap member 20 or 120 as being detachably mounted on the casing 10 or 110 through the diaphragm member 30 or 130, instead the cap member can be mounted directly upon the casing.

WHAT WE CLAIM IS:—

1. A liquid reservoir comprising a casing for storing liquid, a cap member detachably mounted on the upper, open, end of said casing, a resilient seal member, the outer peripheral portion thereof being secured between the casing and the cap member for sealing in the liquid stored in said casing, a first chamber within said casing and defined between the cap member and the seal member, said first chamber being in communication with the atmosphere through a vent provided in said cap member, a second chamber within said casing and defined between the seal member and the liquid surface of the liquid when housed in said casing, said second chamber being normally sealed by said seal member to maintain the pressure therein at the atmospheric level, a well in said cap member extending from a central portion of the cap member through the seal member into the second chamber, and check valve means including an annular lip formed by a central portion of said seal member to make sealing contact with the outside of said well and a lip-engaging portion on said outside of the well for co-operating with the lip whereby when the pressure in said second chamber rises above atmospheric level said annular lip is deformed by the pressure difference and is separated from the outside of the well thereby to allow air flow from the second chamber to the first chamber and when the pressure in said second chamber drops below the atmospheric level the annular lip is displaced into engagement with said lip-engaging portion of said annular projection thereby to allow air flow from the first chamber to the second chamber.

2. A reservoir according to claim 1, wherein said lip-engaging portion of said well has a convex outer surface and said annular lip is deformed by riding over said convex surface to be separated from the outside of the well when the pressure in the

second chamber drops below atmospheric level.

3. A reservoir according to claim 1, wherein said lip-engaging portion has a concave outer surface and said annular lip is caused to move into a position straddling the concave surface to break the seal between the lip and the outside of the well in response to displacement of said annular lip when the pressure in said second chamber drops below atmospheric level.

4. A reservoir according to any preceding claim, wherein the seal member has an extendable portion between an outer peripheral rim portion and said annular lip, said extendable portion being movable within said casing to change the volume of the second chamber in response to variations in liquid level whereby to maintain the pressure in said lower chamber at the atmospheric level for liquid level variations over a limited range.

5. A reservoir according to any preceding claim including a reed relay within the well and a magnetic float within the second chamber co-operable magnetically with the reed relay to cause the reed relay to switch when the liquid level drops below a predetermined level.

6. A liquid reservoir comprising a casing closed by a cap, membrane trapped between the cap and the casing to define two chambers, the cap having a well extending through the membrane to lie in both chambers, the inner, circumferential, portion of the membrane having a lip which is in sealing engagement with the outside of the well to make an acute angle with the outside of the well, release means on the outside of the well located within the acute angle and arranged to break the seal between the lip and the well when the lip is displaced towards the release means whereby when the pressure in one said chamber exceeds that of the other said chamber, the pressure difference will displace the membrane in a sense to cause the lip to co-operate with the release means and so equalise the pressure between the two chambers whereafter the membrane will resile to bring the lip into sealing engagement with the outside of the well again and, when the pressure in the other said chamber exceeds the pressure in said one chamber, the lip will be displaced by the pressure difference out of contact with the outer wall until the pressures have equalised again.

7. A reservoir according to claim 6, wherein the release means comprises an interrupted rib encircling the outside of the well.

8. A reservoir according to claim 6, wherein the release means comprises recesses in the outside of the well.

9. A liquid reservoir substantially as hereinbefore described with reference to Figures 1 to 6 of the accompanying drawings.

10. A liquid reservoir substantially as hereinbefore described with reference to Figures 7 to 9 of the accompanying drawings.

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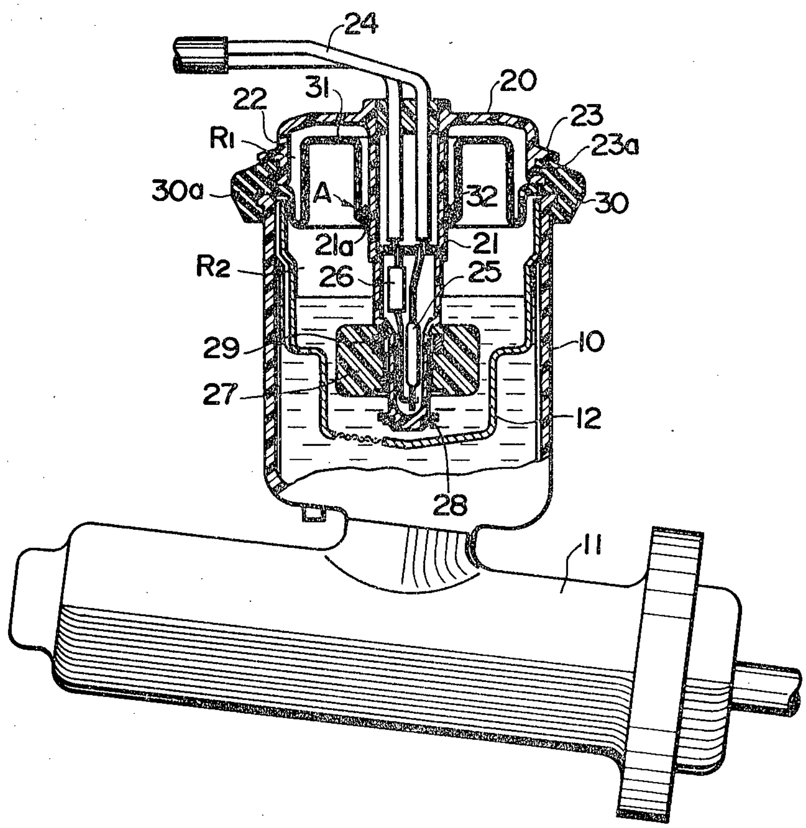
FIG. 1



1590884 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

FIG. 2

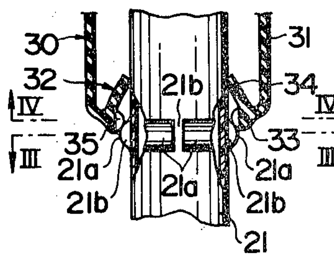


FIG. 3

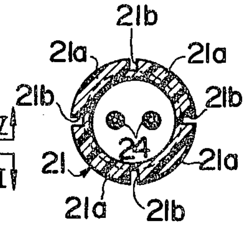


FIG. 4

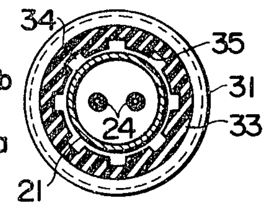


FIG. 5

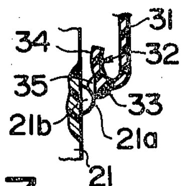


FIG. 6

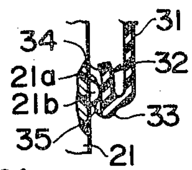


FIG. 7

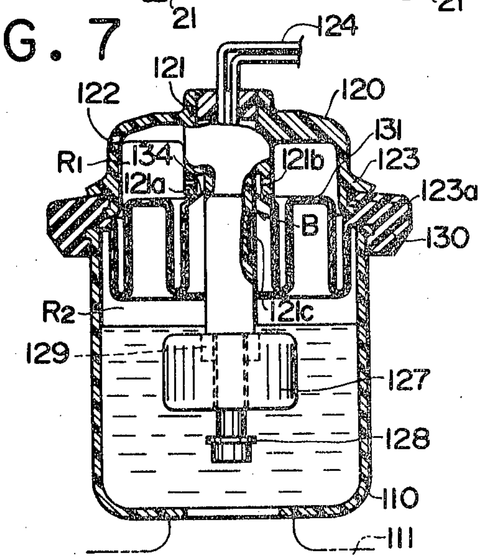


FIG. 8

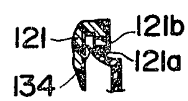


FIG. 9