980,916

PATENT SPECIFICATION 980,916

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in Hydraulic Operating Systems.

We, GIRLING LIMITED, a British Company, of Kings Road, Tyseley, Birmingham 11, 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:—

This invention relates to improvements in hydraulic systems such for example as vehicle braking systems in which any loss of the hydraulic fluid in the system is replenished from a reservoir which, when the system is not under pressure, is in communication with a part of the system such as a master cylinder for applying pressure to the fluid in the system.

Most hydraulic operating systems require the reservoir to be vented to atmosphere so that air can enter to replace fluid drawn into the system, and to maintain a substantially uniform back pressure.

This means that the fluid in the system is exposed to air drawn from the atmosphere in which the system is located, and such air can, and usually does, contain injurious particles or corrosive vapours. Also a particular problem in brake operating systems is brought about by the hygroscopic nature of the fluids commonly used in such systems, as the fluid absorbs water and its boiling point is seriously lowered, resulting in the earlier onset of vaporisation troubles when the temperature of the brakes rises during extreme duty.

According to our invention, the problem of fluid contamination by exposure of the fluid in the reservoir of an hydraulic system to atmospheric air is overcome by providing in the reservoir a flexible sac or membrane which, when the reservoir contains fluid, forms a movable wall between the fluid and the atmosphere that remains in contact with the fluid as the volume of fluid in the reservoir changes. The sac or membrane preferably has at least one predetermined fold line to facilitate its change of shape as the volume of fluid changes, and it may take the form of a collapsible bellows, closed at one end and provided at the other end with a flange to be secured by a cap or cover. Preferably the exterior surface of the bellows is in contact with the fluid, and the interior in communication with the atmosphere through an opening in the cap or cover. When the reservoir is full, the sac is in a collapsed condition above the fluid. As the fluid level falls, air enters the sac through the opening in the cap or cover and distends the sac to increase its volume by an amount substantially equal to the volume of fluid drawn from the reservoir.

The sac preferably has the form of a bellows closed at its lower end and having at its upper end a radial flange of substantial thickness which is clamped between the upper end of the reservoir and a closure cap or cover screwed on to or otherwise secured to the reservoir.

A practical embodiment of our invention is illustrated by way of example in the accompanying drawings in which:—

Figure 1 is a vertical section of a collapsible sac in the form of a thin-walled bellows; and

Figure 2 is a vertical section of a reservoir with a sac in position.

The sac shown in Figure 1 is a thin-walled bellows 10 having at its upper end a radially projecting annular stepped flange 11 of substantial thickness. The lower end of the bellows is closed. The bellows is preferably moulded from silicone rubber which is unaffected by the hydraulic brake fluids in

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normal use and does not absorb moisture, and which also has a substantial amount of natural resilience.

Tests with bellows of different dimensions and shapes have shown that in practice the best result is achieved when, with the bellows in the as-moulded or unstressed condition, the frusto-conical sections that make up its length have an inclination of between 40° and 50° to the axis of the bellows, and in the preferred form shown this angle has a value of 46°. This means that each fold line between adjacent sections has, in cross-section, an included angle of between 80° and 100°, with a preferred value of 88°. The wall thickness of the material lies between 0·010 and 0·020 of an inch, and is preferably 0·012 of an inch in the example shown, which has an outside diameter (ignoring the flange) in the free condition of 2·062 inches.

Figure 2 shows the bellows fitted to a reservoir 12 which is a rigid cylindrical chamber in the bottom of which is a fitting 13 adapted to receive a pipe leading to the master cylinder of an hydraulic braking or other system.

The axial length of the bellows when fully extended is slightly less than the axial depth of the reservoir. The flange 11 of the bellows is clamped between the upper end of the reservoir and a cap 14 screwed on to the reservoir so that the contents of the reservoir are sealed off from contact with the atmosphere. The interior of the bellows is open to atmosphere through breather orifices 15 in the cap.

If the reservoir is full of fluid when the bellows and cap are fitted the bellows will collapse to the form shown in full lines. Then as the fluid level falls, the bellows will expand and increase its volume by an amount equal to that of the fluid withdrawn from the reservoir, and the natural resilience of the bellows will maintain a slight pressure on the fluid.

The flange 11 of the bellows may be made of a slightly harder material than the corrugations but is preferably moulded in one piece with the corrugations although it may be formed separately and bonded to the uppermost corrugation by a suitable adhesive.

Our invention is of particular advantage in an hydraulic braking system for vehicles in which the reservoir is associated with a master cylinder from which hydraulic fluid is supplied under pressure to the slave cylinders of wheel brakes. In such a system fluid is progressively withdrawn from the reservoir as the friction elements wear and the effective volume of the braking system increases, and when worn friction elements are replaced fluid is returned to the reservoir owing to the decrease in the effective volume of the system.

A flexible sac or membrane as described herein follows the surface of the liquid in the reservoir and remains in close contact with it as fluid is withdrawn from or returned to the reservoir and if desired the natural resilience of the bellows can be used to maintain a slight pressure on the liquid.

WHAT WE CLAIM IS:—

1. An hydraulic system in which a reservoir for hydraulic fluid incorporates a flexible sac or membrane which, when the reservoir contains fluid, forms a movable wall between the fluid and atmosphere and remains in contact with the fluid as the volume of fluid in the reservoir changes, the sac or membrane including at least one predetermined fold line or corrugation facilitating its change of shape as the volume of fluid changes.

2. An hydraulic system according to Claim 1, in which the sac or membrane is in the form of a collapsible bellows.

3. An hydraulic system incorporating a reservoir for hydraulic fluid in which fluid in the reservoir is sealed against contact with atmosphere by a collapsible sac or membrane of thin synthetic rubber or like material located between a cap or cover for the reservoir and the fluid, one surface of the sac or membrane being in communication with atmosphere and the other surface being in contact with the fluid, and the sac or membrane including at least one predetermined fold line or corrugation facilitating its change of shape as the volume of fluid changes.

4. An hydraulic system as claimed in Claim 3, in which the sac or membrane is a thin-walled bellows closed at one end and having at its other end a radially projecting annular flange adapted to be clamped between the upper end of the reservoir and the closure cap or cover.

5. An hydraulic system as claimed in Claim 4, in which the bellows is adapted to be clamped in position with its exterior surface in contact with the fluid, and in which the closure cap or cover is provided with an opening that puts the interior of the bellows in communication with the atmosphere.

6. An hydraulic system as claimed in any of Claims 1 to 5, in which the sac or membrane is moulded from silicone rubber.

7. Means for preventing contact of hydraulic fluid in the reservoir of an hydraulic system with atmosphere comprising a collapsible thin-walled bellows closed at its one end and having at its other end a radially projecting annular flange adapted to be clamped between the upper end of the reservoir and a closure cap or cover to seal the reservoir, the interior of the bellows being open to atmosphere when in position in the reservoir.

8. A collapsible thin - walled bellows according to Claim 7 in which, in the unstressed condition of the bellows, the frusto-

normal use and does not absorb moisture, and which also has a substantial amount of natural resilience.

Tests with bellows of different dimensions and shapes have shown that in practice the best result is achieved when, with the bellows in the as-moulded or unstressed condition, the frusto-conical sections that make up its length have an inclination of between 40° and 50° to the axis of the bellows, and in the preferred form shown this angle has a value of 46°. This means that each fold line between adjacent sections has, in cross-section, an included angle of between 80° and 100°, with a preferred value of 88°. The wall thickness of the material lies between 0·010 and 0·020 of an inch, and is preferably 0·012 of an inch in the example shown, which has an outside diameter (ignoring the flange) in the free condition of 2·062 inches.

Figure 2 shows the bellows fitted to a reservoir 12 which is a rigid cylindrical chamber in the bottom of which is a fitting 13 adapted to receive a pipe leading to the master cylinder of an hydraulic braking or other system.

The axial length of the bellows when fully extended is slightly less than the axial depth of the reservoir. The flange 11 of the bellows is clamped between the upper end of the reservoir and a cap 14 screwed on to the reservoir so that the contents of the reservoir are sealed off from contact with the atmosphere. The interior of the bellows is open to atmosphere through breather orifices 15 in the cap.

If the reservoir is full of fluid when the bellows and cap are fitted the bellows will collapse to the form shown in full lines. Then as the fluid level falls, the bellows will expand and increase its volume by an amount equal to that of the fluid withdrawn from the reservoir, and the natural resilience of the bellows will maintain a slight pressure on the fluid.

The flange 11 of the bellows may be made of a slightly harder material than the corrugations but is preferably moulded in one piece with the corrugations although it may be formed separately and bonded to the uppermost corrugation by a suitable adhesive.

Our invention is of particular advantage in an hydraulic braking system for vehicles in which the reservoir is associated with a master cylinder from which hydraulic fluid is supplied under pressure to the slave cylinders of wheel brakes. In such a system fluid is progressively withdrawn from the reservoir as the friction elements wear and the effective volume of the braking system increases, and when worn friction elements are replaced fluid is returned to the reservoir owing to the decrease in the effective volume of the system.

A flexible sac or membrane as described herein follows the surface of the liquid in the reservoir and remains in close contact with it as fluid is withdrawn from or returned to the reservoir and if desired the natural resilience of the bellows can be used to maintain a slight pressure on the liquid.

WHAT WE CLAIM IS:—

1. An hydraulic system in which a reservoir for hydraulic fluid incorporates a flexible sac or membrane which, when the reservoir contains fluid, forms a movable wall between the fluid and atmosphere and remains in contact with the fluid as the volume of fluid in the reservoir changes, the sac or membrane including at least one predetermined fold line or corrugation facilitating its change of shape as the volume of fluid changes.

2. An hydraulic system according to Claim 1, in which the sac or membrane is in the form of a collapsible bellows.

3. An hydraulic system incorporating a reservoir for hydraulic fluid in which fluid in the reservoir is sealed against contact with atmosphere by a collapsible sac or membrane of thin synthetic rubber or like material located between a cap or cover for the reservoir and the fluid, one surface of the sac or membrane being in communication with atmosphere and the other surface being in contact with the fluid, and the sac or membrane including at least one predetermined fold line or corrugation facilitating its change of shape as the volume of fluid changes.

4. An hydraulic system as claimed in Claim 3, in which the sac or membrane is a thin-walled bellows closed at one end and having at its other end a radially projecting annular flange adapted to be clamped between the upper end of the reservoir and the closure cap or cover.

5. An hydraulic system as claimed in Claim 4, in which the bellows is adapted to be clamped in position with its exterior surface in contact with the fluid, and in which the closure cap or cover is provided with an opening that puts the interior of the bellows in communication with the atmosphere.

6. An hydraulic system as claimed in any of Claims 1 to 5, in which the sac or membrane is moulded from silicone rubber.

7. Means for preventing contact of hydraulic fluid in the reservoir of an hydraulic system with atmosphere comprising a collapsible thin-walled bellows closed at its one end and having at its other end a radially projecting annular flange adapted to be clamped between the upper end of the reservoir and a closure cap or cover to seal the reservoir, the interior of the bellows being open to atmosphere when in position in the reservoir.

8. A collapsible thin - walled bellows according to Claim 7 in which, in the unstressed condition of the bellows, the frusto-

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conical sections that make up the wall of the bellows make an angle of between 40 and 50° with the axis of the bellows.

9. A collapsible thin - walled bellows according to Claim 8 in which the angle referred to therein is substantially 46°.

10. A collapsible thin - walled bellows according to any of Claims 7 to 9 in which the wall thickness of the material of the bellows lies between 0·010 and 0·020 of an inch.

11. A collapsible thin-walled bellows according to Claim 10, in which the wall thickness of the material of the bellows is substantially 0·012 of an inch.

12. A collapsible thin-walled bellows according to any of Claims 7 to 11, which is formed as a moulding in silicone rubber.

13. An hydraulic braking system comprising a reservoir associated with a master cylinder from which hydraulic fluid is supplied under pressure to the slave cylinders of wheel brakes, in which the reservoir incorporates a flexible sac or membrane which includes at least one predetermined fold line or corrugation and which, when the reservoir contains fluid, forms a movable wall between the fluid and atmosphere and remains in contact with the surface of the fluid in the reservoir as fluid is drawn from and returns to the reservoir.

14. An hydraulic system incorporating a reservoir for hydraulic fluid having means for preventing contact between the fluid and atmosphere substantially as described with reference to the accompanying drawings.

15. A collapsible thin-walled bellows for use in the fluid reservoir of an hydraulic system substantially as described with reference to Figure 1 of the accompanying drawings.

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