

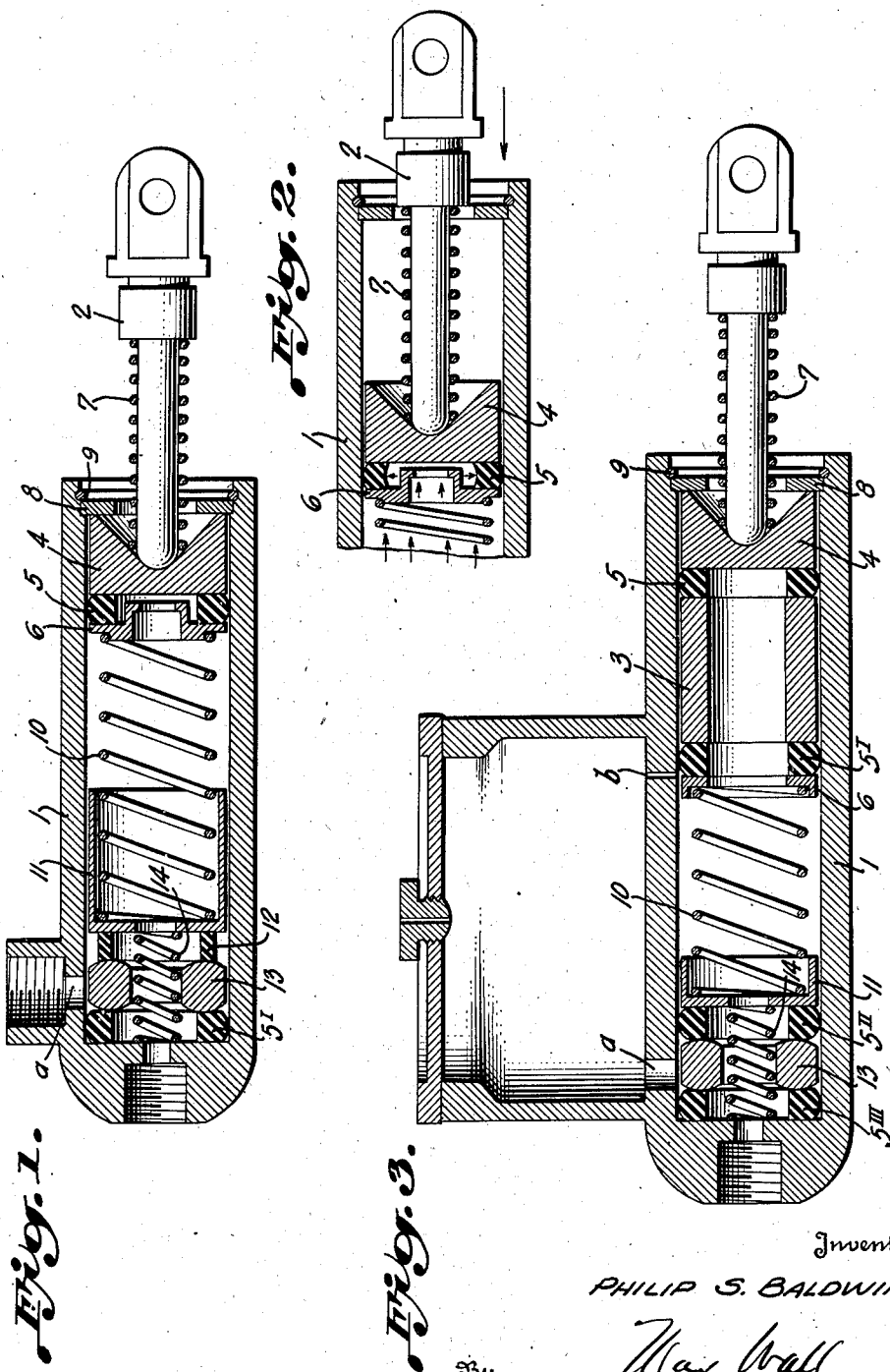
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P. S. BALDWIN
MASTER CYLINDER

2,444,181

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2 Sheets-Sheet 1



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Fig. 4.

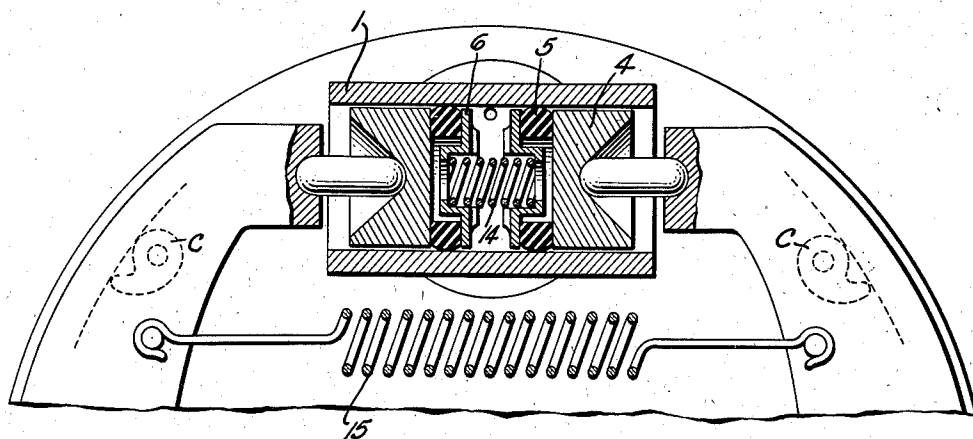
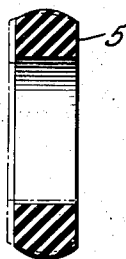


Fig. 5.



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MASTER CYLINDER

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3 Claims. (Cl. 60—54.6)

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This application is a continuation in part of my prior application Serial Number 143,805, filed May 20th, 1937, now Patent No. 2,276,009, March 10, 1942.

This invention relates to improvements in hydraulic pressure transmission systems and more particularly to the arrangement and structure of the pistons and piston packings of the type disclosed in my prior application referred to above.

An object of this invention is to provide a piston in which elastic packing rings are freely mounted between rigid piston members which are co-axial with the rings and are held together as a unit under yielding opposing mechanical axial pressure.

Another object is to simplify the construction of the pistons to lower production costs and ensure maximum unification of the working parts.

Still another object is to provide packings for the pistons which are readily adaptable to relatively high temperatures without unduly increasing the frictional resistance to reciprocal movements in the cylinders.

Other objects and advantages of the invention will appear during the course of the following description.

These improvements may be put into practice in various ways, and in the accompanying drawings are illustrated by way of example several forms of practical application of the invention to a hydraulic brake master cylinder and to a wheel motor cylinder, respectively.

In all the various figures, like reference characters designate like parts.

Figure 1 is a longitudinal sectional view of a master cylinder with two opposed pistons, constructed according to the present invention.

Figure 2 is a partial longitudinal sectional view of Figure 1 showing the prime mover piston advanced in the cylinder under pressure.

Figure 3 is a longitudinal sectional view showing a modified form of master cylinder constructed according to the present invention.

Figure 4 is a longitudinal sectional view of a wheel cylinder with opposed pistons constructed according to the present invention.

Figure 5 is an enlarged longitudinal sectional view of the packing element of Figure 4, showing thermic deformation of the element.

The master cylinder illustrated in Figure 1 is suitably connected to the wheel motor cylinders. Two opposed pistons 4, 5, 6, and 11, 12, 13 are mounted in the cylinder 1 and are held in spaced relation to each other by the return spring 10 which is held in the cylinder under initial axial

compression. Piston 4, 5, 6 functions as the prime mover and piston 11, 12, 13 as a valve member to control communication with the reserve tank located over the cylinder.

The elastic packing ring 5 of the prime mover piston has an outer surface which is normally convex in cross-section with a maximum free diameter which is equal to or slightly greater than that of the cylinder bore. It therefore contacts the cylinder wall at the apex of its elastic periphery and is spaced from the said wall at its two extremities when not under hydraulic pressure. It is freely mounted and yieldably supported between the metal piston head 4 and the thrust member 6 under the opposing axial mechanical pressure of springs 10 and 7. The packing member is not attached to any part of the piston or piston assembly. Spring 7 has a free length which is greater than the maximum piston stroke and is mounted under axial compression between the piston rod base 2 and the piston head 4, the compression of spring 7 being approximately one fourth of the initial compression of spring 10 when in released position in the cylinder. The constant opposing pressure of spring 7 against the piston head 4 serves to keep the packing ring always in engagement with the piston head and the thrust member, and prevents air being drawn into the cylinder or liquid escaping therefrom during the retractile stroke; the packing providing a positive plug seal for the cylinder. A stop washer 8 and lock spring ring 9 at the rear end of the cylinder limit the retractile stroke of the piston.

The elastic packing ring 12 of the valve piston is freely mounted and yieldably supported between the metal head 13 and the thrust cup 11, and has a maximum free diameter which is less than that of the cylinder bore so that the packing is initially completely spaced from the cylinder wall when it is not under pressure. The packing member is not attached to any part of the valve or valve assembly. An elastic packing ring 5' which is identical to the prime mover packing ring, inserted in the base of the cylinder and against which abuts the valve piston head 13, remains stationary in the cylinder and provides an end seal between the valve piston head and the reserve tank communicating port *a*. The head 13 serves to space the packing ring 12 from the said port. The packing for the valve and piston is unattached, that is, not physically fastened to any other part.

The valve piston metal parts 11 and 13 have a normal sliding fit in the cylinder. Spring 14 which abuts against the thrust member 11 and

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the base of the cylinder, is held under axial compression by spring 10. The compressions of the two springs in released position of the prime mover piston equalize each other so that the valve packing ring is relieved of all initial mechanical compression, the pressure of spring 10 being counteracted by that of spring 14. The initial compression of spring 14 may be slightly greater than that of spring 10 so that the packing ring is initially loosely supported between the thrust member 11 and the head 13. The valve piston is bored longitudinally throughout to establish free, unobstructed communication between the cylinder and the external hydraulic circuit.

In operation, when the prime mover piston is advanced, air which is highly compressible, is freely expelled from the cylinder into the reserve tank through port *a*, around the periphery of the valve piston for the whole compression stroke of the prime mover piston because the maximum axial mechanical pressure supplied by spring 10 is not of itself sufficient to expand the packing ring 12 radially into sealing contact with the cylinder wall. During the retractile stroke, the valve piston is retracted by suction from the cylinder base packing ring 5' and liquid is drawn into the cylinder from the reserve tank through the port *a*, and through the longitudinal bore of the valve piston.

When all air has been expelled from the cylinder, and the prime mover piston is advanced, there is resistance to the passage of the liquid around the periphery of the valve thrust member 11, and hydraulic pressure is thus built up on the end face of the packing ring 12 and radially on the inner face of same, and the ring self-centres in the cylinder. This hydraulic pressure is complemented by the progressively increasing axial mechanical pressure of spring 10, and the valve packing ring is expanded radially into sealing engagement with the cylinder to close the circuit with the reserve tank at the start of the compression stroke. Upon release of pressure, the elastic ring contracts radially away from the cylinder wall, and communication between the reserve tank and the cylinder is re-established around the valve piston periphery, thus permitting escape of any excess liquid drawn into the system and compensating for any differential in the volume of the liquid due to variations in temperature.

As illustrated in Figure 2, upon advance of the prime mover piston, when the circuit with the reserve tank is closed and the cylinder is completely filled with liquid, hydraulic and mechanical pressure is built up axially on the leading face of the prime mover piston packing ring, and hydraulic pressure is exerted on the inner surface of the same as in the case of the valve piston packing ring. These combined pressures expand the spaced trailing end of said prime mover packing ring into contact with the cylinder. The leading end of this ring which is surrounded by liquid, remains spaced from the cylinder during the whole compression stroke. Upon release of pressure, the trailing end of the ring contracts radially away from the cylinder wall and fluid is discharged from the ring. The contact area of the ring with the cylinder wall is thus reduced to a minimum and adequate lubrication of the elastic periphery is ensured. As a consequence, very low frictional resistance to recovery in the cylinder is offered by the piston so that the latter is returned very rapidly to its position of rest

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under action of spring 10, upon release of pressure. Were the whole elastic periphery kept in static contact with the cylinder wall, the latter would be wiped dry and high frictional resistance and wear would result.

The fact that hydraulic pressure takes effect both radially and axially on the prime mover and valve piston packing rings prevents their permanent deformation. In fact, after these rings are once initially expanded radially into contact with the cylinder wall, under pressure as described, the radial hydraulic pressure on the inner surfaces counteracts the axial hydraulic pressure on the end faces and positively prevents any further deformation of the rings. In other words, the axial pressure tends to depress the rings axially and spread them radially while the radial pressure tends to depress them radially and extend them axially, the two pressures neutralizing each other. Were the elastic rings only compressed in one plane, axially for example, they would tend to be permanently deformed under continued high pressure through flow of the elastic mass which would take a set with a tendency to permanently fill any empty space between the elastic periphery and the cylinder wall. This, of course, would eventually render the valve piston inoperative by cutting off communication with the reserve tank around the piston periphery when the packing ring is in released condition. The opposing axial and radial hydraulic pressure on the valve packing ring also prevents the ring from collapsing or buckling upon application of pressure.

In the arrangement shown in Figure 3, two opposed pistons are mounted in the master cylinder 1 and are yieldably held in spaced relation to each other by the return spring 10 which is inserted in the cylinder under axial compression. The prime mover piston comprises the thrust member 6, the two packing rings 5 and 5', the tubular spacer member 3 and the piston head 4. The two packing rings have a convex periphery in cross-section and are freely mounted and yieldably supported between the rigid parts 6 and 3, and 3 and 4 under opposing axial pressure of springs 10 and 7 which are similar in their function and arrangement to the corresponding springs 10 and 7 of Figure 1. A stop washer 8 and lock ring 9 limit the retractile stroke of the piston as in the case of the arrangement of Figure 1.

The valve piston comprises the rigid head 13, the elastic packing ring 5'' and the thrust cop 11, and is bored throughout its length to establish free, unobstructed communication between the cylinder and the external hydraulic circuit. At the base of the cylinder is inserted another packing ring 5''' which abuts the valve piston head 13. All the packing rings of Figure 3, namely, 5, 5', 5'', 5''', are identical and have a maximum free external diameter which is equal to or slightly greater than the diameter of the cylinder bore, as indicated in the description of the packing ring 5 of Figure 1.

The valve packing ring 5'' is freely mounted and yieldably supported between the rigid parts 13 and 11 under axially opposing pressure of springs 14 and 10 as already indicated in the description of the arrangement of Figure 1. As in Figure 1, a port *a* insures communication between the cylinder and the reserve tank situated above the cylinder. At the opposite end of the cylinder just in advance of the leading prime mover packing ring 5' is located a minute vent *b* communicating with the reserve tank.

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In operating, when all air has been bled from the system in the usual manner through bleeder vents located at the wheel cylinders, and the prime mover piston is advanced, the vent *b* is immediately covered by the leading prime mover packing, communication with the reserve tank is shut off, and hydraulic pressure is transmitted to the motor cylinders. Upon release of pressure, the prime mover piston is returned in the cylinder by spring 10, suction is created in the cylinder and the valve piston parts are retracted so that the head 13 becomes disengaged from abutting contact with the cylinder base packing 5", and hydraulic fluid is drawn into the cylinder through port *a* around the leading face of the head. When the prime mover piston is fully retracted, the vent *b* is uncovered and any excess liquid drawn into the cylinder may be discharged into the reserve tank therethrough. The vent *b* also serves to ensure equalization in the volume of the brake fluid in the system and the reserve tank to compensate for thermic expansion and contraction of the fluid.

As already indicated the opposing pressure of spring 7 on the prime mover piston serves to keep the freely mounted piston parts in engagement with each other during the retractile stroke and thus prevent escape of the brake fluid or influx of air.

As illustrated in Figure 4, two opposed pistons are mounted in a motor cylinder as commonly located between the brake shoes on the wheels of motor vehicles, and is suitably connected with the master cylinder. The pistons are identical in structure to the prime mover piston of Figure 1. They are held in spaced relation to each other at the center of the cylinder 1 under the opposing force of the compensator spring 14 which may be identical to spring 14 of the master cylinder arrangement of Figure 1, and the brake shoes return spring 15. The spacing of the opposed pistons at the center of the cylinder may be secured by a cam registering device *c* commonly mounted against the inner rims of the brake shoes.

The opposing mechanical pressure under which the opposed pistons 4, 5, 6 are mounted in the cylinder is sufficient to expand the packing rings 5 radially into permanent partial contact with the cylinder wall at the apex of the elastic peripheries to ensure an initial hydraulic seal regardless of the thermal deformation of the rings. In fact, under the influence of braking heat which in the wheel cylinders may reach a temperature of 150 degrees Centigrade or more, the elastic mass expands to a considerable extent and when packings are used which have a maximum free diameter equal to that of the cylinder bore, the radial thermal expansion will be rigidly resisted by the cylinder wall and an axial flow of the elastic mass will result. This flow produces a permanent deformation of the packings which, as indicated by the dotted lines on Figure 6, will assume a free diameter at the apex of the periphery which is less than the diameter of the cylinder bore with a corresponding contraction in the elastic bore and an increase in the length. After this initial thermal deformation has taken place, the shape of the packings remains unchanged in subsequent heatings of like temperature and the contrasting radial and axial hydraulic pressure on the elastic bodies tends to keep it so, as already described.

As already indicated, the opposing pressure of the compensator spring 14 and the brake shoes

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return spring 15 on the elastic packing rings tends to keep them in permanent partial contact with the cylinder wall under all circumstances and thus provide a positive seal against escape of fluid and influx of air. Any radial thermal contraction of the rings is automatically taken up by the opposing axial pressure of spring 14 which holds the freely mounted piston parts in engagement with one another and permits of their free return as a unit in the cylinder upon release of pressure, under action of the return spring. By keeping the mean free external diameter of the packing rings well under that of the cylinder bore, a piston with very low frictional resistance is secured even when subjected to heat and this ensures a prompt return of the pistons upon release of the hydraulic pressure with consequent ready recovery of the brake shoes.

Owing to the structure of the elastic packing rings which have sufficient body to support of themselves the axial mechanical compression without buckling or twisting in the cylinder, rigid supports within the elastic bodies may be dispensed with and the rings may be freely mounted between their rigid terminals as illustrated. This is important because such supports aggravate the thermal deformation by rigidly resisting the inner radial expansion of the rings and increasing the axial flow of the elastic mass which also increases the frictional resistance of the packings in the cylinder under heat. It might be noted, in passing, moreover, that thermal deformation of the packings may be prevented altogether by fashioning them with a free maximum external diameter which is less than that of the cylinder bore, the difference in diameter being equal to or less than the factor of the thermal expansion of the packings. The axial compression of the compensator spring 14, however, must always be sufficient to expand initially the rings radially into partial contact with the cylinder wall, as already described.

It is to be understood that the various constructions and arrangements of the parts as illustrated and described are submitted as practical embodiments of the working principles involved, and may be modified as to details without departing from the spirit of the invention.

Having thus described my invention, I claim:

1. An hydraulic pressure transmission system comprising a master cylinder, a reserve tank in communication therewith by means of a port and a vent positioned between the two, a piston and a valve operable in said cylinder at opposite ends thereof and spring means between the two for maintaining the parts thereof in assembled relation, the piston and valve each including a resilient, expansible ring packing which is unattached to any portion of said piston or valve but is freely movable therewith in the cylinder under the action of the forces developed by the piston and is expanded mechanically and hydraulically thereby, said valve being positioned between said port and said piston and controlling the flow of hydraulic fluid between the reservoir and cylinder in response to the movements of the piston, the packing of the valve and the piston being expanded and contracted in response to the reciprocal movements of the piston in the cylinder, the vent being positioned in the cylinder adjacent the piston and operating, when the piston is in inoperative position, to equalize the volume of fluid between the system and the reserve tank.

2. An hydraulic pressure transmission system comprising a master cylinder, a reserve tank in

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communication therewith by means positioned between the two, a piston and a valve operable in said cylinder at opposite ends thereof and spring means between the two for maintaining the parts thereof in assembled relation, the piston and valve each including a resilient, expansible ring packing which is unattached to any portion of said piston or valve but is freely movable therewith in the cylinder under the action of the forces developed by the piston, and is expanded mechanically and hydraulically thereby, said valve being positioned between said communicating means and said piston and controlling the flow of hydraulic fluid between the reservoir and cylinder in response to the movements of the piston, the packing of the valve being normally completely spaced from the cylinder bore and expanded into contact therewith on the forward stroke of the piston, the packing of both the valve and the piston being expanded and contracted in response to the reciprocal movements of the piston in the cylinder, the cylinder being vented around the periphery of the valve packing when the piston is in inoperative position, to equalize the volume of fluid between the system and the reserve tank.

3. An hydraulic pressure transmission system comprising a master cylinder, a reserve tank in communication therewith by means positioned between the two, a piston and a valve operable in said cylinder at opposite ends thereof and means between the two for maintaining the parts thereof in assembled relation, the piston and valve each including a resilient expansible ring packing which is unattached to any portion of

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said piston or valve but is freely movable therewith in the cylinder under the action of the forces developed by the piston, and is expanded mechanically and hydraulically thereby, said valve being positioned between said communicating means and said piston and controlling the flow of hydraulic fluid between the reservoir and cylinder in response to the movements of the piston, the packing of both the valve and the piston being expanded and contracted in response to the reciprocal movements of the piston in the cylinder, the cylinder being vented when the piston is in inoperative position, to equalize the volume of fluid between the system and the reserve tank.

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