Sept. 6, 1932. V. SUSSIN 1,876,092

HYDRAULIC SHOCK ABSORBER

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Fig. 2.

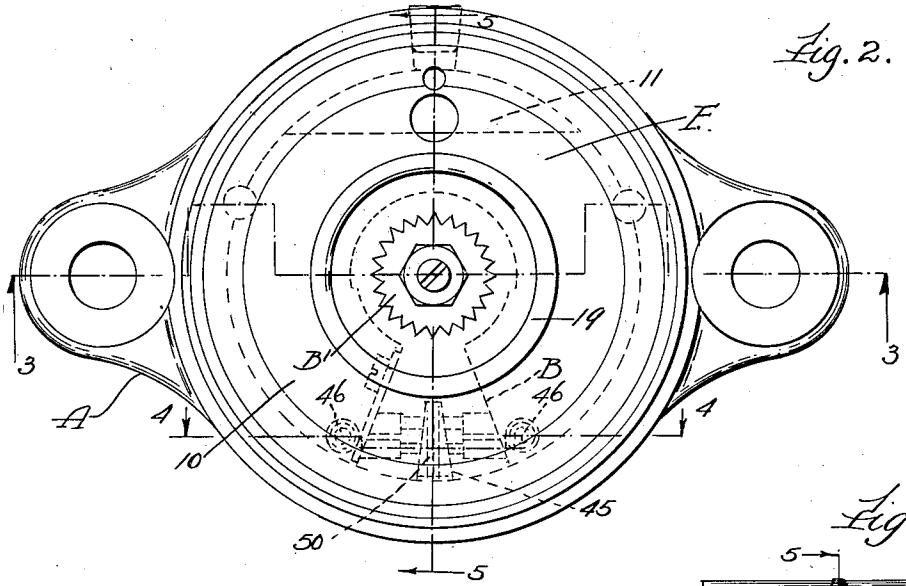


Fig 1

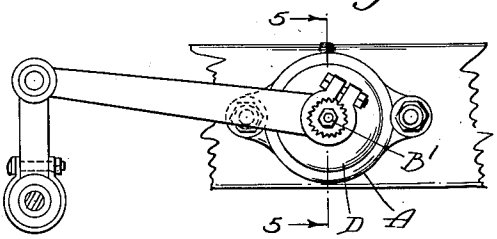
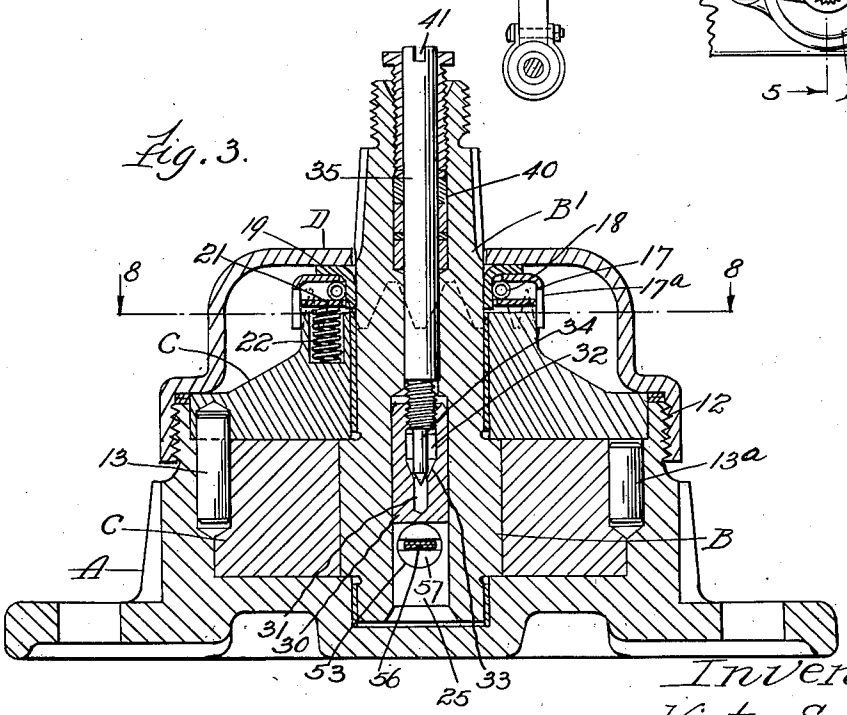


Fig. 3.



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Sept. 6, 1932. V. SUSSIN 1,876,092

HYDRAULIC SHOCK ABSORBER

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Fig. 4.

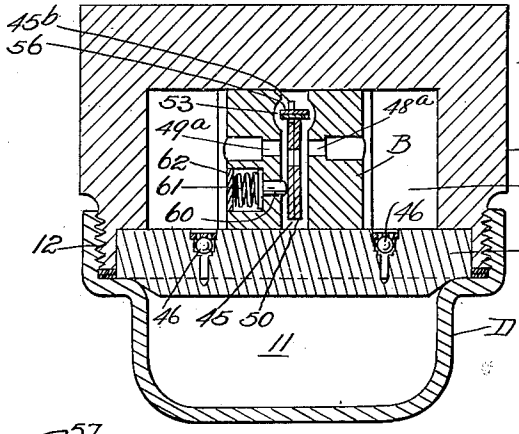


Fig. 12.

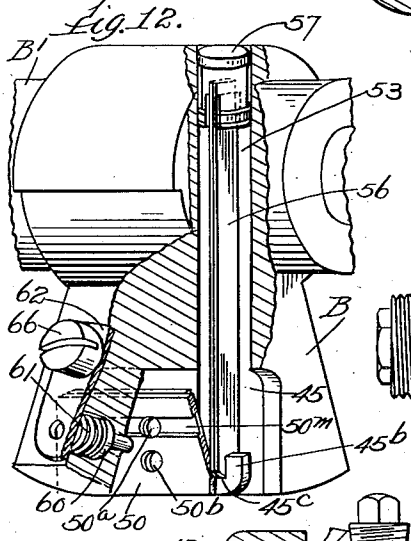


Fig. 6.

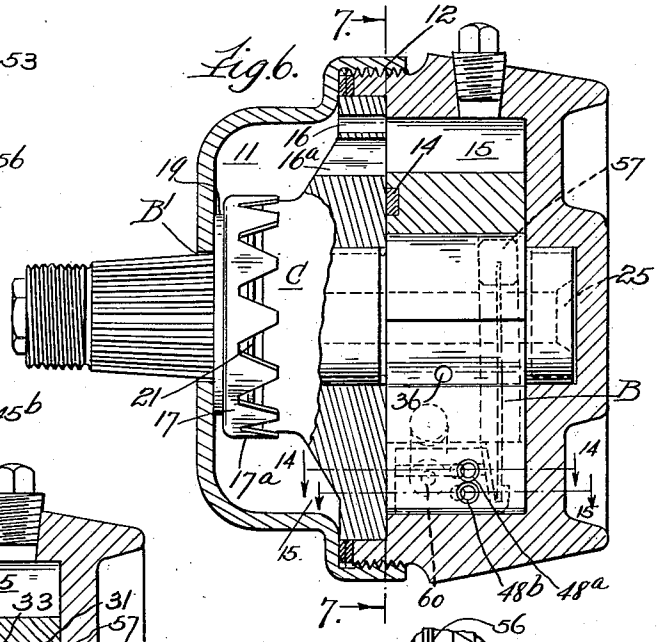


Fig. 5.

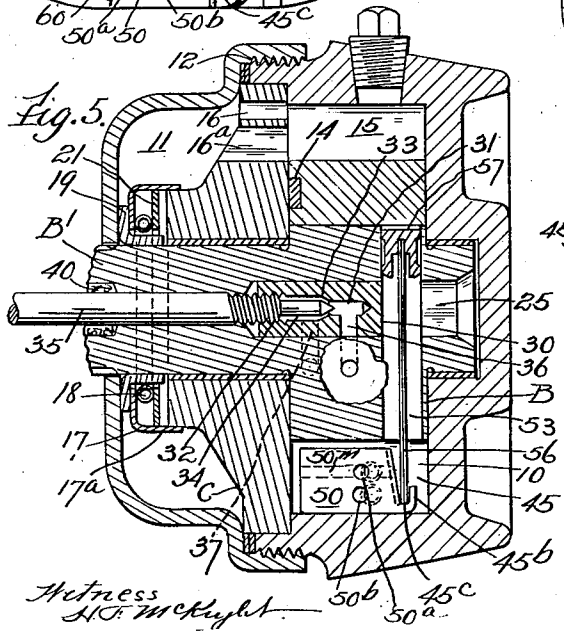
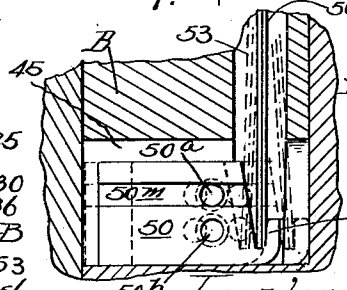


Fig. 13.



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HYDRAULIC SHOCK ABSORBER

Filed July 15, 1929 3 Sheets-Sheet 3

Fig. 7.

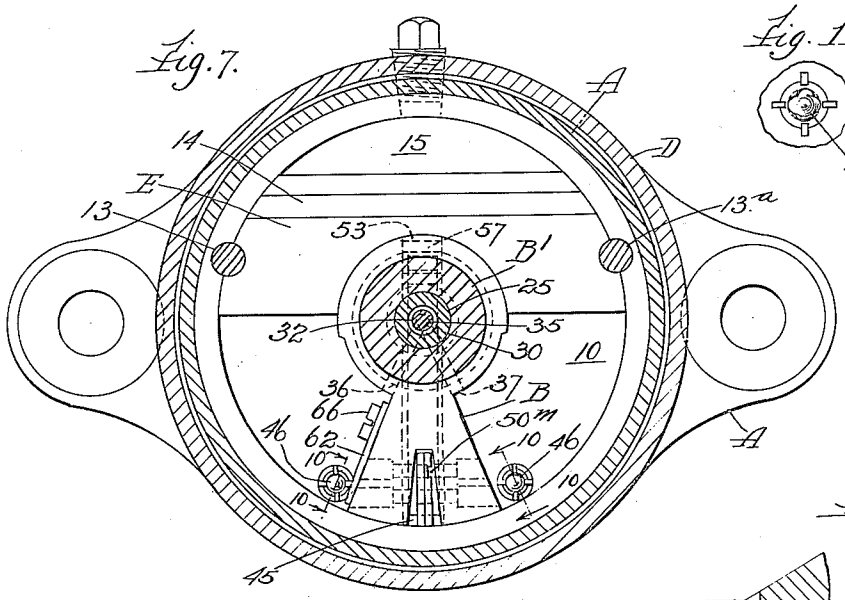


Fig. 11.

Fig. 10.

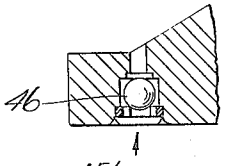


Fig. 8.

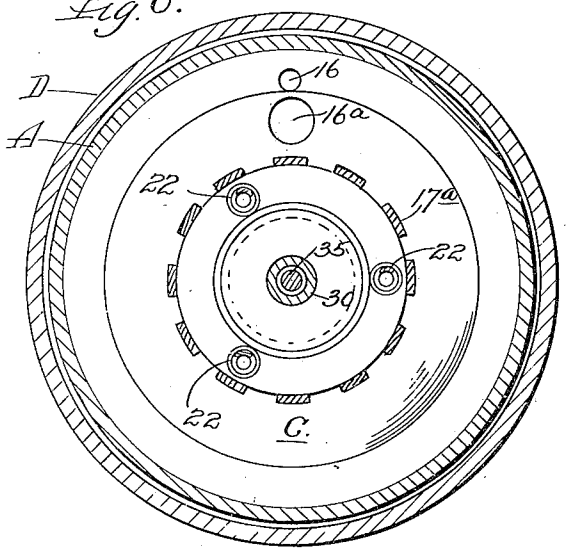


Fig. 14.

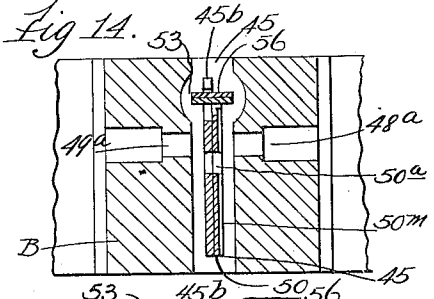


Fig. 15.

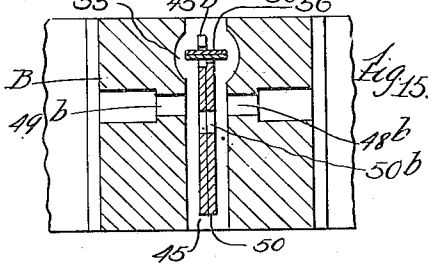


Fig. 9.

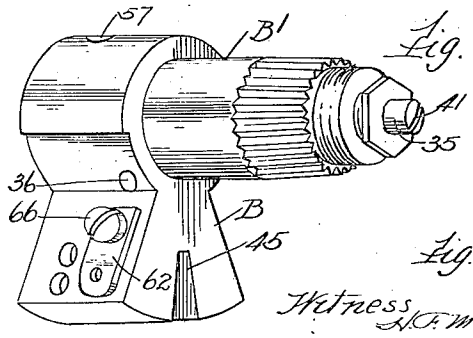
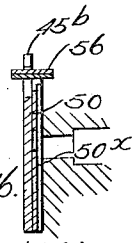


Fig. 16.



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Patented Sept. 6, 1932 1,876,092

UNITED STATES PATENT OFFICE

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HYDRAULIC SHOCK ABSORBER

Application filed July 15, 1929. Serial No. 378,302.

The primary purpose of this invention is to provide a hydraulic shock absorber in which the flow capacity of the passages which determine the retardment of the moving elements of the device under shock or in rebound shall be automatically varied concurrently and correspondingly to temperature change, and thereby substantially concurrently with and correspondingly to the change in viscosity or fluidity of the liquid element employed.

The invention includes also certain detail features of construction more or less directly related to or designed in view of and in connection with the details for the primary purpose above stated. The invention consists in the elements and features of construction shown and described as indicated in the claims.

In the drawings:

Figure 1 is an outer side elevation of a structure embodying this invention, showing the same mounted on a frame bar of the vehicle with operating connections to the vehicle axle.

Figure 2 is an elevation looking in the same direction, showing the same on a larger scale without the connection to the axle.

Figure 3 is a staggered section at the line 3—3 on Figure 2.

Figure 4 is a section at the line 4—4 on Figure 2.

Figure 5 is a section at the line 5—5 on Figure 2 with the protruding end of the piston rock shaft broken away.

Figure 6 is a partly sectional view, section being made of the fixed members of the casing in the same plane as Figure 5, showing the vane piston and rock shaft in side elevation.

Figure 7 is a section at the line 7—7 on Figure 6.

Figure 8 is a section at the line 8—8 on Figure 3.

Figure 9 is a perspective view of the vane piston with its integral rock shaft.

Figure 10 is a detail section as at either of the lines 10—10 on Figure 7.

Figure 11 is a detail elevation looking in the direction of the arrow, 11, on Figure 10.

Figure 12 is a perspective view, on an enlarged scale, of the valve in the vane piston for controlling the liquid flow through the vane piston, said view showing also the thermostatic bar for automatically adjusting the valve at varying temperatures of the liquid.

Figure 13 is a sectional view on the scale of Figure 12, showing the valve in full line and dotted line in the different positions with relation to the piston ports which it assumes under the action of the thermostatic regulating device.

Figures 14 and 15 are detail sections on an enlarged scale at the lines 14—14 and 15—15 respectively, on Figure 6.

Figure 16 is a view similar to Figure 14 showing a modification.

Referring to the drawings, A is a main casing member in which there is mounted for oscillation a vane or oscillating piston member, B. C is a journal bearing member which forms one side wall of the piston chamber, 10, of the main casing member, said member, C, constituting also a partition between the piston chamber, 10, and a liquid reserve chamber, 11, which is further enclosed by a cap member, D, screwed onto the main casing member, A, as seen at 12, and serving to clamp the journal bearing and partition member, C, securely in position for closing the piston chamber at one side. E is a paraxial partition bounding the piston chamber at a diametric plane and partitioning from the piston chamber, 10, a chamber, 15, which constitutes the remainder of the cylindrical cavity of the casing member, A, and constitutes an addition to the liquid reserve chamber and a filling passage hereinafter more particularly explained. The partition, E, is held securely positioned by key pins, 13, 13^a, engaging said partition, E, at its ends with the casing member, A, the key pin, 13, also extending into a journal bearing and partition member, C, for securely positioning the latter against rotative displacement. A compression packing, 14, lodged in a groove in the edge of the partition member, E, serves to render the joints between the latter and the journal bearing partition, C, liquid-tight.

The chamber, 15, communicates with the liquid reserve chamber, 11, by ports, 16 and 16ª, through the journal bearing partition, C, said reserve chamber being formed, and enclosed, by the cap member, D, which has a central aperture for the emergence of the rock shaft, B¹, which carries the oscillating piston, B, and, as shown, is formed integrally therewith. For rendering the rock shaft liquid-tight at its emergence through the cap, D, there is provided a cup leather, 19, held closely clasped upon the rock shaft at its emergence from the journal bearing member, C, by a coil spring, 18, between which and the end of the journal bearing member, C, there is interposed a washer, 21, a second annular member, 17, being interposed between the coil spring ring and the transaxial leaf of the cup leather, 19, said annular member, 17, being formed with a flange, 17ª, dimensioned for admitting the washer, 21, and the end of the journal bearing member, C, when the parts are assembled as seen in Figure 3, the flange of said annular member being serrated, reducing it substantially to a multiplicity of teeth or fingers which serve to engage it properly with the end of the journal bearing member. Three coil springs, one of which is seen at 22, in Figure 3, lodged in the end of the journal bearing member, C, serve to keep the washer, 21, spaced slightly from the end of the latter cooperating thus with the notches in the flange, 17ª, to ensure access of lubricant to the journal bearing.

The rock shaft, B¹, is axially bored as seen at 25, for receiving a valve seat member, 30, which is drive-fitted in the bore, 25, said valve seat member being axially bored from one end as seen at 31, and counterbored, as seen at 32, to form the seat, 33, for a needle valve, 34, which is screwed into the interiorly threaded end of the counterbore, 32, as seen at 33. From points immediately adjacent the opposite converging sides of the vane piston, B, ducts, 36 and 37, are formed by boring radially with respect to the rock shaft, B¹, leading respectively into the bore, 30, and the counterbore, 32, that is, at opposite sides of the seat of the needle valve, 35, so that said valve is interposed between said two ducts, and serves to control the communication from the one duct to the other and thereby control the communication between the two parts of the piston chamber at opposite sides of the piston operating therein.

The needle valve, 35, extends out through the rock shaft, B¹, being furnished with a stuffing box, 40, for maintaining it liquid-tight in said rock shaft, and the protruding end of the valve is slotted, as seen at 41, to facilitate adjustment of the valve for regulating flow communication between the two opposite end portions of the piston chamber, as mentioned.

For providing liquid flow from one side to the other of the oscillating piston, otherwise than through the passages controlled by the needle valve, 35, the piston, B, is formed with a recess leading in from its arcuate end radially with respect to the axis of oscillation of the piston and substantially midway between the two radially converging faces of the piston. This recess, 45, has its opposite sides converging, that is, the recess is tapered narrowing from the outer end inwardly for accommodating a valve member hereinafter described. For transverse liquid communication through the piston it is apertured from side to side at the portion of its radial extent which contains the end recess, 45. For convenience of manufacture this transverse communication is effected by a bore forming aligned apertures through the opposite sides of the end recess, 45, as seen at 48ª, 48ᵇ, on one side, and at 49ª, 49ᵇ, on the other side of said end recess. In this end recess there is lodged so as to pivot at one edge at the narrow end of the recess, a valve member, 50, having apertures, 50ª, 50ᵇ, positioned for registering substantially with the apertures, 48ª, 49ª, and 48ᵇ, 49ᵇ, at certain positions of the valve member longitudinally in the recess, 45, in which said valve member is dimensioned so as to be longitudinally movable, that is, said valve member being shorter than the axial dimension of the piston and consequent length of the aperture, 45, which extends the whole distance between the two parallel sides of the piston.

The valve member, 50, is arranged to be longitudinally adjustable in the piston recess, 45, a distance sufficient to permit it to be moved from a position of registration of its apertures 50ª and 50ᵇ respectively with the piston apertures, 48ª and 48ᵇ, to a position at which the apertures of the valve are out of registration with said apertures of the piston. And in the construction shown the means for such longitudinal adjustment of the valve is thermostatic, the intent being that the registration shall be complete so as to permit the flow of the liquid to be as free as possible at low temperature of the liquid when its viscosity would tend to retard the flow, and to reduce the area of registration as the temperature of the liquid increases, rendering its viscosity less, so that its freedom of flow is greater.

For the purpose of such thermostatic control of the valve, 50, there is formed in the piston member and extending through the rock shaft, proximate the side of the piston member opposite that through which the needle valve is entered, a bore, 53, and through this bore there is extended a thermostatic member consisting of a bi-metallic bar, 56, having a headpiece, 57, to which it is rigidly secured and which is dimensioned for drive-fit in the bore, 53, at the end thereof opposite the arcuate end of the piston, through which arcuate end said bore extends, intersecting

at the end portion the corresponding end portion of the tapered recess, 45, in the arcuate end of the piston. The valve member, 50, has one end extending in the intersecting portions of the bore, 53, and the tapered recess, 45, where said valve is engaged by the free end of the thermostatic bar, 56, the valve having at that end a projection, 45^b, in which a suitable notch is formed for the engagement of the free end of the thermostatic bar, as seen at 45^c.

Provision for replenishing the piston chamber from the reserve chamber is shown at similar check valve controlled ports located at opposite sides of the piston at middle position, and having the ball check valve 46, opening for flow from the reserve chamber into the piston chamber, and seating against reserve flow; so that in the movement of the piston in the direction from its middle position for enlarging the chamber at one side, the tendency of such movement to produce a partial vacuum in the chamber at that side operates to draw liquid from the reserve past the check valve, and into the piston chamber, and thus ensure that on the reverse stroke of the piston it will meet the instant opposition of the liquid to the extent that the flow from one side to the other is restricted.

The operation of the valve, 50, in the operation of the piston in its back and forth movement in its arcuate chamber, may be understood to be substantially as follows:—

At all ordinary temperatures the thermostatic bar, 56, holds the valve, 50, at the longitudinal position within its range of longitudinal movement in the piston recess, 45, at which the ports 50^a, 50^b, are in alignment for registration respectively, with the ports, 48^a, 49^a, and 48^b, 49^b, in the opposite walls of the tapered recess, 45, of the piston; so that the movement of the piston in either direction, causing the valve to be actuated by the liquid entering the ports at the side toward which the piston is moving, and swinging the valve over against the other side of the recess, 45, will bring the ports of the valve into registration with the ports of said other side, so that the flow of the liquid through the piston will be free to the full limit of the flow capacity of the valve ports. With the construction as thus described it will be understood that the retardment effected by the restriction of the flow of the liquid through the piston will be the same in both directions, that is, both in the descent of the vehicle and in the rebound. Since it is desirable,—and the purpose of the present construction is primarily,—to retard the rebound rather than the descent, the latter being presumed to be sufficiently retarded by the stiffness of the vehicle springs, provision is made for reducing the flow capacity of the passages through the piston in the movement of the piston due to the rebound. The details of construction for this purpose will now be described.

First, it will be noted that the valve, 50, being shorter than the tapered recess, 45, in the end of the piston, there will always be clearance around one end or the other of the valve at whatever position it may occupy longitudinally in the piston recess; and that accordingly the liquid entering the port, 48^a, 48^b, or 49^a, 49^b,—according to which way the piston is moving,—will always be able to pass around the end of the piston into contact with the opposite wall of the tapered recess, 45, and if access is in any manner provided for the liquid to pass between said wall and the face of the valve seating thereon so as to reach the port in said wall without passing through the valve port, free flow through the piston would be obtained to the extent of the access which the liquid thus obtained, in addition to whatever access may be obtained directly through the valve at the registered port. To thus increase the access of the liquid to the port, 49^a, when the valve is seated at the side of the recess, 45, at which it is seated by the flow of the liquid forced by the descending movement of the vehicle, the valve is formed on the face which is seated against the wall of the piston recess, 45, having the port, 49, in the movement caused by the stroke of the piston in the descending movement of the vehicle, with a channel, 50^m, leading from either or both ends of the valve to one of the apertures, 50^a, in the valve. By this means it will be understood that in the descending movement of the vehicle when the valve is seated with this channelled face against the corresponding wall of the piston recess, 45, the liquid will have access for flow through the piston, not only through the port, 50^a, 50^b, to the extent that they are registered with the ports, 49^a, 49^b, but additionally through the channel, 50^m, to the entire area of the port, 49^a, which is several times greater than the area of the port, 50^a, even when registered to the full extent of said port, 50^a, with the port, 49^a. And to the extent that the freedom of flow through the piston is thus increased the retardment of the descending movement of the vehicle will be diminished in comparison with the retardment of the rebound. Upon consideration it will be recognized that when the vehicle wheels drop into a depression in the roadway, causing a sudden rebound, the resulting sudden reversion of the piston stroke will tend to cause the valve, 50, to be slapped over against the opposite side of the piston recess as by an instant blow, which tends to make the operation of the device unpleasantly noisy, and suggestive of injury caused by the jolt. To avoid both this unpleasant suggestion and any actual injury which might be caused under such circum-

stances, there may be provided in the wall of the piston slot, 45, against which the valve is driven in such rebound, a cushioning device which is shown in the form of a little plunger pin, 60, set through from the outer side of the piston, projecting from the face of the piston recess, 45, said plunger pin being held protruding in the piston recess by a spring, 61, held compressed against the pin by a cover piece, 62, closing the bore in which the spring is lodged for bearing against the head of the pin, said cover piece being secured by a screw, 66. Any other convenient means may be substituted for holding the spring compressed for yieldingly resisting the impact of the valve against the inwardly protruding end of the pin.

Upon consideration it may be recognized that the provision above described, shown in Figures 4 and 7, for obtaining more freedom of flow of the liquid in the direction required in the descent than in the rebound of the vehicle, is not dependent for its efficiency upon the longitudinal channel in the valve face through which increased liquid access is obtained to the piston ports, being arranged to connect with one of the valve ports or with any aperture extending through the valve; but that, on the contrary, it is only necessary for the function of said channel that it lead to an opening in the seating face of the valve; and that in the construction above described only the end portion of the valve port, 50^a, toward the wall of the recess, 45, on which the valve seats in the descent of the vehicle, and not the whole extent through the valve of said aperture, 50^a, is to be taken into account as an opening in the face of the valve in defining this feature of the construction.

In Figure 16 there is illustrated a modification in which, instead of the aperture, 50^a, extending through the valve, there is provided only a recess, 50^x, in the face of the valve, to which recess the channel 50^m, leads; and it may be understood that this part of the invention includes such modification.

Certain details of the construction of the valve, 50, may require explanation for understanding the showing of these details in the drawings. The valve, 50, is made of two pieces of metal for the reason that one piece of the necessary thickness cannot be readily formed by die-cutting from metal plate of that thickness without tendency to deform the edge, requiring subsequent machining to put it in proper order for service. Also, the notch for engagement by the end of the thermostatic bar is narrower than can be made by die-cutting a piece of the full thickness of the valve; but by making it of two pieces a notch may be cut of any desired width, which can be well done by a die, and the excess width may be taken up, as shown in the drawings, by lapping the other piece whose edge will form one side of the notch, as shown in Figures 12, 14 and 15 of the drawings.

I claim:

1. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve being constructed to permit liquid entering through one of said ports to pass the valve to the other side thereof, and having at said other side a face opening positioned for registering with the port at that side of the piston recess and accessible to the liquid passing the valve from the first mentioned port.

2. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied with liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve being constructed to permit liquid entering through one of said ports to pass the valve to the other side thereof, and having at said other side a face opening positioned for registering with the port at that side of the piston recess and accessible to the liquid passing the valve from the first mentioned port, and means for adjusting the valve to vary the extent to which said face opening registers with the port at said other side.

3. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, a chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from

one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve having at one side a face opening positioned for registering with the port at that side of the piston recess, the valve being constructed to permit the liquid entering through the port at the other side to pass the valve to the first mentioned side thereof, and means for adjusting the valve to vary the extent to which said face opening registers with the port at said first mentioned side.

4. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve having at one side a face opening positioned for registering with a port at that side of the piston recess, the valve having in said face a groove leading from the edge of the valve to said face opening, the valve being dimensioned transversely of the piston movement less than the depth of the piston recess in that direction, whereby the liquid entering the piston recess through one of said ports may pass the valve at said edge thereof and reach said face opening in the valve.

5. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve being constructed to permit liquid entering through one of said ports to pass the valve to the other side thereof, and having at said other side a face opening positioned for registering with a port at that side of the piston recess and accessible to the liquid passing the valve from the first mentioned port, a temperature responsive element exposed to the liquid and operatively connected with the valve for adjusting the latter to vary the extent to which said valve face opening registers with said second mentioned port.

6. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve having at one side a face opening positioned for registering with the port at that side of the piston recess, the valve being constructed to permit the liquid entering through the other of said ports to pass the valve to the first mentioned side thereof, and a temperature responsive element exposed to the liquid and operatively connected to the valve for adjusting the latter to vary the extent to which said valve face opening registers with said first mentioned port.

7. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, the valve having at one side a face opening positioned for registering with a port at that side of the piston recess, the valve having in said face a groove leading from the edge of the valve to said face opening, the valve being dimensioned transversely of the piston movement less

than the depth of the piston recess in that direction, whereby the liquid entering the piston recess through one of said ports may pass the valve at said edge thereof and reach said face opening in the valve, and a temperature responsive element exposed to the liquid and operatively connected with the valve for adjusting the latter to vary the extent to which said valve face opening registers with said port.

8. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston chamber being arcuate, and the piston being a vane carried by a rock shaft journaled in the casing, and having a recess in the arcuate end thereof extending through it from side to side, the vane piston and rock shaft having a bore transaxial with respect to the rock shaft, traversing one end portion of said recess, a valve device in the recess extending therein at the intersection of said recess with the bore, and a temperature responsive element mounted in said bore and having a free end engaged with the end of the valve in the intersection of the bore and piston recess.

9. A construction for the purpose indicated comprising a casing having a piston chamber, and a piston member arranged and connected for back and forth movement therein, the chamber being adapted to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston chamber being arcuate and the piston being a vane carried by a rock shaft journaled in the casing, and having a recess at the arcuate end thereof extending through it from side to side, the vane piston and rock shaft having a bore transaxial with respect to the rock shaft, traversing one end portion of said piston recess, a valve device in the recess extending therein at the intersection of said recess with the bore, a thermostatic element consisting of a bi-metallic bar having one end mounted rigidly in said bore at the end thereof remote from said valve recess, said bi-metallic bar extending longitudinally of said bore and having its free end engaged with the end of the valve in the intersection of the bore and piston recess.

10. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied by liquid, the piston member having a passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and constituting ports communicating with the recess at its opposite sides; a valve carried in said recess and arranged for oscillating therein from side to side thereof to seat at said ports respectively in the back and forth movements of the piston, a cushioning device mounted in the piston and protruding in said recess for encounter by the valve in its movement for seating, whereby the seating movement is retarded and the encounter with the wall of the recess is made less abrupt.

11. The construction defined in claim 10, the cushioning device constituting a headed pin reciprocably lodged in and counterbored through the lateral wall of the piston recess with its head stopped on the shoulder of the counterbore, with a compression spring in the counterbore reacting on the head of the pin, and means for retaining the spring compressed in the counterbore.

12. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied with liquid, the piston member having passage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess comprising two ports at each side of the recess communicating therewith, a valve carried in said recess and arranged for oscillating therein from side to side thereof, and seating over said opposite-side ports respectively in the back and forth movements of the piston and corresponding movements of the valve with respect to the piston, the valve having two ports positioned for registering respectively at one end with the two piston ports at one side of the recess, one of said valve ports being positioned for registering also with the corresponding one of the piston ports at the other side of the recess, the valve being formed for affording access of liquid from the first mentioned side of the recess past the valve to the other piston port at the other side of the recess, independently of the second valve port, and means for adjusting the valve to vary the registration of the valve ports with the piston ports.

13. A construction for the purpose indicated comprising a casing having a piston chamber and a piston member arranged and connected for back and forth movement therein, the chamber being arranged to be occupied with liquid, the piston member having a pas-

sage for the liquid from one side to the other of the piston in the movement of the latter in the chamber, the piston being recessed from one side transversely of the direction of its back and forth movement, and having the liquid passage traversing said recess and comprising ports in the piston communicating with the recess at opposite sides of the latter, a valve carried in said recess and arranged for oscillating therein from side to side thereof, and seating at said opposite-side piston ports respectively in the back and forth movements of the piston and corresponding movements of the valve with respect to the piston, and having a port positioned for registering with the piston port at one side of the recess, the valve being constructed to permit the liquid entering through said last mentioned port to pass the valve to the other side thereof and of the recess, the valve having at said other side a face opening positioned for registering with a port of the piston leading from said other side of the recess, and means rendering said face opening accessible to the liquid passing the valve as mentioned, and means for adjusting the valve to vary the extent to which the first mentioned valve port registers with the first mentioned piston port.

In testimony w. ereof, I have hereunto set my hand at Chicago, Illinois, this 11th day of July, 1929.

VICTOR SUSSIN.