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[54] **HYDRAULIC VALVE LIFTER**

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[51] **Int. Cl.** **F01l 1/14**

[58] **Field of Search** 123/90.55, 90.56, 90.16

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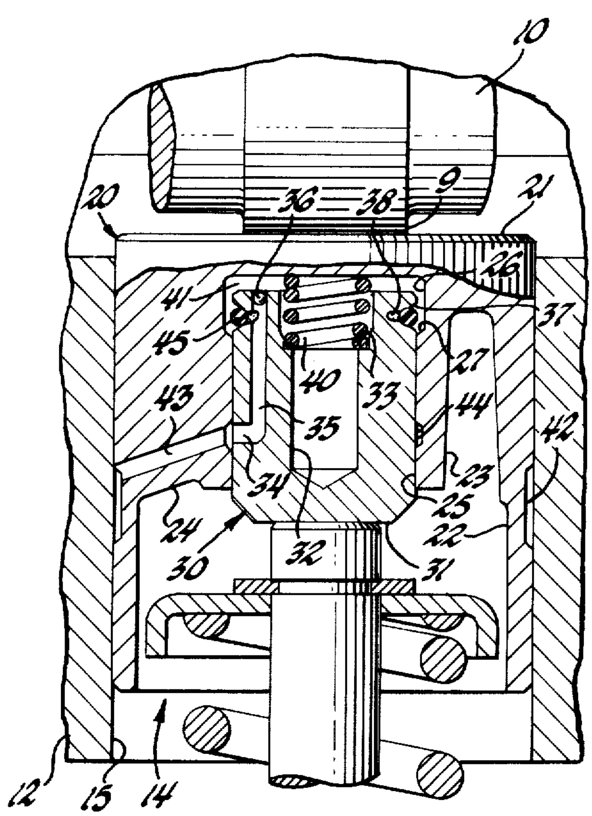
[57] **ABSTRACT**

A self-adjusting hydraulic valve lifter for an overhead cam engine wherein this pressure fed hydraulic valve lifter is interposed directly between a valve and cam, the lifter including an upright, cup-shaped plunger engaging on the valve stem and being reciprocally received in a larger, inverted, cup-shaped follower which engages the cam and which is slidably guided in a fixed bore surrounding the valve stem, a pressure chamber being formed between an end of the plunger and the follower, with a helical compression spring positioned therein to normally bias the plunger and follower against the valve stem and the cam, respectively, and a fluid supply passage is provided to supply fluid under pressure to the pressure chamber, the fluid supply passage including a V-shaped groove with an O-ring seated therein to serve as a one-way check valve controlling the flow of fluid to the pressure chamber.

7 Claims, 4 Drawing Figures



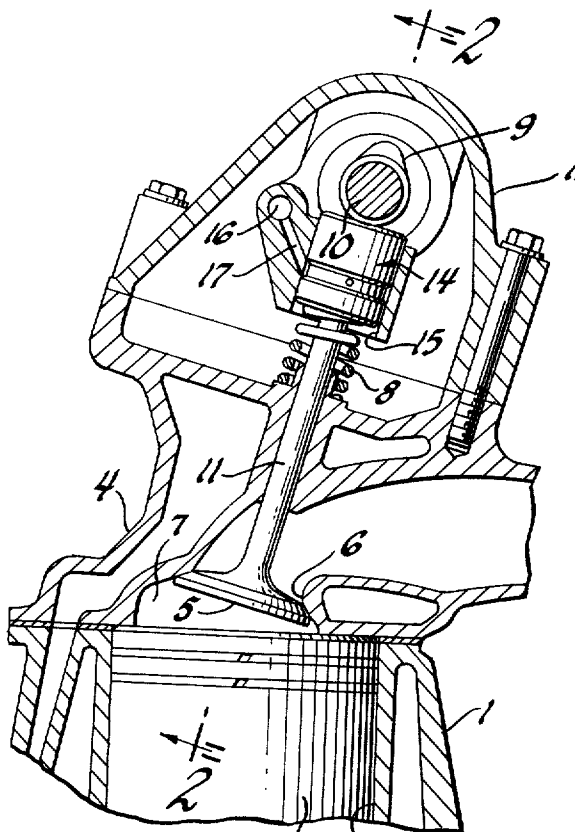


Fig.1

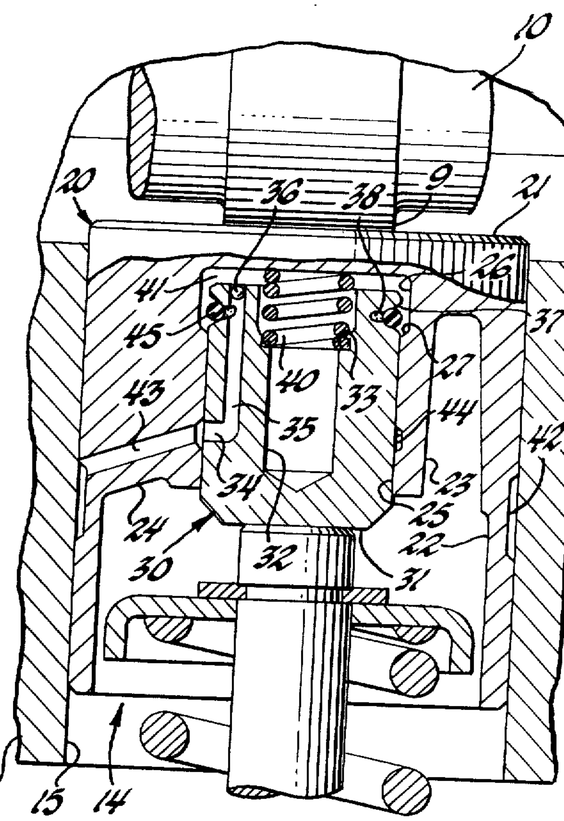


Fig.2

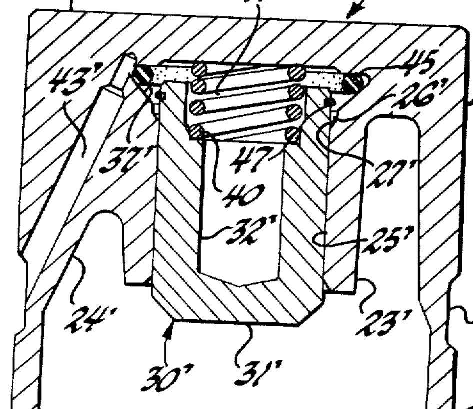


Fig.3

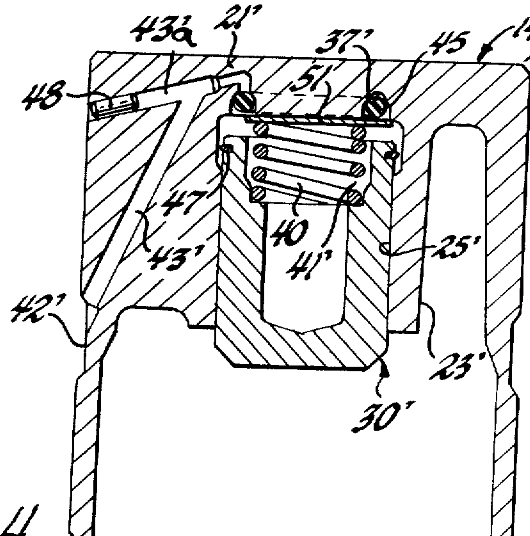


Fig.4

HYDRAULIC VALVE LIFTER

This invention relates to hydraulic valve lifters or tappets, such as are used, for example, in maintaining substantially zero lash in valve operating mechanism of an internal combustion engine and, in particular, to a self-adjusting hydraulic valve lifter for use in an overhead cam engine.

Various forms of hydraulic valve lifters or tappets of the type for use specifically in overhead cam engines are known and these generally include a lifter body or follower within which a plunger or piston is slidably positioned either directly in the follower, per se, or in a cylindrical, inner cup member which, itself, is slidably positioned directly in the follower. In most of the known hydraulic valve lifters, the plunger thereof is provided with a central passage and an inlet ball check valve is used to control flow through this central passage to a variable volume hydraulic pressure chamber defined, in part, by one end of the plunger, the hydraulic lifter further including a spring positioned to abut against the plunger to normally move it in a direction to increase the volume of the hydraulic pressure chamber.

It is therefore a primary object of this invention to provide an improved hydraulic valve lifter structure whereby a single, annular, ring valve is used as a one-way check valve for controlling fluid flow to a pressure chamber within the valve lifter.

Another object of this invention is to improve a hydraulic valve lifter whereby it can be easily fabricated with a minimum of parts, the lifter incorporating as an element thereof an O-ring of resilient material which in a preferred embodiment functions both as a one-way check valve and as a retainer for a plunger within a follower element of the lifter.

These and other objects of the invention are obtained by a hydraulic valve lifter which includes an inverted, cup-shaped follower having a stepped bore therein to slidably receive a spring biased, cup-shaped plunger forming with the follower a pressure chamber supplied with oil through a feed hole in the follower and a V-shaped groove in communication with the feed hole, the V-shaped groove opening into the pressure chamber with flow therefrom controlling by an O-ring valve normally seated in the V-shaped groove.

For a better understanding of the invention, as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a transverse, sectional view through the upper portion of an internal combustion engine incorporating a hydraulic valve lifter in accordance with the invention;

FIG. 2 is an enlarged, fragmentary, sectional view taken substantially along the lines 2—2 of FIG. 1 showing a preferred embodiment of a hydraulic valve lifter in accordance with the invention;

FIG. 3 is a view corresponding to FIG. 2 showing an alternate embodiment of the hydraulic valve lifter; and,

FIG. 4 is a view corresponding to FIG. 3 illustrating still another alternate embodiment of the hydraulic valve lifter.

Referring now in detail to the drawings and, in particular, to FIG. 1, an engine cylinder block 1 is shown as having a cylinder 2 in which an engine piston 3 operates in the usual manner. Covering the upper end of the cylinder 2 is a cylinder head 4 in which a poppet valve 5 is slidably fitted to control and closing of the port 6 communicating with the combustion chamber 7 above the piston. The valve 5 is biased to its normally closed position shown by a coil spring 8. Downward actuation of the valve 5 in the opening direction is effected by a cam 9 on a camshaft 10 which directly overlies the upper end of the valve stem 11 and which is suitably journalled in a housing 12 bolted to the cylinder head.

A hydraulic valve lifter or tappet, generally designated 14, and hereafter referred to as the valve lifter, is reciprocally journalled in a lifter guide bore 15 in the housing 12 and is interposed directly between the cam 9 and the valve stem 11. Hydraulic fluid in the form of oil from the engine lubricating system, now shown, is supplied under moderate pressure via an oil gallery 16 and a branch port 17 to the valve lifter 14, the branch port 17 extending to the lifter guide bore 15.

Referring now to FIG. 2, there is illustrated a preferred embodiment of a valve lifter 14, in accordance with the invention, which includes an inverted, cup-shaped, cylindrical outer member or follower 20 having a closed, upper head or end wall 21 which is in abutting engagement with cam 9, a depending outer skirt 22, defining a substantially cylindrical recess, and a central boss 23, the skirt 22 and a central boss 23 being interconnected by spaced apart webs 24 integral therewith and with the end wall 21. The central boss 23 is provided with a cylindrical stepped bore which includes a bore 25 extending from the free end of the boss and an enlarged bore 26 at the opposite end which terminates at the interior surface of the end wall 21, the bores 25 and 26 meeting coaxially with an intervening shoulder 27.

The valve lifter 14 further includes a cylindrical plunger 30 of an upright, cup-shape configuration which is slidably received in the bore 25 and extending into bore 26 within the follower 20, the plunger 30 having a closed, lower head or end wall 31 for abutting engagement with the valve stem 11. Plunger 30 is provided with a stepped bore 32 at its upper end to receive one end of a helical wound compression spring 40 which at one end abuts against a suitable abutment, in the form of a shoulder 33 in the plunger, while the opposite end of spring 40 abuts against the interior surface of the end wall 21 of follower 20 whereby the follower 20 and plunger 30 are normally biased into contact with the cam 9 and valve stem 11, respectively.

The follower 20 and plunger 30 cooperate to form a fluid chamber 41 within the follower 20, above and around the upper end of the plunger 30, and specifically around that portion of the plunger 30 which extends out into the enlarged bore 26 within the follower 20. This fluid chamber 41 is supplied with engine oil under presure from the oil gallery 16 and branch port 17 via an outer annulus or annular groove 42 provided for this purpose around the outer peripheral surface of the follower 20, the groove 42 being in communication via one or more radial extending ports or passages 43, only one being used in the embodiment shown, in the web 24 and boss 23 of the follower 20 with an inner annulus or annular groove 44 in the boss 23 formed concentric with the bore 25 therein.

Oil supplied to the groove 44 flows via a radial passage or side port 34 in plunger 30 to an axial passage 35 extending from the upper or open end of the plunger, this end then being suitably closed as by a ball plug 36 suitably fixed in the end of this passage in the upper end of the plunger 30. The axial extending passage 35 is in fluid communication with the apex or bottom of a substantially V-shaped groove 37 formed on the outer periphery of the plunger 30 closely adjacent to its open or upper end, that is, the portion of the plunger normally extending into the enlarged bore 26 in follower 20, with the V-shaped groove 37 formed to open outward into fluid chamber 41. Flow from the passage 35 through the V-shaped groove 37 is controlled by a one-way check valve in the form of an annular ring or O-ring 45, as it is normally referred to, which is made of a suitable resilient material, such as synthetic rubber. The O-ring valve 45 is of a size to seat within the V-shaped groove in a manner to be described.

The included angle between the sides of the V-shaped groove 37 can be varied, as desired, to accommodate O-rings of different cross sectional diameters and, for example, the included angle can be in the range of 40° to 80° but is preferably about 60°. The bottom of the V-shaped groove 37 may be directly intersected by the passage 35, if the included angle of groove 37 and the cross sectional diameter of the O-ring valve 45 is such as to permit the O-ring valve to seat in a position to block flow from a port defined by the intersection of the groove 37 with passage 35 or, as shown, the bottom of the V-shaped groove 37 may be further cut inward, in a radial direction, to provide a supply groove 38 which itself intersects the passage 35.

During engine operation, with the camshaft 10 rotated to a posotion so that the cam 9 is at zero lift position relative to follower 20, as shown in FIG. 1, and with the valve 5 seated by spring 8, the lifter spring 40 will effect axial separation of the follower 20 relative to the plunger 30 so that they engage the cam 9 and valve stem 11, respectively. Upon axial separation of the plunger 30 relative to the follower 20 in this manner, the volume of the fluid chamber 41 will increase resulting in a reduction of the pressure of oil within the fluid chamber, it being assumed that the fluid chamber 41 has previously been filled with oil. As this occurs, engine oil under pressure as supplied to the branch port 17 via oil gallery 16 will enter the groove 42 to flow through port 43 to groove 44 and then via passages 34 and 35 to groove 38 and the inner portion of the V-shaped groove 37 behind the O-ring valve 45 to effect unseating of the O-ring valve 45 relative to the sides of the V-shaped groove 37 whereby oil can flow around the O-ring valve 45 into fluid chamber 41. The O-ring valve 45 will only unseat relative to the sides of the V-shaped groove 37 to the extent necessary to maintain the fluid chamber 41 full of oil.

During the valve opening or lift stroke of the cam 9, downwardly movement of the follower 20 tends to force the plunger 30 further into the follower and the resulting pressure rise of the oil in the fluid chamber 41 will act against the O-ring valve 45 to cause it to immediately seat against the sides of the V-shaped groove 37. With continued downward movement of the follower 20, the plunger 30 is likewise moved downwardly under the thrust of the oil trapped in the fluid chamber 41, forcing the valve 5 to unseat or open against the closing bias of spring 8. As the cam continues on the valve opening or lift stroke to depress the valve lifter 14 downward, it will effect corresponding downwardly movement of valve 5 until such time as the lobe of the cam 9 is at maximum lift as it engages the follower 20 of the valve lifter, the valve 5 then being in its fully opened position.

Further rotation of the cam 9 will then bring the down-ramp thereof into engagement with the valve lifter 14 so that the valve spring 8 is then operable to cause the valve 5 to start closing to effect upward movement of the valve lifter until such time as the cam 9 has rotated back into a position with its base circle in contact with the follower 20 of the valve lifter, thus completing the cycle.

As the above described cycle is repeated over a period of time, any excess of oil entering the fluid chamber 41 is forced out through a leak-down clearance provided for this purpose between the bore 25 in the follower 20 and the outside peripheral surface of the plunger 30, whereby controlled leakage from the fluid chamber 41 into the groove 42 is affected, as desired.

The plunger 30 movement within the follower 20 is limited between its bottom position, that is, the position in which the open end of the plunger 30 is in contact with the inner surface of head 21 of the follower 20, and its extended position, the position in which the O-ring valve 34, serving as a retainer ring in this preferred embodiment of the valve lifter as shown in FIG. 2, engages the shoulder 27 within the follower 20. The axial distance which the plunger 30 moves relative to the follower 20 is so chosen as to insure that the installed length of the valve lifter will occupy the resulting space between the free end of the valve stem of the valve 5, when in its seated position, and the cam 5 in its zero lift position in all conditions of engine tolerances and temperature.

Referring now to FIG. 3, there is illustrated a second embodiment of a valve lifter, generally designated 14', which is similar in construction to that previously described and includes an inverted, cup-shaped, cylindrical outer member or follower 20' having a closed upper head or end wall 21', a depending outer skirt 22' and a central boss 23', the skirt 22' and central boss 23' being interconnected by spaced apart webs 24' integral therewith and with the end wall 21'. The central boss 23' is provided with a cylindrical stepped bore which includes a bore 25' extending from the free end of the boss and an enlarged bore 26' at the opposite end which terminates at the interior surface of the end wall 21', the bores 25' and 26' meeting coaxially with an intervening shoulder 27'. In addition, a V-shaped groove 37' is provided in the follower 20' intermediate the ends of the bore 26' and concentric therewith. The V-shaped groove 37' can be formed symmetrical or, as shown, formed non-symmetrical and, in the embodiment illustrated, the included angle of this V-shaped groove 37' is approximately 45°. This non-symmetrical configuration of the V-shaped groove 37' permits a more symmetrical opening where the inlet passage or port 43' from an outer annular groove 42' on the outer periphery of the follower intersects or breaks into the groove 37' thus allowing the O-ring valve 45 positioned in this groove to seat slightly higher within the fluid chamber 41' in the follower 20', as defined in part by the open upper end of the plunger 30 slidably received within the bore 25' extending into bore 26'.

In this embodiment, the plunger 30' is simply a cylindrical, cup-shaped element having a closed lower end 31' and a stepped bore 32' extending from its opposite or upper end to receive the spring 40. This plunger 30' is provided on its outer periphery adjacent to its open or upper end with an annular split ring retainer **47** positioned in a suitable annular groove provided for this purpose whereby the split ring retainer **47** forms a shoulder which extends radially outward from the plunger **30'** for engagement against the shoulder **27'** of follower **20'** to thereby limit axial outward movement of the plunger **30'** relative to the follower **20'**.

Referring now to FIG. **4**, there is illustrated an alternate embodiment from that shown in FIG. **3** in that in this embodiment, the O-ring valve **45** seats in an inverted, V-shaped groove **37'** in the follower **20'** in the end wall **21'** thereof to open into the top end of the fluid chamber **41'**. In this embodiment, the oil passage **43'** intersects a second radially extending passage **43'** a formed by a drilled bore closed at one end by a plug **48**, the opposite end of this passage intersecting the V-shaped groove **37'** at the base thereof. With this construction, since the O-ring valve **45** is positioned in the inverted, V-shaped groove **37'**, a valve retainer plate **51** is used to limit axial movement of the O-ring valve downward into the fluid chamber **41'**. As shown, the valve retainer plate **51** is positioned on the upper end of the spring **40** to abut against the interior surface of the head **21'** as biased by this spring to limit movement of the O-ring valve in an unseating direction relative to the V-shaped groove. It should be realized that sufficient limited axial movement of the O-ring valve **45** relative to the side walls of V-shaped groove **37'** is permitted to allow unseating of the valve **45** so that oil can flow around the O-ring valve **45** into the fluid chamber **41'**. With this arrangement of the inverted, V-shaped groove **37'** in the follower **20'**, the oil inlet into the fluid chamber **41'** is at the extreme top end thereof to thereby minimize the possibility of any trapped air accumulating in the fluid chamber.

As in the embodiment shown in FIG. **3**, the embodiment of the valve lifter shown in FIG. **4** also has a split ring retainer **47** positioned in a suitable groove provided for this purpose around the outer peripheral surface of the plunger **30'** closely adjacent to its upper end.

What is claimed is:

1. A self-adjusting hydraulic valve lifter including an outer member of cylindrical cup shape closed at one end by a head and provided with a cylindrical recess at its opposite end to receive the stem of a valve, said head having a central boss integral therewith extending axially into said recess, said boss having a stepped bore therein including a first bore of a predetermined diameter extending from the free end of said boss and a second bore of a larger diameter, said first bore and said second bore meeting coaxially with an intervening radial extending shoulder, a plunger of cylindrical cup shape journalled for reciprocal movement in said first bore of said outer member in oppositely presenting relation to said outer member, said plunger having a cylindrical recess extending from one end and a head closing the opposite end thereof, said plunger being of an axial length such that the closed end of said inner member extends axially outward of said first bore from said boss and the open end of said plunger extends into said second bore, said plunger defining with the peripheral surface around said second bore and the interior surface of said head within said outer member a fluid chamber, spring means positioned in said fluid chamber for abutment against said plunger and said outer member to normally bias said plunger in one axial direction relative to said outer member and, oil supply passage means including an O-ring valve for supplying and maintaining a body of hydraulic fluid in said fluid chamber, said oil supply passage means including at least one supply channel means in said outer member and at least one supply passge in communication with a V-shaped annular groove opening into said fluid chamber, said O-ring valve being positioned in said V-shaped groove for controlling the one-way flow of fluid from said supply passage to said fluid chamber.

2. A self-adjusting hydraulic valve lifter according to claim **1** wherein said V-shaped groove is in the outer peripheral surface of said plunger adjacent to the open end thereof and said O-ring is of an external diameter whereby, with said O-ring valve positioed in said V-shaped groove, the outer periphery of said O-ring valve will extend radially outward of the nominal outside diameter of the plunger to provide a shoulder on said plunger extending into said second bore whereby to limit axial movement of said plunger by engagement of said O-ring valve with said shoulder, and wherein said oil supply passage means further includes passage means in said plunger positioned in communication with said supply channel means in said outer member and with said supply passage, and wherein said supply passage is in said plunger.

3. A self-adjusting hydraulic valve lifter in accordance with claim **1** wherein said V-shaped groove is provided in the inner peripheral wall forming said second bore in said outer member, said V-shaped groove and said O-ring valve positioned therein being of such a diameter so as to be out of interference relationship with said plunger upon reciprocation of said plunger within said outer member.

4. A self-adjusting hydraulic valve lifter according to claim **1** wherein said V-shaped groove is in said head of said outer member at the axial end of said second bore in said boss, said V-shaped groove being concentric with said second bore, said supply passage extending axially in said head of said outer member and, wherein said valve lifter further includes a valve disc retainer positioned between said spring and said head in position to limit axial movement of said O-ring valve.

5. A self-adjusting hydraulic valve lifter according to claim **3** further including a retainer means positioned in an annular groove in the outer peripheral surface of said plunger adjacent the open end thereof to extend radially outward of said plunger into said second bore for engagement against said shoulder whereby said plunger, said O-ring valve and said spring are retained in unit assembly with said outer member.

6. A self-adjusting hydraulic valve lifter according to claim **4** further including a retainer means positioned in an annular groove in the outer peripheral surface of said plunger adjacent the open end thereof to extend radially outward of said plunger into said second bore for engagement against said shoulder whereby said plunger, said O-ring valve and said spring are retained as a unit assembly within said outer member.

7. In an overhead valve and camshaft engine having a valve with a generally upwardly extending valve stem, the housing of the engine having a lifter guide bore therein concentric with the valve stem and an engine oil supply passage extending to the lifter guide bore, a cam spaced above the valve stem and, a hydraulic valve lifter interposed between the vale stem and the cam;

said hydraulic valve lifter comprising an inverted cup-shaped outer member reciprocable in the lifter guide bore, said outer member having a central, lower bore extending from its lower end and a larger upper bore meeting said lower bore coaxially with an intervening shoulder and a head closing off the upper end of said outer member, said outer member further having an oil supply passage means extending from said lower bore to the outer periphery of said outer member in position to receive oil from the engine oil supply passage, an oppositely presented, cup-shaped, plunger having a closed head at its lower end, said plunger being reciprocably received in said lower bore with its upper end extending into said upper bore to define therewith a fluid chamber, said plunger having a V-shaped groove in the outer periphery thereof opening into said fluid chamber and a passage means therein opening at one end into the apex of said V-shaped groove and terminating at its other end in a side port in communication with said oil supply passage means in said outer member, an O-ring valve positioned in said V-shaped groove, said O-ring valve serving as a one-way check valve to control oil flow from said V-shaped groove into said fluid chamber and also serving as a shoulder extending radially outward from said plunger to limit axial movement of said plunger in one direction by engagement of said O-ring valve with said shoulder in said outer member and, a spring positioned in said fluid chamber to abut against said outer member and said plunger for normally maintaining said head of said outer member abutting the cam and said closed head of said plunger abutting the valve stem.

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