

Feb. 23, 1965

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3,170,446

VALVE ACTUATING MECHANISM

Filed Aug. 7, 1963

2 Sheets-Sheet 1

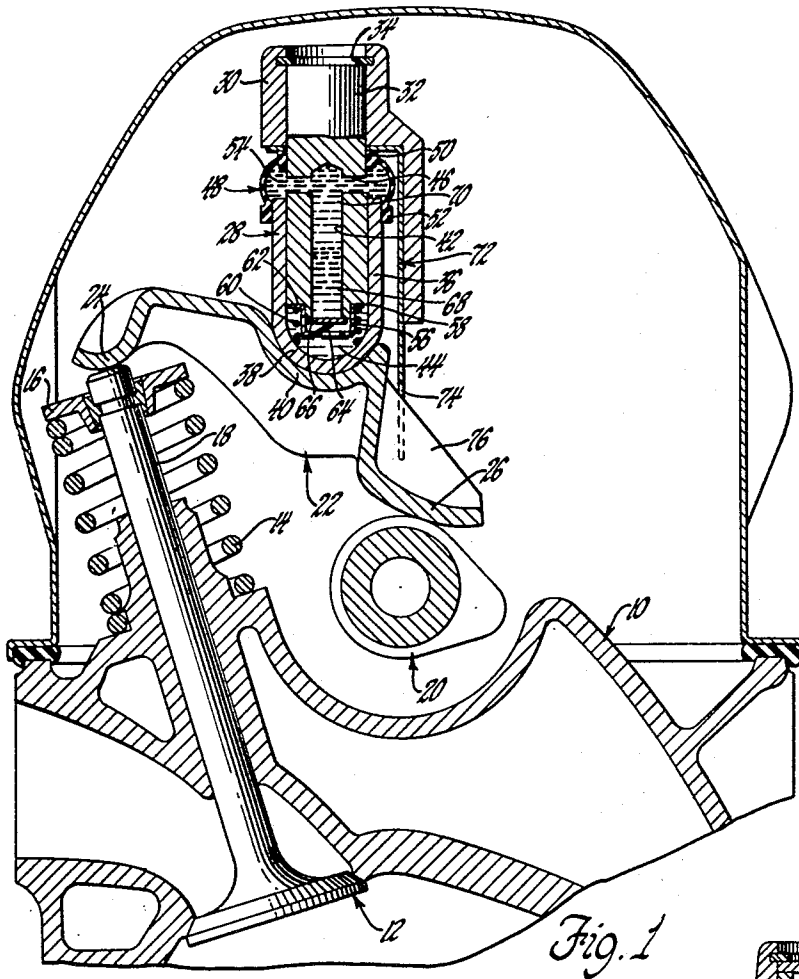


Fig. 1

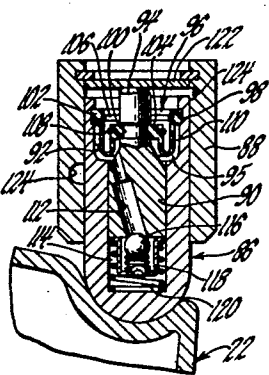


Fig. 3

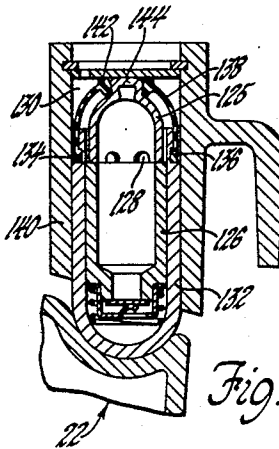


Fig. 4

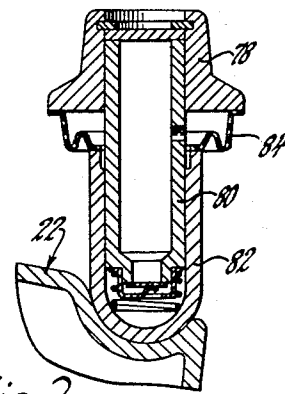


Fig. 2

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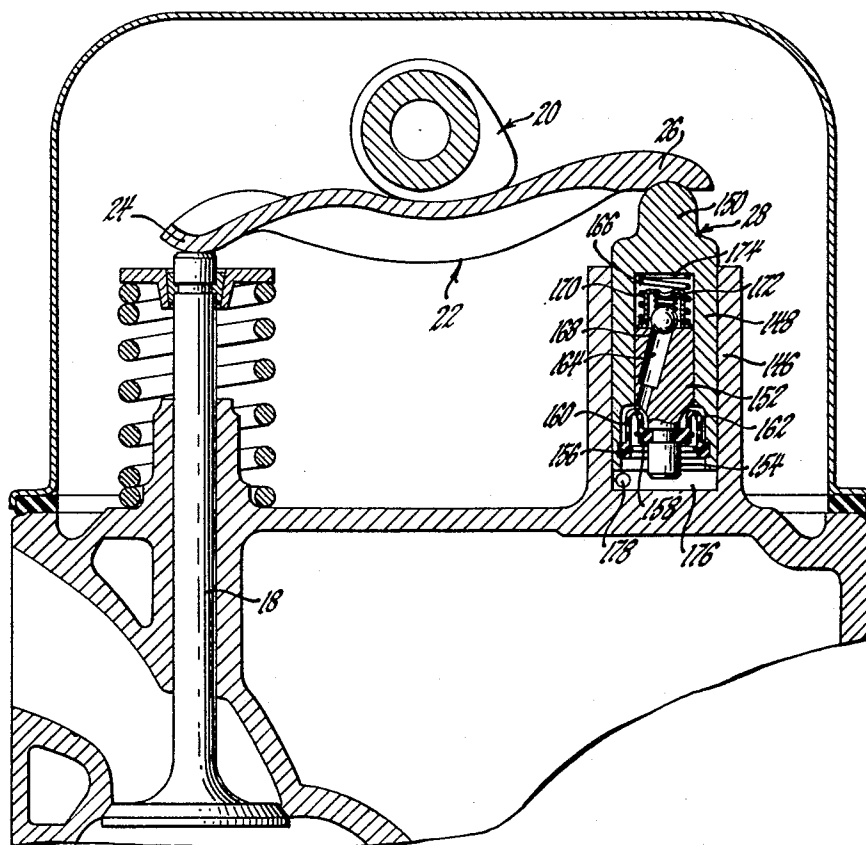


Fig. 5

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VALVE ACTUATING MECHANISM
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Filed Aug. 7, 1963, Ser. No. 300,611
4 Claims. (Cl. 123-90)

The present invention relates to a new and improved hydraulic lash adjuster and particularly of the type in which the adjuster mechanism provides a fulcrum for a valve actuating rocker arm. While not necessarily limited thereto, the present invention relates to a hydraulic lash adjuster which is especially applicable to an overhead valve camshaft engine.

It is the general purpose of the present invention to provide a hydraulic lash adjuster which provides the fulcrum for a rocker arm, further which includes a self-contained supply of fluid and is, therefore, completely independent of the engine lubricating system.

It has been the practice to supply the liquid used in an hydraulic lash adjuster from the engine oil system. The use of engine lubricating oil in hydraulic lash adjusters has several inherent undesirable characteristics which have primarily contributed to the malfunctioning of such devices. An hydraulic lash adjuster includes precision made parts which coact within close tolerances. In using engine crankcase oil, which is exposed to the products of combustion and road dirt, it is inevitable that the oil eventually contains impurities such as air, gasoline, and dirt particles which unavoidably find their way into the hydraulic lash adjusters. Such impurities and particles contribute to the malfunctioning of hydraulic lash adjusters by deteriorating parts, causing foaming, and otherwise inhibiting the free movement of parts.

A further and important problem which occurs in hydraulic lash adjuster systems utilizing engine lubricating oil results from the fact that such oil has a viscosity range which varies considerably with temperature. In other words, engine lubricating oil is relatively viscous when the engine is cold and becomes considerably less viscous as engine temperature increases. This viscosity variation creates a serious operating problem in an hydraulic lash adjuster.

Fundamentally, an hydraulic lash adjuster includes a plunger which is closely fitted so as to slide within a support structure whereby the length of the adjuster is variable to take up clearances in the valve operating system. The plunger and support must be relatively extensible and yet provide, in effect, an axially rigid structure in transmitting motion between camshaft and valve. This result is achieved by releasably trapping and transferring an incompressible fluid between chambers in the adjuster. It is apparent that the rate of transfer of such fluid between chambers is greatly affected by variations in viscosity. Part of the fluid transfer is occasioned by leakage between relatively slidable parts. Therefore, the clearance between these parts has been a compromise between that necessary to accommodate thick and thin fluid or oil.

It is, therefore, an important objective of the present invention to provide a sealed and independent fluid source for each adjuster whereby a relatively constant viscosity fluid may be utilized permitting closer tolerances between parts and a more constant operation of the adjuster.

In the present invention, a unique lash adjuster construction is achieved whereby a completely sealed source of fluid is provided for each adjuster and assumes a more accurate, trouble-free operation than has previously been available in such devices.

It is an important aspect of the present invention that the hydraulic lash adjuster is not associated with the

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other elements of the valve operating mechanism so as to be reciprocable with the periodic movement of the camshaft. In other words, while the overall length of the adjuster is variable in accordance with changes in size of the various components, due to variations in ambient operating conditions, the adjuster is mounted as a relatively fixed member so as not to be subjected to reciprocating movement. Reciprocating movement of a hydraulic lash adjuster, as normally occurs when such adjuster is placed in the operative line of movement between a camshaft and push rod, creates severe operating problems for the adjuster which heretofore has made a sealed system commercially impractical. Rapid reciprocation of an hydraulic lash adjuster creates serious problems of sealing which may fail and cause the loss of the fluid within the lash adjuster.

It is, therefore, an object of the present invention to provide a non-reciprocating hydraulic lash adjuster having a sealed and independent source of fluid which permits the use of a relatively stable viscous medium throughout the temperature operating range of an engine.

It is also an important object of the present invention to provide an expandable fluid reservoir within the lash adjuster whereby variations in the overall length of the adjuster may be accommodated without creating internal fluid pressures of a sufficient value to otherwise upset the normal functioning of said adjuster.

Other objects and advantages of the present invention will be apparent from a perusal of the detailed description taken in conjunction with the drawings which follow.

In the drawings:

FIGURE 1 is a partially sectioned elevational view of an overhead valve camshaft engine embodying the subject invention.

FIGURE 2 is a modified form of the invention shown basically in FIGURE 1.

FIGURE 3 is a further modification of the basic invention in which the axially movable plunger is supported directly within a bracket member rather than on an intermediate stud member.

FIGURE 4 is a modification of the form of invention shown in FIGURE 3.

FIGURE 5 is a further modification of the invention. Referring to FIGURE 1 of the drawings, an engine cylinder head is indicated generally at 10 and includes a valve member 12 reciprocably disposed therein. For purposes of the present invention, valve 12 may be either an inlet or an exhaust valve and is biased into a closed position by a coiled spring 14 disposed between the cylinder head and a retainer washer 16 fixed to the upper end of valve stem 18.

While the present invention is not limited to an engine construction in which the camshaft 20 is disposed overhead, it is particularly useful with this type of engine. In other words, the camshaft may be disposed in the lower portion of the cylinder block with its motion being transmitted to rocker arm 22 through a push rod. However, in the engine with which the subject invention is illustrated, rocker arm 22 includes arcuate ends 24 and 26 which coact respectively with valve stem 18 and camshaft 20.

An hydraulic valve lash adjuster is indicated generally at 28 and is supported upon a fixed bracket member 30 secured to or formed integrally with cylinder head 10. In the modification of FIGURE 1, lash adjuster 28 includes a stem member 32 pressed within a corresponding opening formed in bracket 30 and locked therewithin by a split ring retainer 34. The lower end of stem 32 projects considerably below bracket 30 so as to provide clearance for slidably receiving a cylindrical sleeve plunger member 36 which is open at its upper end and termi-

rates in closed arcuately shaped portion 38 at its lower end. The arcuate or bearing end 38 of slidable plunger 36 is adapted to coact with a correspondingly shaped bearing portion 40 formed on rocker arm 22.

Stem 32 includes a coaxially extending passage 42 which communicates at its lower end with a chamber 44 formed by the stem and slidable plunger member 36. The other end of passage 42 communicates with diametrically extending passage 46. A flexible diaphragm seal member 48 includes annular bead portions 50 and 52, which respectively coact with stem 32 and the upper end of plunger 36 to define an expandable or variable capacity chamber 54.

A perforate cage member 56 includes a flange portion 58 biased by a coil spring 60 against a radial shoulder 62 formed proximate the lower end of stem member 32. The other end spring 60 biases against the inner surface of the arcuate end 38 of slidable plunger 36. Cage 56 includes an inwardly offset tab 64 which supports a disc member 66 in an off-center relationship whereby the disc operates as a valve to admit fluid to chamber 44 when plunger 36 moves downwardly away from stem 32 and closes when the movement of the plunger is in the opposite direction.

Chambers 44 and 54, as well as passages 42 and 46, constitute a sealed reservoir and are adapted to be filled with a suitable fluid whereby the overall length of the adjuster may be varied by relative movement between plunger 36 and fixed stem 32 such that rocker arm ends 24 and 26 may be maintained at zero clearance with respect to valve stem 18 and camshaft 20.

As already noted, crankcase oil is used for normal engine lubrication purposes and is continuously supplied to present commercial hydraulic lash adjusters. This oil is relatively unstable from the point of view of viscosity. On the other hand, oils or related fluids which are relatively viscosity-stable are relatively expensive and not necessarily suitable for the lubrication of high-load engine parts. Thus, under cold starting conditions a hydraulic lash adjuster supplied with crankcase oil is apt to be relatively stiff operating, causing adjuster operation to lag behind clearance requirements of the valve operating mechanism in maintaining the aforementioned zero clearance or non-lash coaction of the rocker arm with the camshaft and valve stem. As a result, for a limited time after starting the engine, clearance may develop between these members, causing the valve operating mechanism to "knock."

Since the present invention provides a construction in which the fluid contained in each of the lash adjusters is independent of and isolated from the general engine lubricating system and further in which limited quantities of fluid are required, a more viscosity-stable liquid may be utilized. For instance, the subject hydraulic lash adjuster has been designed to permit the use of a silicone liquid which has high viscosity stability throughout the engine temperature operating range. Consequently, without series viscosity fluctuations, the relatively slidable surfaces of the adjuster may be more economically manufactured to tolerances that will permit the desired amount of leakage under the full range of operating conditions.

In operation, when it is necessary for the relative length of the hydraulic adjuster to be increased to maintain the aforementioned non-lash coaction between the various valve operating members, spring 60 will urge the slidable plunger member 36 downwardly whereby a fluid pressure differential is created across valve 66 causing the same to open and admit a limited quantity of fluid from passage 42 into chamber 44 until the rocker arm portions 24 and 26 respectively engage valve stem 18 and camshaft 20. As the valve mechanism operates, a limited amount of leakage of the fluid in chamber 44 will occur between the inner wall of plunger 36 and the outer wall of stem 32 whereby such fluid will flow upwardly into the chamber 54 and hence inwardly through

diametral passage 46 back into stem passage 42. Such controlled leakage within the closed hydraulic circuit also provides proper lubrication for the relatively sliding surfaces.

Under other operating conditions, such as when the engine is shut down and where valve 12 may be stopped in an open position, valve spring 14 creates an upward or clockwise moment on rocker arm 22 about the point of engagement with camshaft 20 and, in turn, imposes a vertical force on slidable plunger 36. Such force will maintain the fluid in chamber 44 under sufficient pressure to cause the same to leak between the plunger and the stem and thereby flow into the expandable chamber 54. Since disc valve 66 is maintained, closed circulation of the fluid in the system is prevented and the displaced liquid volume is accommodated by the flexure of seal 48. As a result, the overall length of adjuster 28 is shortened as spring 14 moves valve 12 to a closed position. After valve 12 becomes seated against cylinder head 10, adjuster spring 60, acting in the opposite direction to valve spring 14, will maintain the rocker arm in abutting engagement with the valve and camshaft.

The simplicity of construction of adjuster 28 results in a device which, notwithstanding the normally greater cost of adjuster fluid, is at least no more expensive than present valve lash compensating devices and does achieve significant functional improvements.

To further reduce the cost of the subject type lash adjuster, it is possible to utilize two fluids of different specific gravities for a composite adjuster fluid. To illustrate, the lower portion of stem passage 42 may be filled with a silicone liquid 68, while the upper portion of the passage, as well as diametral passage 46 and expandable chamber 54 may be filled with a conventional lubricating oil 70. The lubricating oil in the upper portion of the reservoir would be of a lower specific gravity than the silicone liquid and, therefore, fluid would remain stratified with the silicone on the bottom and the oil on the top. Even during operation of the adjuster with the leakage of the silicone liquid between the plunger and the stem, the heavier silicone liquid will pass underneath the lighter oil to return to the lower portion of the stem passage.

Inasmuch as the oil in the upper portion of the sealed reservoir does not circulate to any significant degree throughout the adjuster, its lesser viscosity stability in relation to the silicone fluid has no adverse effect on the functioning of the adjuster. Further, and to the extent that a limited amount of the oil might become exposed to the coating surfaces of the plunger and stem, the lubrication of these parts would be improved since such oil is normally a better lubricant than is the silicone fluid.

In the event that rocker arm 22 tends to rotate about the longitudinal axis of the adjuster, a guide member 72 may be provided. Guide member 72 includes a downwardly extending portion 74 which is bifurcated or split at its lower end so as to straddle a rib 76 on the rocker arm. In this manner the rocker arm 22 is positively restrained against the aforesaid rotary movement.

FIGURE 2 represents a modified form of the invention shown in FIGURE 1 wherein basically the same combination of elements is utilized and including support 78, a fixed stem 80, and a plunger 82. In this modification, a bellows-type expandable member 84 is utilized in place of the flexible diaphragm member 48 shown in FIGURE 1. Bellows 84 may be formed of metal, plastic, or an elastomeric material which is unaffected by exposure to the fluids used in and outside the adjuster.

In the modifications of both FIGURES 1 and 2, the side thrust forces imposed by the actuation rotating camshaft 20 are transmitted by the plunger supporting stem to the support member 30 or 78.

Reference is now made to the modification of FIGURE 3. Plunger 86 is slidably mounted directly within fixed support 88. An inner plug member 90 is relatively slidably supported within plunger 86.

Plunger 86 includes a radially relieved portion 92 formed near its upper end and which generally coacts with a radially reduced stem portion 94 of plug 90 to define an annular chamber 95 enclosed by a flexible sealing member 96. Both the plunger and plug include annular recesses 98 and 100 adapted to receive the annular lips 102 and 104 of the flexible seal member whereby the latter is retained within the adjuster assembly. To insure retention of the seal within the assembly, an outwardly expanding spring member 106 biases the seal lip 102 into engagement with the plunger and an inwardly biasing member 108 secures lip 104 to the plug. It is to be noted that the seal lips 102 and 104 are proximately disposed relative to the longitudinal axis of the adjuster so as to form a thin U-shaped portion 110 therebetween. U-shaped seal portion 110 depends within chamber 95 for purposes which will subsequently be described.

The lower end of plunger 86 is again spherically formed to provide the fulcrum support for a rocker arm, as shown in FIGURE 1.

Plug 90 includes a passage 112, communicating chamber 95 with a chamber 114 formed by the plug, and plunger 86. A ball valve member 116 is adapted to control fluid flow between chambers 95 and 114. The ball member is confined by a perforate retainer member 118 which is biased against the bottom end of plug 90 by a coiled spring 120. The other end of spring 118 seats against the inner end of plunger 86 and provides a downward or extending bias to the plunger to facilitate the zero lash or clearance relationship between the rocker arm and the coacting valve and camshaft members, supra.

Again, the flexible seal member 96 encloses a sealed fluid reservoir comprised of chamber 95, plug passage 112, and chamber 114. The reservoir is filled with a viscosity-stable fluid, such as the silicone fluid already discussed, whereby as plunger 86 is caused to move axially downwardly to increase the overall length of the adjuster, valve 116 will open to permit fluid to flow into chamber 114. During operation of the valve actuating system, a limited amount of fluid will leak from chamber 114 between plunger 86 and plug 90 into chamber 95 to be cycled back into the former chamber if the length of the adjuster is to remain the same or be increased.

Under operation conditions causing a diminution in the overall length of the adjuster, i.e. upward movement of the plunger, fluid leaking into chamber 95 will be retained therein. It is apparent that as the volume of chamber 114 is diminished, chamber 95 must experience a corresponding increase in volume. This increase in volume of the upper or storage chamber is achieved through radial collapsing, inward and outward, of the U-shaped portion 110 of seal 96.

Accordingly, the total sealed fluid volume of the adjuster remains constant even though the volume of chambers 95 and 114 vary in accordance with the axial position of plunger 86 relative to both support 88 and plug 90.

One of the difficulties in providing a sealed fluid system for a lash adjuster is to insure a transfer of fluid from the compression chamber 114 proximate the fulcrum end of the adjuster, and the storage or reservoir chamber 95 proximate the upper end of the plunger, without creating internal fluid pressure forces which will adversely affect adjuster operation. To illustrate, spring 120 urges the upper end of plug 90 into engagement with retaining disc 122. Accordingly, there is a resultant downward force urging plunger 86 in an extended direction. With the reservoir chamber at its maximum volume, as when the plunger is fully retracted, a taut sealing member would create an upward force on the plunger thereby diminishing or even overcoming the plunger-extending action of spring 120.

Ideally, flexible seal 96 should have no effect whatsoever on the functioning of spring 120. To achieve this result, seal 96 is made in a distinct bellows or pleated form whereby changing volumes of reservoir chamber 95

are accommodated by the expansion or collapsing of the walls of U-shaped seal portion 110 rather than through a stretching or tensioning of the seal member. Consequently, fluid induced deformation of seal 96 occurs without the creation of excessive forces which might otherwise tend to interfere with the control of plunger movement by spring 120.

In this modification of the invention in which plunger 86 directly slidably engages support member 88 rather than being mounted on an intermediate stem member, a distinct advantage is realized in that the vertical overall length of the adjuster may be considerably diminished. At the same time in this modification it becomes necessary to assure that the coacting surfaces between plunger 86 and support member 88 are lubricated. Such lubrication may be left to the normal splashing of rocker arm lubricant on the plunger which will, in turn, be carried up to support 88. As an alternative, engine lubricant may splash on top of retainer disc 122, which can be perforated to permit the oil to drip downwardly between the support and the plunger. A further alternative is to provide an oil passage 124 in support 88 which is supplied with engine lubricating oil to provide for proper lubrication of the plunger.

It is to be appreciated that the internal lubrication of plunger 86 and plug 90 will be achieved through the normal circulation of the sealed fluid as already described.

The modification of FIGURE 4 varies only slightly from that of FIGURE 3. In this case, the inner plug member is of a tubular construction comprising an upper portion 125 and a lower portion 126. Ports 128 are formed in portion 125 to communicate the interior of the plug with reservoir chamber 130.

Plunger 132 includes an annular groove 134 formed proximate the upper end thereof and into which fits annular bead 136 of seal 138. Thus, the lower end of the seal is retained between plunger 132 and fixed support 140.

The upper end of seal 138 includes a smaller diameter bead 142 which snaps over a button 144 formed on plug portion 125. In this form of adjuster seal spring retainers are eliminated.

It is also intended that the walls of seal 138 will be pleated or otherwise formed with an excess of material whereby the seal may freely expand without creating any significant internal fluid pressure in reservoir chamber 130 and to permit movement of plunger 132 within the support 140. Lower portion 126 moves with plunger 132 in accordance with the pressures within the assembly.

In the modification shown in FIGURE 5, the various elements are arranged in such a way that the hydraulic lash adjuster and the valve member coact with the ends of the rocker arm and the camshaft actuates said arm intermediate the ends thereof.

Referring specifically to FIGURE 5, valve stem 18 coacts with the spherical end 24 of rocker arm 22 while the hydraulic lash adjuster 28 coacts with the other end 26'. In this instance, both the valve member and lash adjuster are disposed on the same side of the rocker arm. Camshaft 20 coacts with the intermediate portion of rocker arm 22 and is disposed on the opposite side thereof relative to the valve and lash adjuster.

Lash adjuster 28 is mounted in a stationary support 146 and includes a hollow plunger 148 including a closed end having a spherical portion 150 and an open end. A plug 152 is disposed within the hollow plunger 148 so that the plunger and plug are relatively slidably related. Plug 152 includes a diametrically reduced portion which forms a stem 154 adapted to bottom within support 146. As in FIGURE 3, plunger 148 and plug stem 154 are suitably formed to receive adjacently disposed annular beads 156 and 158 of U-shaped flexible seal member 160. Once again, the plunger 148, plug 152, and seal 160 coact to form a variable volume fluid chamber 162. Reservoir 162 is communicated through a plug passage 164 with a

second variable volume chamber 166 formed by the closed end of plunger 148 and the adjacent end of plug 152. Ball check valve member 168 disposed in chamber 166 permits the contained fluid to flow from chamber 162 to chamber 166 but prevents the reverse flow. Ball member 168 is maintained in position by a retainer member 170 and a spring member 172 which normally biases the valve to a seated position.

A spring member 174 is disposed in chamber 166 to maintain retainer 170 against plug 152 and biases plug 152 and plunger 148 in axially opposite directions.

A third fluid chamber 176 is defined by support 146, plunger 148, plug 152 and seal 160. Oil from the engine lubricating system may be supplied to chamber 176 through passage 178. In some cases it is desirable to provide means to facilitate flow of fluid from the reservoir chamber 162 to chamber 166 in order to assure prompt response to a need for lash take-up. To this end, engine lubricating oil in chamber 176 will create a pressure on seal diaphragm 160 which, in turn, pressurizes the fluid contained in reservoir chamber 162. In thus pressurizing the contained fluid, the pressure drop across valve 168 is also increased whereby movement of plunger 148 away from plug 152 will cause a prompt flow of fluid into chamber 166 diminishing the likelihood of cavitation which otherwise occurs when fluid flow into said chamber lags behind plunger extension. It will be appreciated that the problem of cavitation can become particularly severe when the contained fluid is very viscous as when the engine is cold. The problem of cavitation is thus greatly diminished by the fluid pressure created in chamber 176.

The oil in chamber 176 is sealed from the contained fluid in chambers 162 and 166 by seal 160. In addition, the oil in chamber 176 provides the lubricant between plunger 148 and support 146.

I claim:

1. An hydraulic lash adjuster device comprising a fixed support, a hollow plunger member slidably supported within said support, said plunger including an open end and a closed end formed to provide a spherical seat, a stop member disposed within said support and adapted to limit the axial movement of said plunger within said support, a plug member disposed within said plunger member and including an end portion projecting through the open end of said plunger, spring means urging said plug into engagement with said stop member and also urging said plunger axially away from said support and said plug member, the closed end of said plunger and said plug forming a first variable volume fluid chamber, an expandable seal member including a first portion secured to the plunger proximate the open end thereof and a second portion secured to said plug whereby said plunger, plug, and expandable seal define a second variable volume fluid chamber, passage means formed through said plug member and communicating said first and second fluid chambers, and a valve member coacting with said passage means to permit flow from said second to said first fluid chamber and preventing flow from said first to said second chamber.

2. An hydraulic lash adjuster device as set forth in claim 1 in which sufficient clearance is provided between the relatively sliding surfaces of said plunger and said plug to permit a limited flow of fluid from said first to said second chamber when said plunger is moved toward said fixed support.

3. An hydraulic lash adjuster comprising a hollow plunger open at one end and closed at the other end, a member with which said plunger slidably coacts in a telescoping relationship, the closed end of said plunger and said member defining a first variable volume fluid chamber, an expandable seal coacting with said plunger and said member to define a second variable volume fluid chamber, a constant volume of fluid filling said chambers and sealed within said adjuster, said fluid including a first liquid having substantially constant viscosity through the ambient temperature operating range of the adjuster and a second lubricating liquid of less specific gravity than said first liquid, and valve means for controlling fluid flow between said chambers as said plunger slides relative to said member.

4. An hydraulic lash adjuster comprising a hollow plunger open at one end and closed at the other end, a member with which said plunger slidably coacts in a telescoping relationship, the closed end of said plunger and said member defining a first variable volume fluid chamber, an expandable seal coacting with said plunger and said member to define a second variable volume fluid chamber, means biasing said plunger axially away from said member, first and second passage means interconnecting said chambers, said second passage means being formed by limited clearance between the slidably coacting surfaces of said plunger and said member, a one-way valve coacting with said first passage means to permit fluid to flow from said second to said first chamber as said plunger moves axially away from said member, and a fluid including a first liquid having substantially constant viscosity throughout the ambient temperature operating range of the adjuster, and a second lubricating liquid of less specific gravity than said first liquid, said first liquid being primarily contained in said first variable volume chamber, said second passage means being restricted whereby as said plunger is moved toward said member fluid will leak through said second passage means from said first to said second chamber.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,170,446

February 23, 1965

John Dolza

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 58, for "series" read -- serious --.

Signed and sealed this 3rd day of August 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents