Feb. 24, 1959 E. A. THOMPSON 2,874,684

VALVE LIFTER STRUCTURE

Filed Jan. 20, 1954 4 Sheets-Sheet 1

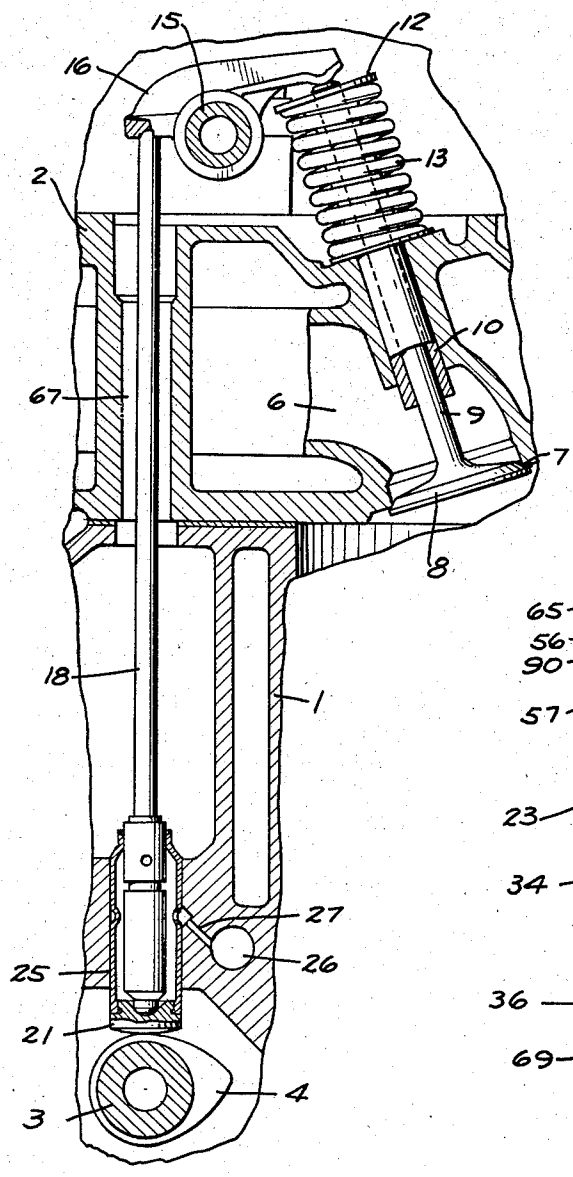


FIG. 1

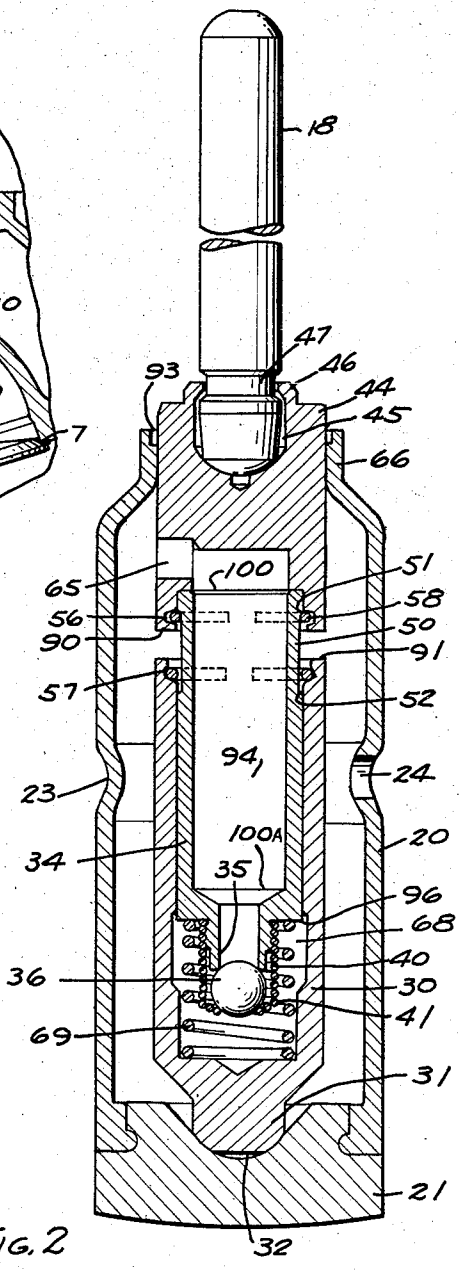


FIG. 2

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VALVE LIFTER STRUCTURE

Filed Jan. 20, 1954 4 Sheets-Sheet 2

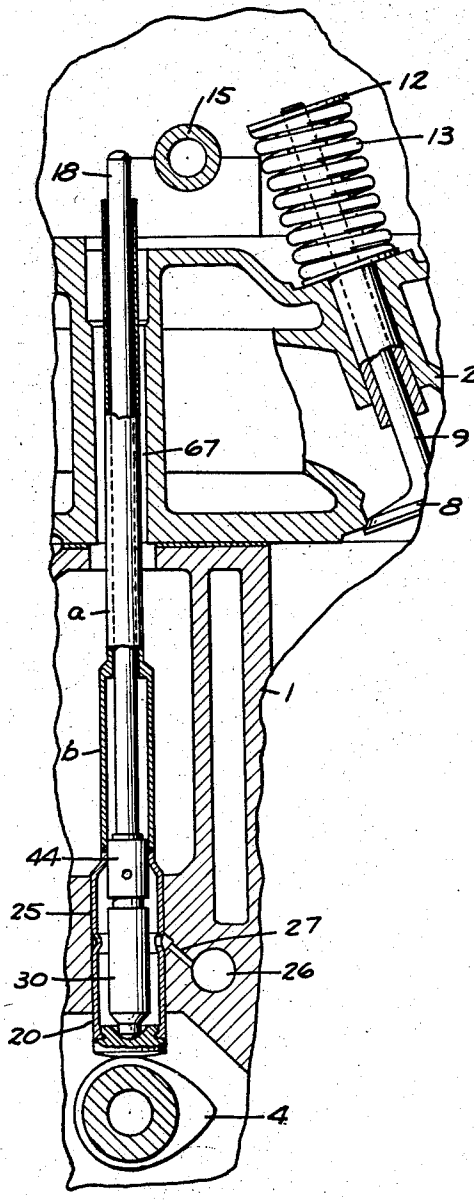


FIG. 3

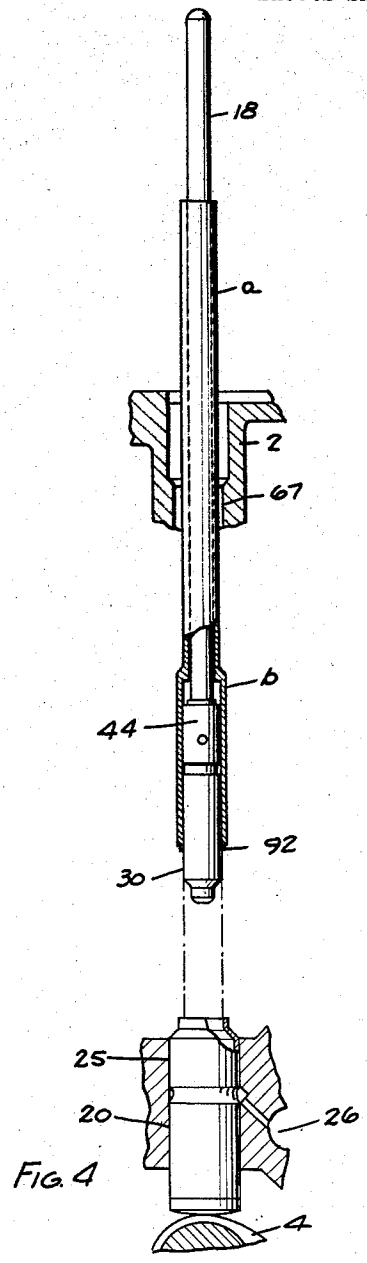


FIG. 4

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VALVE LIFTER STRUCTURE

Filed Jan. 20, 1954 4 Sheets-Sheet 3

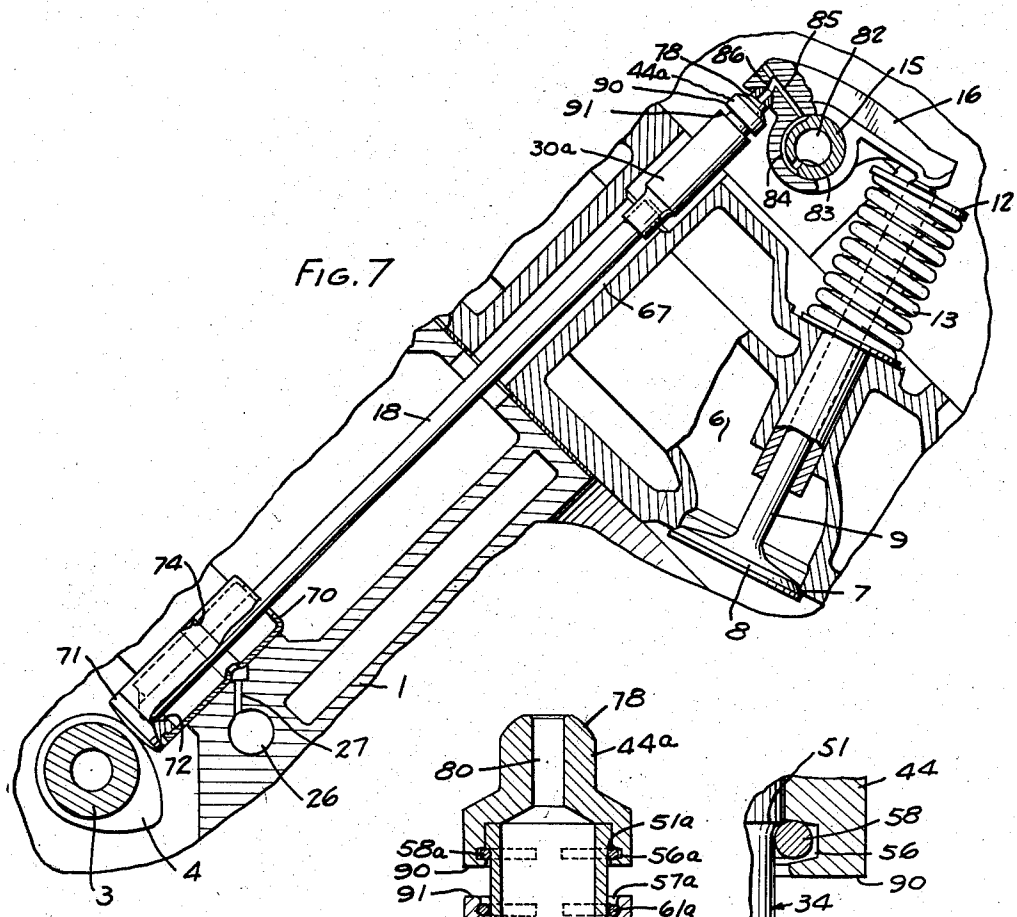


FIG. 7

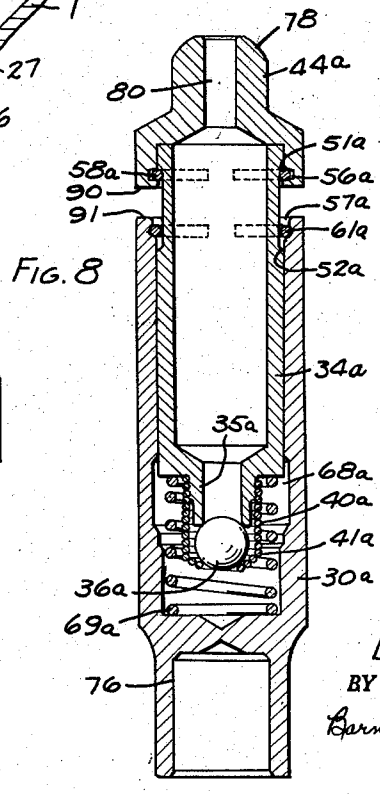


FIG. 8

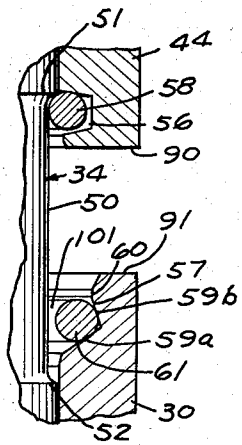


FIG. 5

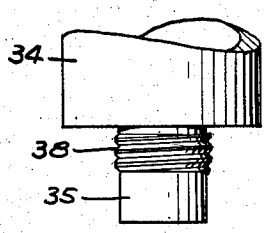


FIG. 6

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VALVE LIFTER STRUCTURE

Filed Jan. 20, 1954 4 Sheets-Sheet 4

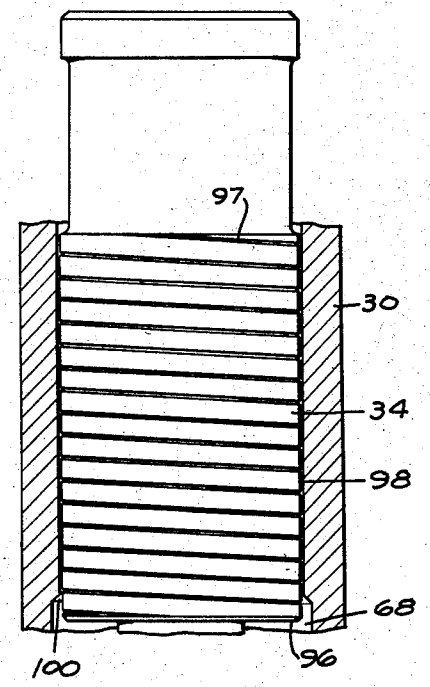


FIG. 9

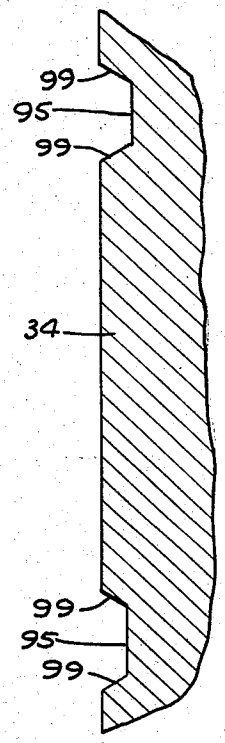


FIG. 10

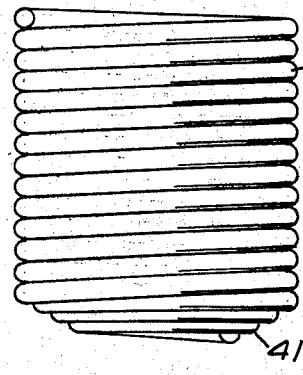


FIG. 11

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United States Patent Office 2,874,684 Patented Feb. 24, 1959

2,874,684

VALVE LIFTER STRUCTURE

Earl A. Thompson, Ferndale, Mich.

Application January 20, 1954, Serial No. 405,088

25 Claims. (Cl. 123—90)

This invention relates to means for operating poppet valves of engines. The poppet valves are usually closed by one or more springs and are opened against the spring or springs by mechanical means sometimes referred to as valve lifters.

The invention herein aims to provide an improved valve lifter structure of the so-called hydraulic type. Such valve lifting structure embodies mechanical parts with an intervening body of hydraulic medium, such as oil, wherein the oil transmits thrust between the lifting elements or cam and the valve member.

In accordance with the invention an improved hydraulic lash adjustor assembly is provided which may be connected to the valve push rod so that the said rod and assembly can be inserted in, or removed from, the engine as a unit. The assembly is arranged so that parts thereof may be assembled or disassembled in an efficient and economical manner. The assembly is further constructed and arranged so that the parts thereof which may, in use, become defective, may easily and quickly be removed and repaired for easy insertion or replaced by new parts.

The invention further contemplates a valve lifter structure wherein the hydraulic lash adjustor assembly can be visually examined without being disassembled and while in its operative position in the engine, to determine whether or not the hydraulic unit is working. This object is accomplished by providing the hydraulic lash adjustor assembly with normally spaced external stops which limit the amount that the lash adjustor can be compressed and which act as a tell-tale for trouble. If the gap between the stops is closed, then one is apprized of the fact that the hydraulic unit is not working.

Since the oil in a hydraulic valve lifter often becomes areated, for example, when the engine oil supply becomes low, the oil chamber in the hydraulic lash adjustor assembly becomes partially or completely filled with air thus causing the hydraulic valve lifter to shorten and operate noisily. Therefore the volume of the oil chamber in the hydraulic lash adjustor assembly should be kept as small as possible so that when the oil is replenished the rate of oil interchange in the oil chamber is high and the air purged therefrom quickly. This invention contemplates a hydraulic lash adjustor assembly which, whenever the oil supply fails or is aerated, will operate successfully to open the engine valves without damage to the lifter until the oil supply is replenished.

It is also an object of this invention to produce a hydraulic lash adjustor assembly which is comparatively free from clogging due to the presence in the oil system of the engine of the usual foreign ingredients or bodies contained therein such, for example, as small machining particles and dust. This object is achieved by arranging the hydraulic unit so that it will freely pass through the unit those particles of a size which normally cause sticking or binding between the piston and cylinder in the hydraulic lash adjustor assembly.

The invention will be better understood by reference to the following description in conjunction with the accompanying drawings:

Fig. 1 is a view largely in cross section showing a valve and lifter structure of an engine of the overhead valve type.

Fig. 2 is an enlarged cross sectional view of the assembly associated with the push rod.

Fig. 3 is a view illustrating the parts shown in Fig. 1 and demonstrating the manner in which some of the parts may be removed.

Fig. 4 is a view similar to Fig. 3 illustrating some of the parts partially removed.

Fig. 5 is an enlarged detail view illustrating structure for holding some of the parts in assembly.

Fig. 6 is a view illustrating a construction for the check valve cage.

Fig. 7 is a sectional view showing the lifter assembly mounted adjacent the valve rocker arm and associated with the upper end of the push rod.

Fig. 8 is an enlarged sectional view showing details of the construction employed in the form shown in Fig. 7.

Fig. 9 is an enlarged elevational view of the lash adjustor plunger showing the external helical groove in the plunger for dirt removal. This view also shows in section a portion of the lash adjustor cylinder.

Fig. 10 is an enlarged detail sectional view showing the dirt groove.

Fig. 11 is an elevational view of the retainer cage for the ball check valve.

Some of the construction of an internal combustion engine is shown in Fig. 1 including a part of the engine block 1 and the head 2. A cam shaft 3 is shown with a cam 4 thereon for operating the valve shown, it being understood that the cam shaft has a cam for each valve. The engine head is formed with a passage 6 with a valve seat 7. The valve has a head 8 and a stem 9 which is slidably situated in a sleeve 10, and on the stem is a washer 12. A coil spring 13 is positioned between the engine head and the washer 12 to hold the valve normally closed. The passage 6 may be for the inlet of combustible fuel or the outlet of burned gas.

For operating the valve there is a rock shaft 15 with a rocker arm 16 thereon serving as a lever, one end of which engages the stem of the valve and the other end of which engages an element commonly known as a push rod as shown at 18. The push rod is actuated by the cam and interposed between the cam and push rod is the lash take-up assembly. This assembly, as shown in Fig. 2, involves an outer shell 20 with a suitable end piece or cap 21 for engagement with the cam 4. This may be termed the tappet. The shell has an external groove or constricted portion 23 provided with one or more apertures 24. This shell is slidably disposed in an opening 25 formed in the engine block.

There is a conduit 26 which may be formed in the engine block with a branch passage 27 leading to the opening 25 so that oil may be conducted to the circumferential groove formed by the constricted portion 23 where the oil may pass through the port 24 into the interior of the member 20.

There is a sub-assembly of parts associated with the tappet, one member of which may be termed a cylinder member and is illustrated at 30. This member has a head 31 of rounded or partially spherical form which seats in the partially spherical socket 32 in the member 21. The cylinder body 30 is of hollow construction.

An inner member 34, which may be termed a piston, is slidably disposed within cylinder 30. This member is hollow as shown and it has an extension 35 which forms a seat for a check valve member advantageously in the

form of a ball 36. The exterior of the extension 35 is provided with screw threads 38 (Fig. 6). A cage for retaining the ball in position takes the form of a helix or helical winding of wire-like material as indicated at 40 (Fig. 11). One end is of a diameter such that it engages the threads 38 and, in fact, may be rotated during the assembly to engage the threads in screw fashion. The other end is constricted as shown at 41 sufficiently to provide an opening at the end of such small size as to prevent the ball from passing therethrough. The convolutions of the cage may be in abutting relationship but this is not necessary. The wire stock may be of spring or elastic metal and it may serve so that the portions of the convolutions engaging the underside of the ball, as Fig. 2 is viewed, lightly holds the ball on its seat.

A third member of the assembly is an end piece 44 with a socket 45 for receiving the lower end of the push rod and the socket and the lower end of the push rod may be hemispherically fashioned as indicated. This end piece and the push rod are held in assembly by means of an extension 46 fashioned to engage in a retaining groove 47 in the push rod.

The three members are assembled together as shown in Figs. 2 and 5. The piston member 34 has a reduced portion 50, that is, reduced in outside diameter, which terminates at a shoulder 51 at one end and a shoulder 52 at the opposite end. The end member 44 is provided with an internal circumferential groove 56, and the member 30 is provided with a groove 57. Piston 34 is held assembled with the end member 44 by a split ring 58. To make the assembly the ring 58 is first situated in the groove 56 and then the end of the member 34 is passed through the ring. The ring is preferably of elastic material and it contracts and engages under the shoulder 51. The depth of the groove 56 is sufficient to permit expansion of the spring 58 for the passage of the end of the member 34 therethrough.

The groove 57 is generally of V shape in cross section. The lower surface 59*a* and the upper surface 59*b* of the groove, in general, each take the form of a frustum of a cone. Groove 57 has its mouth or opening defined at its smallest diameter by a land 60. In making this assembly the split resilient or spring ring 61, which when free or unconfined is larger, that is, has a greater outer diameter than the space or groove 57 into which it is crowded, may be placed over the reduced section 50 of piston 34. The ring 61 may be assembled over piston 34 either before or after piston 34 has been telescoped within cylinder 30. Ring 61 is contracted inwardly toward the outer wall of reduced section 34 so that the outer diameter of ring 61 is less than the diameter of land 60. In other words, the diameter of the wire from which ring 61 is fabricated is less than the distance between land 60 and the outer face of reduced portion 50 of piston 34. As thus contracted, ring 61 is passed downwardly by land 60 into groove 57 whereupon it is permitted to expand outwardly into contact with both lower wall 59*a* and upper wall 59*b* of groove 57. When ring 61 is in contact with both walls 59*a* and 59*b*, it extends inwardly beyond the inner wall 30*a* of cylinder 30 and overhangs shoulder 52 at the lower end of reduced section 34 and thus releasably locks the cylinder and plunger together. Thus, the diameter of the wire from which ring 61 is fabricated is sufficiently great so that when the ring contacts both walls 59*a* and 59*b*, ring 61 overhangs shoulder 52 but at the same time there is a gap as at 101 between the inner circumference of ring 61 and the outer face of reduced section 50 of piston 34. It is this last mentioned gap which permits the ring 61 to be contracted and thus clear land 60 upon removal of ring 61 from groove 57. To disassemble piston 34 from cylinder 30, ring 61 is contracted to a slightly smaller diameter than land 60 so that it clears land 60 and may be withdrawn from the groove 57 either with or without piston 34. After ring 61 is removed, piston 34 can be slipped out of cylinder 30.

The end member 44 has a port 65 which establishes a passage interconnecting the interior of the tappet member 20 and interior of the hollow member 34. The upper end of the member 20 is contracted as shown at 66 for slidably engaging the end member 44.

The two members 30 and 34 thus define a chamber 68 for the reception of hydraulic medium, and acting between the two members is a spring 69 advantageously positioned in the chamber. The spring normally urges the members in a direction such as to enlarge the chamber and thus take up looseness or lash in the system between the cam 4 and the valve stem 9.

In the operation of the apparatus, oil under pressure, which may be supplied from the pressure lubricating system of the engine, flows through the passage 26, the passage 27, and through the port 24 into tappet member 20. The oil also flows through port 65 into the interior of the piston 34 and to the check valve 36. The oil flows through the check valve and fills the cavity 68. As the cam lifts the tappet, the body of oil in the cavity 68 is subjected to compressive forces and since the check valve is closed, thrust is transmitted through the oil in chamber 68 from member 30 to member 34. This thrust is transmitted by the push rod to the valve rocker arm. Normally, the chamber 68 is maintained full of oil. The pressure in cavity 94 within piston 34 is relatively light and allows full seating of the valve 8. The spring 69 normally takes up any looseness or lash in the system and oil may enter the cavity 68 through the ball check valve on the downstroke of the mechanism or when the tappet lies on the dwell of the cam. There is a small clearance of the order of twelve hundred thousandths (.00012) of an inch between piston 34 and cylinder 30. This clearance provides a very restricted passageway through which oil under pressure may leave cavity 68.

A gap is provided between the lower edge or face 90 of cap member 44 and the upper edge or face 91 of cylinder 30. This gap preferably will be in the neighborhood of one-tenth of an inch when the lash adjustor assembly is installed in an engine and when not installed in an engine the ends 90, 91 are spread apart their maximum distance (about .168 inch) with shoulder 51 abutting ring 58 and shoulder 52 abutting ring 61. With the lash adjustor mounted in the engine, if ends 90 and 91 abut, this indicates trouble, for example, either that there is no oil or insufficient oil in chamber 68 or that piston 34 and cylinder 30 are stuck together.

The sub-assembly comprising the interconnected parts may be removed as shown in Figs. 3 and 4, should the parts need repair or replacement. This may be done by displacing the rocker arm 16 which is readily accessible at the top of the engine and by inserting over the push rod, a tubular tool *a* which may be enlarged at its inner or lower end as at *b*. The lower end of the tool is reduced as at 92 and the upper end of the tappet is counterbored as at 93 for receiving and centering the lower reduced end 92 of the tool. Adequate clearance for the tool is provided in the engine as shown at 67. However, the diameter or size of opening 67 in the engine is restricted or limited by other factors in the engine, such as the passages for coolant and the intake and exhaust passageway and further passage 67 is not always axially aligned with bore 25 in which the tappet slidably and rotatably fits. Thus, it is essential that the tool *a* have a reduced upper end so that the hydraulic lash adjustor unit can be inserted in the tappet. Also because of this limitation in the size of opening 67, it is essential to permit removal thereof that the hydraulic lash adjustor unit (44, 34, 30) have an external diameter less than the hole 67. The instant lash adjustor unit meets this requirement and thus obviates the need for taking the engine apart or partially disassembling the same each time the hydraulic lash adjusting unit has to be assembled or disassembled from

the engine. The end of the tool engages the upper end of tappet member **20** leaving the upper end of the push rod exposed, as shown in Fig. 3, and then the push rod and hydraulic lash adjustor unit, which are connected together, may be extracted as shown in Fig. 4. The tubular tool thus holds the tappet member **20** in position as the sub-assembly is drawn therefrom. The repaired assembly or a replacement assembly may be again positioned in the tappet member **20** by passing the same through the clearance in the engine structure.

Openings **67** and **25** are not always aligned. Also in a V type engine the axes of these openings will be non-vertical or inclined. If one attempted to insert push rod **18** and the hydraulic lash adjustor unit through bore **67** and into tappet **20**, difficulty would be encountered because of the universal joint between the lower end of the push rod and cap **44** which would cause the hydraulic unit to pivot downwardly about the lower end of the push rod **18**. This condition, due to the restricted size of opening **67**, would make it difficult, if not impossible, to align cylinder **30** with the mouth of the tappet **20** and insert the hydraulic unit into the tappet. In using the tool *a*, the hydraulic unit is drawn upwardly into the enlarged lower end *b* so that the hydraulic unit is held in alignment with the push rod and thus the tool *a* greatly facilitates insertion of the hydraulic unit into the tappet.

The invention, as applied in a different manner, is shown in Figs. 7 and 8. Many of the parts are the same and have the same reference characters applied although they are shown as being at a different angle. In this form the tappet member **70** is in the form of a shell having an end piece or head **71** for engagement with the cam **4**. The push rod **18** passes freely into the shell and its rounded end engages in a recess or socket **72** in the head **71**. The wall of the member **70** is fashioned inwardly as shown at **74** to receive lubricant from the passage **27** to lubricate the same as it reciprocates in the engine block.

The hydraulic sub-assembly is positioned upstairs, that is, between the upper end of the push rod and the rocker arm **16** and this assembly is shown in Fig. 8. The member **30***a* has a socket **76** for receiving with a press fit the upper end of the push rod. The inner member **34***a* may be the same as the member **34**, the same having an extension **35***a*, a ball cage **40***a*, a check valve member **36***a* in the form of a ball, and the spring **41***a* is disposed between the inner and outer members. The upper member **44***a* has a rounded head **78** for seating in one end of the rocker arm **16** as shown in Fig. 7 and it has a passage **80** therethrough. These parts may be assembled in the manner as above described by the split rings. The inner and outer members are connected by the ring **61***a* in recess **57***a* and arranged to engage shoulder **52***a*, while the end member **44***a* and member **34***a* are connected by ring **58***a* in recess **56***a*, the ring being arranged to engage shoulder **51***a*.

In this form oil under pressure from the lubricating system passes through the hollow rocker arm shaft, the passage of which is illustrated at **82**. The rocker arm shaft is provided with a port **83** which leads to a groove **84** in the rocker arm shaft which, in turn, connects to a passage **85** thence to a passage **86** in the rocker arm which communicates with the passage **80**.

In the operation of this construction, oil is pumped into the interior of the member **34***a* from where it may pass through the check valve into the cavity **68***a* and is trapped therein by the check valve so that lifting forces exerted by the cam and push rod are transmitted to the member **34***a* to actuate the rocker arm and open the valve **8**. In this structure as in that described above, oil may escape from the cavity **68***a* between the interfaces of the telescoping walls of the member **34***a* and member **30***a*. The available oil is more than enough to overcome this small loss, and oil flows into the chamber **68***a* when the follower is on the dwell or down-stroke side of the cam.

If it is necessary to replace or repair this construction, the rocker arm **16** may be displaced axially of the rocker shaft **15** and then the sub-assembly is accessible and may be removed, repaired or replaced by another assembly.

When the hydraulic lash adjustor assembly is mounted upstairs, so to speak, as shown in Fig. 7, the gap between ends **90** and **91** of cylinder **30** and cap **44***a* is visible at all times. If there is no gap between faces **90** and **91**, this is a tell-tale advising the observer either that there is insufficient oil in cavity **68** or the piston **34** is stuck in the cylinder **30**. Thus, the repairman is advised that either the hydraulic unit needs cleaning or replacement. During any temporary failure of the oil supply or during aeration of the same in cavity **68**, faces **90** and **91** of members **44** and **30** respectively, will abut and transmit thrust from cam **4** to the rocker arm without injury to the valve lifter. The abutment between faces **90** and **91** is such that the ends of members **30** and **44** will not be peened inwardly over, and bind with, piston **34** and thus there will be no tendency for the hydraulic unit to lock up due to temporary operation in the absence of sufficient oil in chamber **68**.

Small particles of dirt are always present in the lubricating oil system of an engine. These fine dirt particles may be, for example, particles left through the machining and grinding of the engine cylinder block or dust from the atmosphere or dirt brought in with lubricating oil. Perhaps the principal source of small particles of dirt in the engine oil are those which are produced by the wear of the engine parts. It is customary practice to provide an engine with an oil filter but these engine oil filters do not remove or filter out the small or almost microscopic dirt particles with which we are herein concerned and which cause operating difficulties with hydraulic valve lifters. These particles often collect and lodge at the upper end of cavity **68**, thus prevent egress of oil from the cavity and these particles also sometimes lodge between the piston **34** and the cylinder thus preventing any relative movement between the piston and cylinder necessary to lash adjustment. To obviate this effect a helical groove is provided between the cylinder and piston. This helical groove **95** is rolled or otherwise formed in the surface of piston **34** and extends from one end **96** to the other end **97** of the piston. Preferably, but not necessarily, this groove increases in depth from its inlet end **96** to its outlet end **97**. For example, the groove may have a depth of .001 inch at the inlet end **96** and uniformly and gradually increase in depth to about .003 inch at its outlet end **97**. There is also a slight radial clearance **98** of the order of .00012 of an inch between the outer wall of the piston **34** and the inner wall of the cylinder **30**. As shown in the enlarged view, Fig. 10, the groove is preferably provided with tapered side walls **99**, the included angle between which may be of the order of 60°. By way of example, the pitch of the helical groove **95** is about .0417 inch, that is, about twenty-four threads to the inch. Also by way of preference, the helix **95** is of such hand as to aid the flow of oil through the groove from the inlet end to and through the outlet end. The entrance end **96** of the groove will under all operating conditions be positioned in the upper end of chamber **68**.

Cam **4**, according to conventional practice, contacts the lower face of the head **21** of the tappet off-center, thus causing continuous axial rotation of tappet **20** during the running of the engine. This rotation of the tappet **20** is transmitted through its sliding friction joints **31**, **32** and **66** to the cylinder **30** and cap **44** respectively, and these elements in turn transmit through their sliding friction fits rotation to piston **34** and rod **18** respectively. As long as the oil in chamber **68** is under pressure, it tends to leak out of cavity **68** at all times through groove **95** and clearance **98**. Particles having a thickness or diameter larger than the depth of groove **95** at its entrance (approximately .001 inch) plus the clearance **98** (approximately .00012 inch), cannot enter the groove **95** and are

retained in cavity 68. Particles having approximately this size do not plug up the outlet of cavity 68 and do not harm the operation of the hydraulic unit. The rotation of piston 34 relative to, and within the cylinder 30 causes the inlet portion of groove 95 (that portion of the groove which extends into chamber 98) to wipe or clean the entrance end 100 of cylinder 30 around the circumference at which the oil leaves chamber 68 and enters the clearance 98 between piston 34 and cylinder 30. This wiping action removes the small particles of dirt from entrance 100 which would otherwise clog or tend to clog this entrance. Smaller particles pass into the entrance end 96 of groove 95 and, due to the rotating of piston 34, groove 95 acts as a screw and turns the particles outwardly toward outlet end 97 of groove 95 where they pass out into the cavity within tappet 20. Oil is also flowing through this groove and aids in passage of particles. Due to the fact that the groove 95 increases in depth from its inlet end 96 to its outlet end 97, any particle that gets into the groove, due to this relief, is free to move upwardly and outwardly through the groove. During the operation of the cam the oil in cavity 68 reaches a pressure of several hundred pounds as the cam acts through the lifter to open the engine valve. This, due to the elasticity of cylinder 30 which is made of steel or other suitable metal, temporarily expands the cylinder 30 slightly, particularly at its lower end. This expansion permits microscopic particles slightly larger than the clearance 98 between cylinder 30 and piston 34 to enter the clearance through entrance 100. The pressure in chamber 68 falls on the downstroke of the cam and cylinder 30 contracts slightly. This contraction would cause these particles in the entrance end of clearance 98 to lodge between and bind the cylinder and piston if it were not for the presence of groove 95 which picks up and carries away these particles which are admitted into clearance 98.

When the engine stops certain of the engine valves are held open and others closed. The hydraulic lash adjustors for those engine valves which are held open are under pressure or thrust exerted by the engine valve spring 13 through rocker arm 16 against the valve lifter rod 18 and these lash adjustors leak down, that is, the oil in chamber 68 flows out through clearance 98 and piston 34 moves downwardly into cylinder 30 until shoulders 90 and 91 abut. When the engine is again started up, these valve lifters will be noisy unless they are constructed as will be presently set forth. As the engine starts up, still referring to the lash adjustor which has leaked down, the engine cam permits the lifter to travel on its downstroke. On the downstroke of the lifter, spring 69 will raise piston 34 in cylinder 30 thereby opening check valve 36. Unless oil can enter chamber 68 by check valve 36 as spring 69 abruptly moves piston 34 upwardly, air or both air and oil will enter chamber 68 thereby giving the lash adjustor a mushy action. Further, the oil tends definitely to cling to the side walls of cavity 94 whereas the oil in the center of cavity 94 flows a bit more readily. This condition is aggravated when the engine oil is cold. Thus, on the initial downstroke of the valve lifter, the pumping action of piston 34 and cylinder 30 will in the absence of my invention, draw all of the oil out of the center of cavity 94 and create an air passageway therethrough, thus causing aeration, that is, permitting air to get into cavity 68.

As long as there is air in chamber 68, the lash adjustor will not take up the lash between cam 4 and rocker arm 16 and the lifter will be noisy. To avoid this action of the hydraulic lash adjustor unit is one of the objects of this invention. This can be accomplished by maintaining the ratio of length to diameter of cavity 94 at substantially three or more, that is, the length of cavity 94 from its bottom 100A to the upper edge 100 should be substantially three or more times the inside diameter of the plunger 34. For example, if the inside diameter of plunger 34 is $\frac{9}{32}$ of an inch and the stroke of the plunger 34 in cylinder 30 is $\frac{5}{32}$ of an inch,, then the length of the cavity 94 should be substantially $\frac{27}{32}$ of an inch as a minimum. If this minimum ratio is maintained, then upon starting the engine, oil will always be drawn into the cavity 68 immediately as the lash adjustor acts to take up lash in those lash adjustors which bled down while the engine was dead as explained above, and aeration prevented. This feature adds to the quiet operation of the instant hydraulic valve lifter under all operating conditions of the engine.

I claim:

1. A valve lifter sub-assembly for disposition between an operator and an actuator of a valve of an engine or the like, comprising, a cylindrical first member having a closed end adapted to be associated with the operator, a cylindrical second member telescopingly disposed within the first member and having an inner head, means relatively permanently uniting the two members for relative axial sliding movement, the end of the second member projecting outwardly from the first member, a third member relatively permanently secured to the projecting end of the second member, a push rod, means relatively permanently connecting the push rod and the third member, the push rod adapted to be associated with the valve actuator, the first and second members forming a chamber therebetween, the second member having a port in its head for the passage of hydraulic medium into the chamber, a check valve for closing the port to contain hydraulic medium therein for the transmission of thrust from one member to the other, and spring means acting between the first and second members tending to separate them to thereby take up looseness between the operator and the actuator.

2. The valve lifter sub-assembly as described in claim 1 characterized in that the third member has a socket in which the end of the push rod seats, the push rod having a recess therein, and means on the third member positioned loosely in the recess for securing the push rod to the third member.

3. A sub-assembly for disposition between an operator, such as a cam, and an actuator, such as a rocker arm, of an engine to operate an engine valve comprising, a first cylindrical member with a closed end, a second member of hollow form slidably fitting within the first member, the second member having a head at its inner end, the closed end of the first member and the head of the second defining a chamber, the head of the second member having a port for the flow of hydraulic medium into the chamber, a check valve for closing the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other, the first member having an internal undercut circumferential groove, the second member having a portion of relatively smaller diameter terminating in a shoulder, a resilient split ring positioned in said groove and normally expanding into the undercut groove, the cross dimension of the split ring being greater than the depth of the groove, whereby it engages said shoulder to hold the members in assembly, one side of the groove being defined by a land having a height such that the dimension from the land to the surface of the said relatively small portion is greater than the cross dimension of the split ring, whereby the split ring may be passed between the said portion of smaller diameter and the land for assembly and disassembly of the members.

4. A sub-assembly for disposition between an operator, such as a cam, and an actuator, such as a rocker arm, of an engine to operate an engine valve comprising, a first cylindrical member with a closed end, a second member of hollow form slidably fitting within the first member, the second member having a head at its inner end, the closed end of the first member and the head of the second defining a chamber, the head of the second member having a port for the flow of hydraulic medium into the

chamber, a check valve for closing the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other, one member having an undercut circumferential groove therein, the other member having a relieved portion defined by a shoulder, a resilient split ring in the groove normally under tension so that it seats itself in the bottom of the undercut groove, the cross dimension of the split ring being such that it projects from the groove to engage the shoulder on the other member to hold the members in assembly, the groove being defined by a land on one side thereof of a height such that the distance between the land and the relieved portion of the other member is greater than the cross dimension of the split ring, whereby the split ring may be passed between the land and the relieved portion for assembly and disassembly of the members.

5. A sub-assembly for disposition between an operator, such as a cam, and an actuator, such as a rocker arm, of an engine to operate an engine valve comprising, a first cylindrical member with a closed end, a second member of hollow form slidably fitting within the first member, the second member having a head at its inner end, the closed end of the first member and the head of the second defining a chamber, the head of the second member having a port for the flow of hydraulic medium into the chamber, a check valve for closing the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other, the first member having an internal undercut groove, the second member having a portion of relatively small diameter terminating in an external shoulder, a split ring positioned in the undercut groove normally expanding therein, the cross dimension of the split ring being such that it projects from the groove for engagement with the external shoulder to hold the members in assembly, one side by the groove being defined by a land, the distance between the land and the portion of relatively small diameter being greater than the cross dimension of the split ring, whereby the split ring may be passed therebetween for assembly and disassembly of the members, a third member having a hollow portion in which the projecting end of the second member is disposed, said third member having an internal groove, the second member having an external shoulder, a split ring positioned in the groove and engageable with the shoulder for holding the second and third members in assembly, a push rod, the third member having a bearing recess for receiving the end of the push rod, said push rod having a circumferential groove therein, and an extension on the third member having parts fashioned to extend into the circumferential groove to secure the push rod thereto.

6. A sub-assembly for disposition between an operator, such as a cam, and an actuator, such as a rocker arm, of an engine to operate an engine valve comprising, a first cylindrical member with a closed end, a second member of hollow form slidably fitting within the first member, the second member having a head at its inner end, the closed end of the first member and the head of the second defining a chamber, the head of the second member, having a port for the flow of hydraulic medium into the chamber, a check valve for closing the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other, the second member having its end opposite its head projecting from the first member, and having a portion of relatively reduced diameter defined by an external shoulder normally positioned within the first member and a second external shoulder adjacent its extreme end, the first member having an internal annular groove, a split ring positioned in the groove for holding the first and second members together for relative axial sliding movement and engageable with the first shoulder to prevent separation of the members, a third member having a recess into which the projecting end of the second member is disposed, said third member having an internal annular groove in its recess, and a split ring positioned in said groove and engageable with the said shoulder for holding the second and third members in assembly.

7. In a valve lifter structure of the hydraulic type for an engine or the like, an outer member, an inner member, said members being slidably interfitted with each other and forming a cavity therebetween, one member having a passage defining a valve seat for flow of hydraulic medium into the cavity, a valve member on the cavity side of the passage and arranged to engage the seat and serving as a check valve so that hydraulic medium trapped in the cavity transmits thrust delivered from one member to another a helix of wire-like material extending freely around the valve member and constituting a cage therefor, means securing one end of the helix to the member having a seat, the opposite end of the helix having a constricted portion to engage the valve member on the side thereof opposite the seat to thereby hold it in proximity to the seat.

8. In a valve lifter structure of the hydraulic type for an engine or the like, an outer member, an inner member, said members being slidably interfitted with each other and forming a cavity therebetween, one member having a passage defining a valve seat for flow of hydraulic medium into the cavity, a valve member on the cavity side of the passage and arranged to engage the seat so that hydraulic medium is contained in the cavity for the transmission of thrust from one member to another, a helix of wire-like material secured at one end to the member with the valve seat and extending around the valve seat and around the valve member, the convolutions at the opposite end of the helix being constricted to retain the valve member therein and hold it in proximity to the seat.

9. In a valve lifter structure of the hydraulic type for an engine or the like, an outer member, an inner member, said members being slidably interfitted with each other and forming a cavity therebetween, one member having a passage defining a valve seat for flow of hydraulic medium into the cavity, a valve member on the cavity side of the passage and arranged to engage the seat so that hydraulic medium is contained in the cavity for the transmission of thrust from one member to another, a helix of wire-like material, the member with the valve seat having a threaded part, one end of the helix being in threaded engagement with the part, said helix extending around the valve seat and around the valve member, the opposite end of the helix having its convolutions constricted to hold the valve member within the helix and in proximity to the seat.

10. In a valve lifter structure of the hydraulic type for an engine or the like, an outer member, an inner member, said members being slidably interfitted with each other and forming a cavity therebetween, one member having a passage defining a valve seat for flow of hydraulic medium into the cavity, a valve member on the cavity side of the passage and arranged to engage the seat so that hydraulic medium is contained in the cavity for the transmission of thrust from one member to another, a helix of wire-like material, the member with the valve seat having a threaded portion, one end of the helix being in threaded engagement with the portion and the helix extending around the seat, a ball check valve positioned within the helix, the convolutions at the opposite end of the helix being of constricted form to retain the ball therein and hold it in proximity to the seat.

11. A check valve structure comprising a member having a wall with a port which forms a valve seat, a helix of wire like material secured at one end to the member and extending around the port, a ball check valve freely fitting within the helix, the helix, at its opposite end, having means for retaining the ball therein and holding the ball in proximity to said seat.

12. A check valve structure comprising a member having a wall with a port which forms a valve seat, a helix of wire like material, the member having a portion with screw threads, the convolutions at one end of the helix being in threaded engagement with the threads on the member and the helix extending around the port, a ball check valve freely fitting within the helix, the helix, at its opposite end, having means for retaining the ball therein and holding the ball in proximity to said seat.

13. A check valve structure comprising a member having a wall with a port which forms a valve seat, a helix of wire like material, the member having a portion with screw threads, the convolutions at one end of the helix being in threaded engagement with the threads on the member and the helix extending around the port, a ball check valve freely fitting within the helix, the convolutions at the opposite end of the helix being constricted for retaining the ball therein and holding the ball in proximity to said seat.

14. A valve lifter sub-assembly for disposition between an operator and an actuator of a valve of an engine or the like, comprising, a cylinder member having a closed end, a piston member slidably fitting within the cylinder member and having a head portion within the cylinder member and an end portion projecting from the cylinder member, said members being disposed between the operator and actuator, means relatively permanently securing the members together for relative axial sliding movement, the members forming a chamber between the closed end of the cylinder member and the head portion of the piston member, the piston member being adapted to receive hydraulic medium under pressure and having a port in its head portion for the flow of hydraulic medium into said chamber, and a check valve for controlling the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other member, one of the members having a helical groove in its wall which slidably engages the other member, said groove having a greater depth at its exit than at its entrance end to form a leakage path for hydraulic medium from said chamber to the outside of said members, whereby particulate matter may escape from said chamber.

15. A tool for use in removing from a hollow tappet of an engine, a sub-assembly including a hydraulic lash adjuster and valve push rod, wherein the hydraulic lash adjuster operates within the hollow tappet, and for replacing the sub-assembly comprising, an elongated hollow body having a portion for telescoping over the push rod and an end portion for telescoping over the hydraulic adjuster, said tool adapted to be passed over the adjuster and push rod assembly and having an extreme end part for engaging the tappet, whereby the tappet may be held in position while the push rod and adjuster assembly are withdrawn therefrom.

16. The tool as described in claim 15 characterized in that the end of the hollow tool which telescopes over the adjuster assembly has an extreme end wall portion of reduced diameter adapted to engage a correspondingly shaped part of the tappet.

17. The method of removing a valve push rod and a hydraulic lash adjuster sub-assembly from a valve tappet of an engine, wherein the tappet is hollow and the hydraulic adjuster fits within the tappet, which comprises, passing a hollow tool through clearance parts of an engine with the tool passing over the push rod and adjuster, the tool having a part for engaging the tappet with the end of the push rod exposed, holding the tappet in place by means of the tool and withdrawing the push rod and hydraulic adjuster to position the adjuster within the hollow tool, whereby the sub-assembly and the tool may be removed with the tappet remaining in position.

18. The method of assembling a push rod and hydraulic lash adjuster for a valve of an engine wherein a hollow tappet lies in the engine which comprises, placing the push rod and the hydraulic adjuster in an elongated hollow tool, passing the elongated hollow tool into the engine and engaging the end thereof with an end of the hollow tappet, whereby the tool serves as a guide, and then pushing the valve stem and adjuster assembly axially of the tube to move the hydraulic adjuster into the tappet, and then removing the tool.

19. The combination claimed in claim 8 wherein the helix is a tension spring and yieldably holds said valve member against its seat.

20. In a valve lifter structure of the hydraulic type for an engine or the like, an outer member, an inner member, said members being slidably interfitted with each other and forming a cavity therebetween, one member having a passage defining a valve seat for flow of hydraulic medium into the cavity, a valve member on the cavity side of the passage and arranged to engage the seat so that hydraulic medium is contained in the cavity for the transmission of thrust from one member to another, a helix of wire-like material operatively connected to the said member with the valve seat so that the helix moves with the said member, said helix extending around the valve seat and around the valve member, the convolutions at the opposite end of the helix being constricted to retain the valve member therein and hold it in proximity to the seat.

21. A valve lifter structure for operating a valve of an engine or the like having an operating cam and an actuator for the valve, comprising a hollow cylindrical valve tappet member having an end portion for engagement with the cam, said member having a port for the flow of hydraulic medium thereinto, a cylinder member having a head at one end in engagement with the said end of the tappet member, the inner face of the end portion of the tappet having a socket in which the head of the cylinder member is seated, a piston member in the cylinder member, means relatively permanently securing the cylinder and piston members together for lengthwise sliding movement, said piston member projecting from the cylinder member, a third member, means relatively permanently securing the projecting end of the piston member to the third member, the third member being slidably mounted in the upper end of the tappet member whereby the third member slides in the upper end of the tappet member whenever the piston member slides lengthwise of the cylinder member, a push rod, means relatively permanently connecting the third member and the push rod, said push rod being adapted for association with the actuator, the cylinder and piston members defining a chamber therebetween, the piston member having a port in its head, there being a passageway for the flow of hydraulic medium from the hollow tappet member to the piston member, a check valve for closing the port to contain liquid in the chamber for the transmission of axial thrust from the cylinder member to the piston member, whereby the cam may operate the actuator, and a spring acting between the cylinder and piston members to take up clearance between the cam and the actuator.

22. A valve lifter structure for operating a valve of an engine or the like having an operating cam and an actuator for the valve, comprising a hollow cylindrical valve tappet member having an end portion for engagement with the cam, said member having a port for the flow of hydraulic medium thereinto, a cylinder member having a head at one end in engagement with the said end of the tappet member, the inner face of the end portion of the tappet having a centrally located socket in which the head of the cylinder member is seated, a piston member in the cylinder member, means relatively permanently securing the cylinder and piston members together for lengthwise sliding movement, said piston member projecting from the cylinder member, a third member, means relatively permanently securing the projecting end of the piston member to the third member,

the upper end of the tappet member being reduced in diameter for slidably receiving the said third member, the inside diameter of the tappet below said reduced upper end being greater than the outer diameters of said third cylinder and piston members whereby a space is provided between the said three members extending from the reduced upper end of the tappet to the lower end of the tappet member, a push rod, means relatively permanently connecting the third member and the push rod, said push rod being adapted for association with the actuator, the cylinder and piston members defining a chamber therebetween, the piston member having a port in its head, there being a passageway for the flow of hydraulic medium from the hollow tappet member to the piston member, a check valve for closing the port to contain liquid in the chamber for the transmission of axial thrust from the cylinder member to the piston member, whereby the cam may operate the actuator, and a spring acting between the cylinder and piston members to take up clearance bewteen the cam and the actuator.

23. A check valve structure comprising a body member having a passage therethrough, an annular seat forming one end of the passage, means forming a cylindrical threaded surface on the body concentric with and larger in diameter than the seat, a circular valve member engageable with the seat to seal the passage against flow in one direction, and a helical spring having portions of large and of small diameter, the large diameter portion being engaged with the thread and the small diameter portion being in engagement with the valve member to resiliently hold the valve member on the seat.

24. A check valve structure comprising a body member having a passage therethrough, an annular seat forming one end of the passage, means forming a cylindrical threaded surface on the body concentric with and larger in diameter than the seat, a circular valve member engageable with the seat to seal the passage against flow in one direction, and a helical spring having portions of large and of small diameter, the large diameter portion being engaged with the thread and the small diameter portion being in engagement with the valve member to resiliently hold the valve member on the seat, said spring and body member each having portions cooperating to form a cage for retaining the valve member in operative position.

25. A valve lifter sub-assembly for disposition between an operator and an actuator of a valve of an engine or the like, comprising a cylinder member having a closed end, a piston member slidably fitting within the cylinder member and having a head portion within the cylinder member and an end portion projecting from the cylinder member, said members being disposed between the operator and actuator, means relatively permanently securing the members together for relative axial sliding movement, the members forming a chamber between the closed end of the cylinder member and the head portion of the piston member, the piston member being adapted to receive hydraulic medium under pressure and having a port in its head portion for the flow of hydraulic medium into said chamber, and a check valve for controlling the port to contain hydraulic medium in the chamber for the transmission of thrust from one member to the other member, one of the members having a helical groove in its wall which slidably engages the other member, to form a leakage path for hydraulic medium from said chamber to the outside of said members, whereby particulate matter may escape from said chamber, said sub-assembly being adapted to rotate on its axis in use, and being further characterized in that the helical groove is of such a hand as to act to advance the particulate material through the groove toward its outlet end.

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