United States Patent

Miller, Jr.

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[54] **THERMO-COMPENSATING VALVE LIFTER FOR INTERNAL COMBUSTION ENGINES**

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[52] **U.S. Cl.** **123/90.19,** 123/90.35, 123/90.54, 123/90.55

[51] **Int. Cl.** **F01l 1/14,** F01l 1/00, F01l 1/22

[58] **Field of Search** 123/90.19, 90.35, 90.54, 90.55; 184/6

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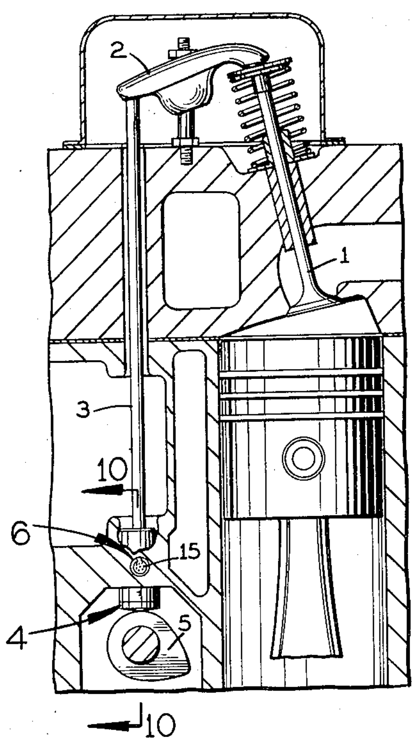
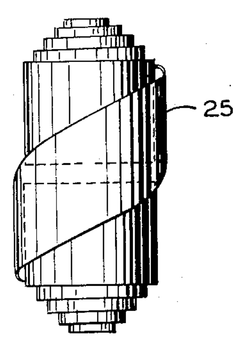
Attorney—Lloyd J. Andres

[57] **ABSTRACT**

A valve lifter for an internal combustion engine embodying a screw member rotated by a thermally responsive control element for holding predetermined clearance in a valve train substantially constant over a relatively wide temperature gradient and including means for positively conducting pressurized lubricant to the entire train.

6 Claims, 19 Drawing Figures





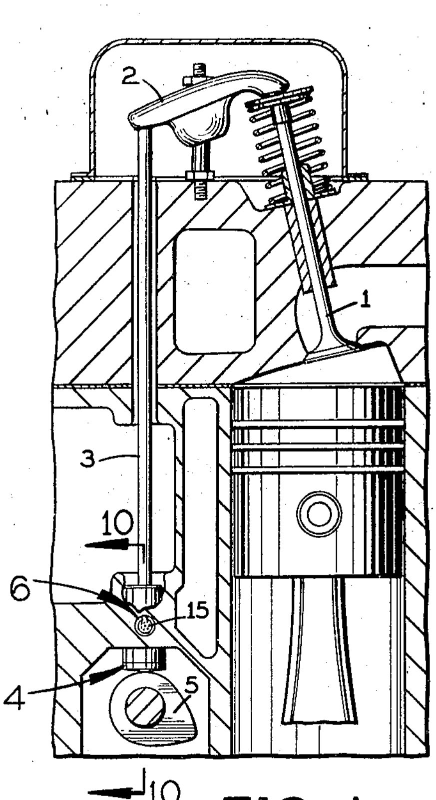


FIG. 1

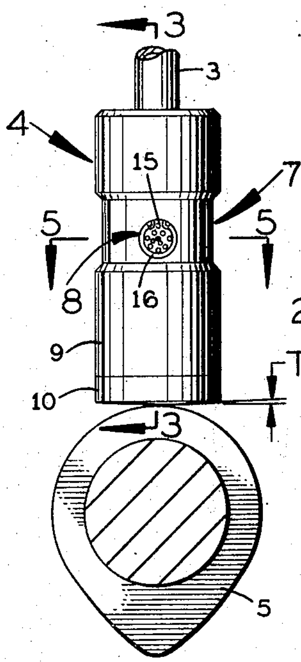


FIG. 2

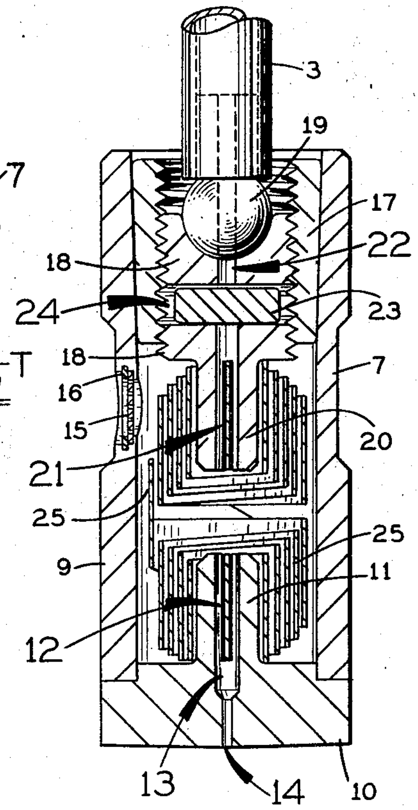


FIG. 3

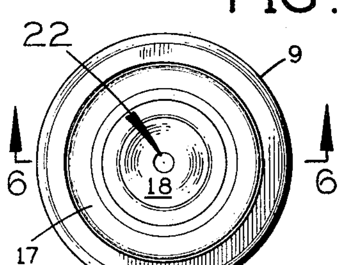


FIG. 4

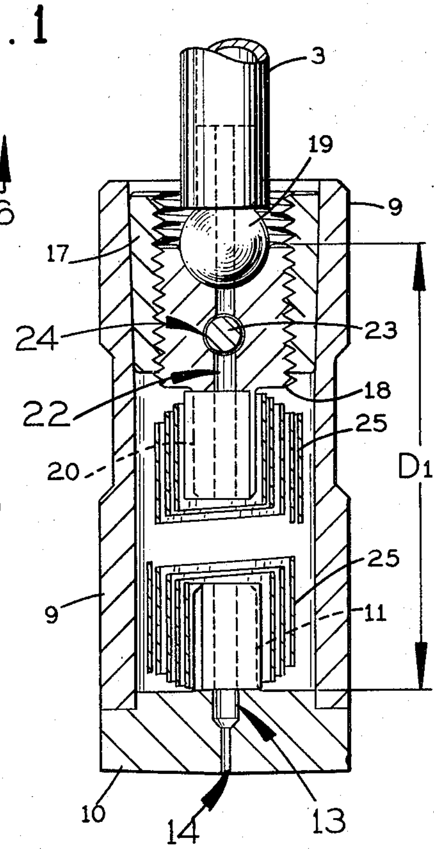


FIG. 6

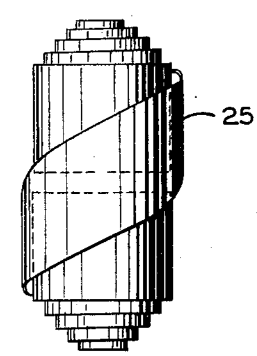


FIG. 7

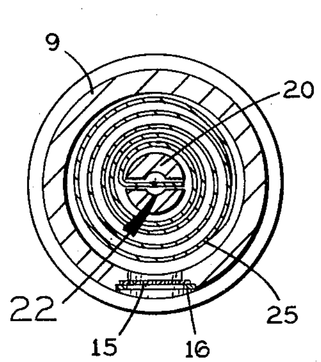


FIG. 5

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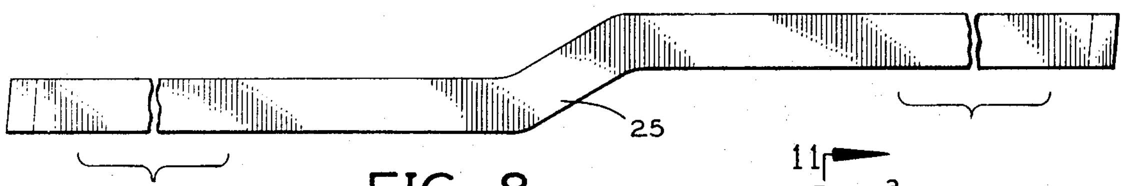

FIG. 8

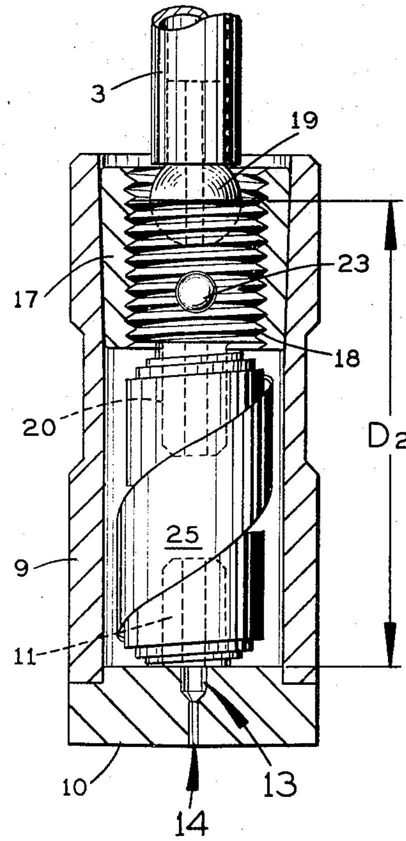

FIG. 9

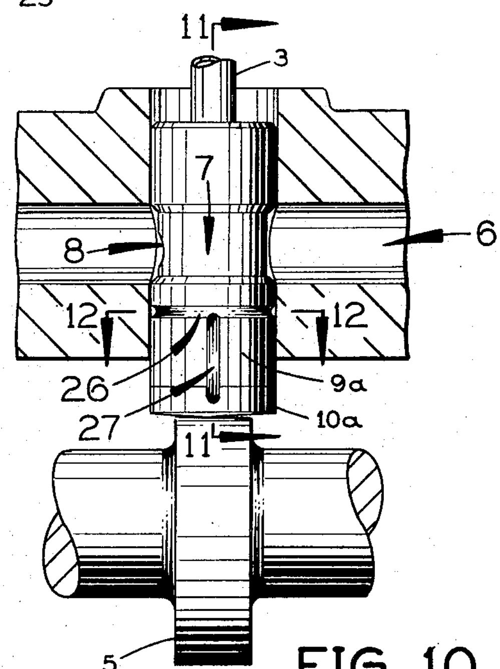

FIG. 10

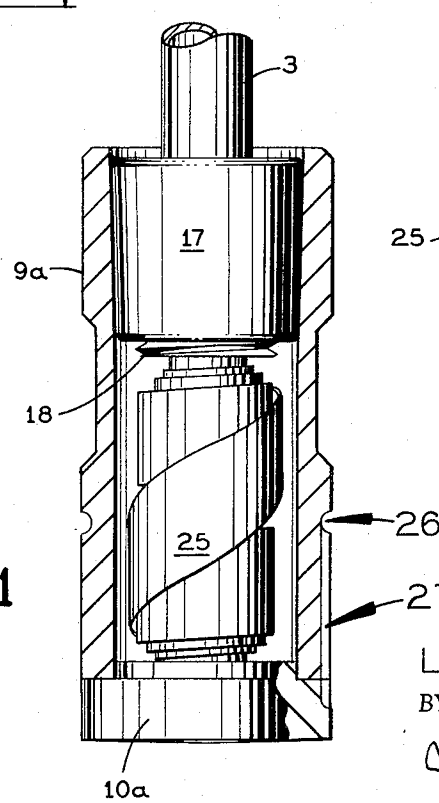

FIG. 11

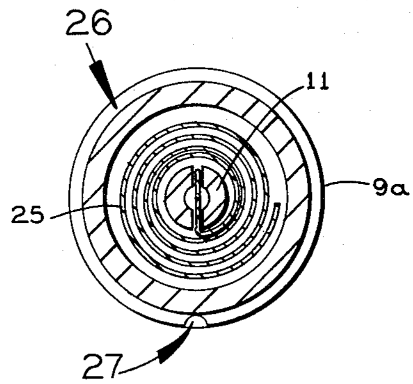

FIG. 12

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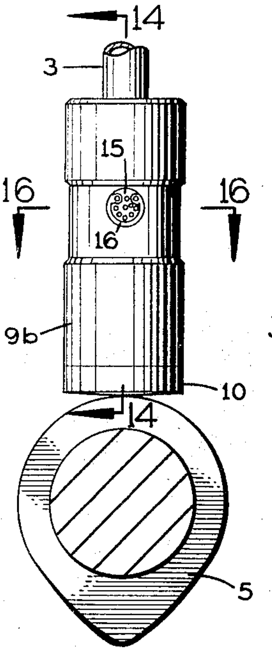

FIG.13

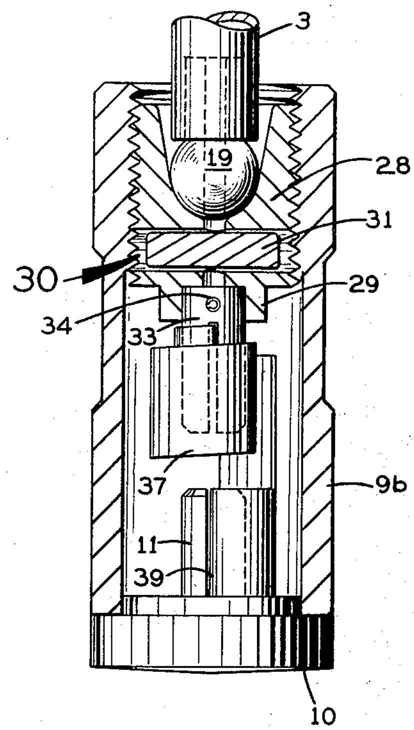

FIG.15

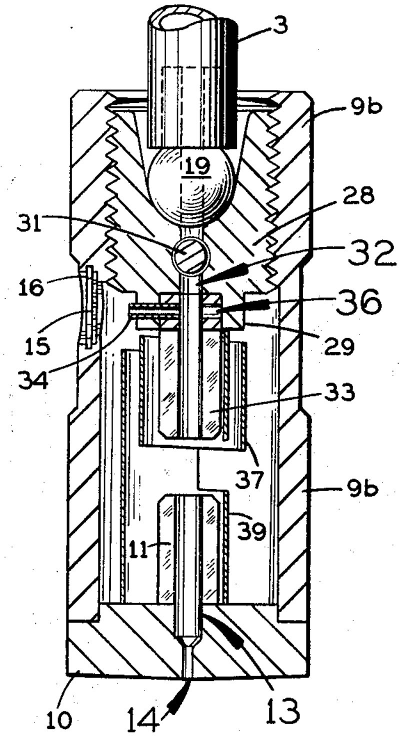

FIG.14

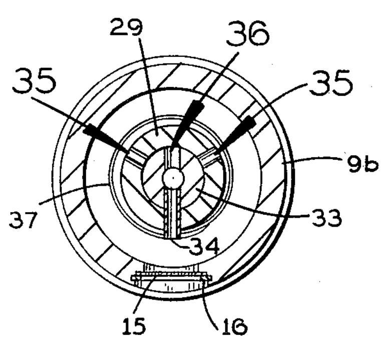

FIG.16

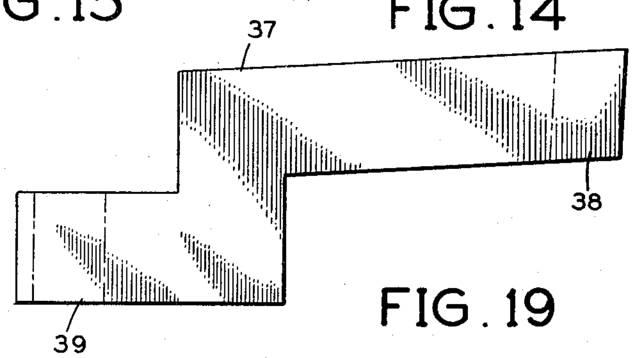

FIG.19

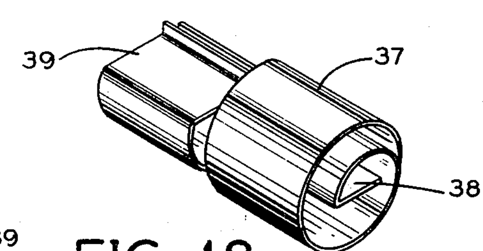

FIG.18

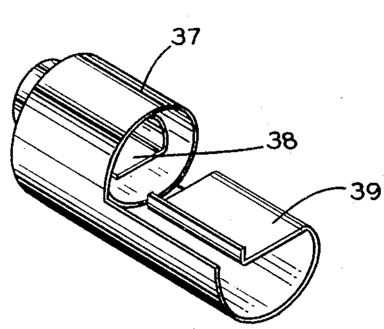

FIG.17

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THERMO-COMPENSATING VALVE LIFTER FOR INTERNAL COMBUSTION ENGINES

This invention relates in general to valve lifters and more particularly to a valve lifter employing a compensating screw operated by a thermal control element for automatically maintaining predetermined axial clearance between all components of a valve train.

Prior valve lifters are generally of two classes: one in which fixed mechanical adjustments are made to provide sufficient clearance for a wide range of temperatures, which adjustment is noisy and induces rapid wear so as to require frequent manual readjustment. The second, or hydraulic type of valve lifter is relatively quiet and normally provides proper valve seating for thermal expansion in the valve train, but because of its complication and close dimensional tolerances is subject to inoperation by the presence of foreign matter carried by the lubricant. Furthermore, hydraulic lifters rob an engine of considerable horsepower through friction since they are constantly expanded in the valve train by the engine's oil pump and are in forced contact with the camshaft even when a given valve is seated and not being opened or closed. This also produces excessive wear on the cam and lifter working surfaces.

The present invention overcomes the above objections and disadvantages by the provision of a relatively simple low cost automatic self-adjusting lifter which utilizes a thermally sensitive element therein to compensate for heat expansion of valve train components, and thereby holds a constant and minimum valve clearance over a wide range of temperature variations, which construction is the principal object of the invention.

Another object of the invention is the provision of means for filtering and metering oil to the entire valve train, as well as to the cam surface in contact with the lifter.

An additional object of the invention is the provision of purging means in the lifter construction for removing dirt particles from the lifter gallery oil supply passage.

A further object of the invention is the construction of a lifter in which the thermal element is readily interchanged to correspond to various expansion ranges of different engines.

Another object of the invention provides construction requiring relatively few parts to insure reliable automatic operation with corresponding low cost.

Reference is had to applicant's pending U. S. application, Ser. No. 844,780.

These and other objects and advantages in four embodiments of the invention are described and shown in the following specification and drawings, in which:

FIG. 1 is a cross sectional illustration of a valve train in an internal combustion engine, in reduced scale.

FIG. 2 illustrates the valve lifter shown in FIG. 1 in contact with a typical cam.

FIG. 3 is an enlarged side elevation taken through section line 3—3, FIG. 2.

FIG. 4 is an enlarged top view of the lifter only, shown in FIG. 2.

FIG. 5 is an enlarged cross sectional top plan view of the lifter taken through section line 5—5, FIG. 2.

FIG. 6 is a cross sectional elevation taken through section line 6—6, FIG. 4.

FIG. 7 is a side elevation of the bimetal element shown in FIGS. 3, 5, and 6.

FIG. 8 is a developed plan view of the element shown in FIG. 7.

FIG. 9 is the same as FIG. 6 in changed position.

FIG. 10 is an enlarged side elevation taken through section line 10—10, FIG. 1.

FIG. 11 is a cross sectional elevation taken through section line 11—11, FIG. 10.

FIG. 12 is a cross sectional top plan view taken through section line 12—12, FIG. 10.

FIG. 13 is a side elevation of a valve lifter alternate to that shown in FIG. 2.

FIG. 14 is an enlarged cross sectional elevation taken through section line 14—14, FIG. 13.

FIG. 15 is an enlarged view of the lifter shown in FIG. 13 with a portion thereof broken away.

FIG. 16 is an enlarged cross sectional top plan view taken through section line 16—16, FIG. 13.

FIG. 17 is a perspective view of the bimetal element shown in FIG. 15.

FIG. 18 is a perspective opposite end view of the element shown in FIG. 17.

FIG. 19 is a developed plan view of the element shown in FIGS. 17 and 18.

FIG. 1 illustrates a typical valve train in an internal combustion engine in which a valve **1**, an adjustable rocker arm **2**, and a push rod **3** are actuated by a cylindrical lifter assembly **4**, which is reciprocated by cam **5** and which automatically adjusts and holds a constant clearance between the elements of the train through wide temperature variations.

It is to be noted that an oil gallery passage **6**, as shown in FIG. **1**, supplies pressurized oil to the lifter **4** via the undercut **7**, shown exposed in FIG. **2**, to provide the flow of pressurized oil from the passage **6** into an oil inlet **8**, to be hereinafter described.

Referring to FIG. **3**, a hollow cylindrical body **9** of the lifter has a cap or base **10** secured to the lower end thereof, which has an integral base shaft **11** extending coaxially upward therefrom and having a transverse axial slot **12** therein for engagement with the spring **25**. A coaxial bore **13** through the base shaft terminates in a metering hole or orifice **14** for providing predetermined lubrication to the cam. A foraminated filter or screen **15** is secured in an aperture through the side of body **9** and retained by a removable snap ring **16**.

An internally threaded bushing **17**, having a tapered outer periphery, is secured in a mating taper in the upper end portion of the bore in body **9** and retains a threaded compensating screw **18** therein which has a spherical shaped socket in the upper end for supporting the spherical end **19** of the push rod **3**. A downward extending drive shaft **20** is coaxial and integral with screw **18** and includes a transverse slot **21**. An axial bore **22** through the screw and its drive shaft **20** is provided to carry oil upward through the hollow push rod **3**. A cylindrical metering pin **23**, of predetermined diameter, provides predetermined clearance in a transverse bore **24** in the screw to provide metering means for controlling the flow of oil to the push rod **3** and rocker arm **2** from the lifter.

A spiral coiled tandem volute spring **25**, made from bimetal material, has each opposite end formed in an axial plane to engage opposite slots **12** and **21**, respectively, as shown.

FIG. **8** is a developed plan view of the spring **25** showing the elongated Z-shape prior to forming into a double coil, as shown in FIG. 7

Referring to FIGS. **10**, **11**, and **12**, an embodiment of the invention is shown for the cyclic purging of foreign matter and dirt particles from the lifter gallery oil passage **6**. Circular groove **26** and connecting longitudinal groove **27**, both formed in the outer periphery of the lifter body **9***a*, provide momentary conduit means between the oil supply passage **6** and the crankcase when the lifter is raised by the cam.

FIGS. **13**, **14**, and **15** show an alternate construction in contrast to that shown in FIG. 3. Body **9***b* having a cap **10** secured at one end thereof has screw threads formed on the inner periphery of the opposite end portion thereof for receiving the combination compensating screw and socket **28** for receiving the push rod **3** and whose opposite end has an annular boss **29** extending inward coaxial with the lifter axis. The compensating screw **28** also has a transverse central bore **30** therethrough for loosely retaining a cylindrical metering pin **31**, as previously described, which pin intersects an axial vertical bore **32** in the screw. The boss **29** has a cylindrical axial bore for receiving one end of the slotted drive shaft **33** therein. The drive shaft **33** is secured in the bore of the boss **29** by a Rollpin **34**, which is inserted through one of three holes **35** in boss **29** and through the transverse hole **36** intersecting the end portion of drive shaft **33**, as shown. The requirement for three holes **35** spaced at 120° will be hereinafter described.

FIGS. **17** and **18** show opposite views of an alternate form of bimetal spring **37**, the ends of which have axial flat portions or tangs **38** and **39** which are adapted to engage shafts **11** and **33**, respectively.

An alternate bimetal spring is shown in FIG. **19** and its shorter length relates to valve train situations requiring less compensation, producing more torque than that provided by spring **25** in FIG. **7**. It should be noted that both spring designs have the same tang end geometry and are fully interchangeable physically in any of the lifter versions shown herein.

In operation and referring to the first embodiment shown in FIGS. **1–9**, the lifter is assembled by engaging the lower tang of the bimetal spring **25** with slot **12** of base shaft **11**, as shown in FIG. **3**. Next, the coil metering pin **23** is installed in the transverse bore **24** in compensating screw **18**. The screw is then threaded into the tapered bushing **17** until the innermost threaded ends of each are approximately adjacent or flush with the other. The slotted drive shaft **20** of the screw is then engaged with the upper tang of the spring **25** and the bushing **17** press-fitted into the internally tapered end of body **9** in tight frictional contact therewith. This tapered connection, it is to be noted, provides a simple and positive method of assembly and is sufficient to resist separation from inertia and oil pressure forces. The exposed internal threads of the bushing above the screw provide disassembly by a puller bolt, not shown.

Upon installation of the lifter in an engine, such as that illustrated in FIG. **1**, the rocker arm nut is adjusted to provide a "-cold" valve train clearance on the order of one to two thousandths of an inch, which is enough to insure seating of the respective valve. Then as the engine is started and comes up to operating temperature the bimetal element **25** rotates compensating screw **18** proportionately to maintain a valve train clearance substantially constant as initially adjusted. Effectively, the lifter shortens itself a predetermined amount equal to the combined axial expansion of the stem of valve **1**, the rocker arm stud, push rod **3** and lifter body **9**. This is shown exaggerated in FIGS. **6** and **9** where the shortened length D_1 would relate to a "hot" retracted attitude and D_2 to a "cold" lengthened lifter. $D_2 - D_1$ would then be the compensation expressed in units of axial length or thousandths of an inch.

As to the lubrication means provided by the lifter, the function of metering pin **23**, as shown in FIG. **3**, is as a regulating valve to govern the precise amount of oil being forced up through push rod **3** to the rocker arm and valve stem. This pin is simply a hardened steel dowel vertically movable in a slightly over-sized hole **24** in the body of screw **18** during the reciprocating motion of the lifter. Its utilization provides reliable lubrication to the said parts without fouling or imposing an inordinate pressure drop on the engine oil pump and is considerably cheaper to manufacture than the disc and cambered seat arrangement used for the same purpose in prior devices.

Another lubrication embodiment of the invention comprises an oil metering orifice **14** through the base **10** in the order of 0.020 inch in diameter for the typical automotive application so as to conserve engine oil pressure. This hole is axially disposed so that lubricating oil is delivered precisely to the line of contact between the cam and lifter face, an area heretofor subjected to intense wear and frictional forces. As a result of the invention, these factors are significantly reduced, more net engine horsepower is obtained and an accrued benefit provides a lessened periodic readjustment of the valve train clearance to account for wear. The cam generally covers the orifice, as may be seen in FIG. **2**, during the major part of its rotation. This, in itself, is inherently a metering relationship, such that a large oil flow occurs through the orifice only when the rise and fall ramps of the cam are in contact with the lifter face. This contact occurs to either side of the orifice, and since the orifice is not blocked during these periods, large quantities of oil are deposited on the ramps at a time when it is urgently needed, so as to appreciably reduce wear at these zones. When the orifice is closed during the remainder of the rotation of the cam, the oil pressure is conserved for other functions in the engine.

Since the orifice **14** is a relatively small hole and subjected to clogging by dirt particles in the oil supply, the invention provides a perforated filter **15** retained in the oil inlet aperture **8** of lifter body **9** by snap ring **16**, to provide protection thereto. Naturally, the size of the perforations or mesh in the filter is smaller than the size of the orifice **14** so that any solid particles passing the filter will not accumulate in the lifter body, but instead pass through the orifice and into the crankcase for refiltering by well known means, not shown. It is to be observed that the filter **15** serves further to prevent the metering pin **23** in FIG. **3** from possible clogging by foreign matter in the oil and thus restricting oil flow to the push rod **3** and rocker arm **2**.

Referring to FIGS. **10**, **11**, and **12**, an embodiment of the invention is shown for purging dirt particles from the lifter gallery oil supply passage **6**. In most engines this passage is a long hole drilled transversely through the lifter gallery, or through both galleries in a V–8 engine. Normally, oil is supplied to one end of the passage from the engine oil pump; the other end of the passage is normally closed. Oil then flows around the undercut **7** of each of the lifters, respectively, and into the oil inlet **8** of each lifter from the oil passage **6** of the engine. Dirt particles, carbon, or metal granules or other solid contaminants pumped into the closed passage were heretofor trapped, with the likelihood of entering the lifters and fouling the valves or working parts therein. Heretofor it was not possible for these undesirable particles to find their way back to the crankcase oil receptacle pump for refiltering without having to be forced through the valve lifter metering valves. In this embodiment of the present invention this handicap is overcome by allowing these particles to bypass the lifters and return directly to the crankcase. This is achieved by providing at least one of the lifters in a given gallery, usually the one most remote from the end supplied by the engine oil pump, with a purging means, as shown in FIG. **10**. Here the lifter body **9*a*** has an oil groove **26** around the periphery thereof, as shown in FIGS. **11** and **12**, for the cyclic conducting of oil from the gallery passage **6** via the longitudinal groove **27** in the body to the engine crankcase.

Groove **27** does not extend completely to the lifter face; the lower portion thereof is always exposed to the crankcase. Such design permits an uninterrupted lifter cam face of maximum area. The oil flow through these purge grooves is intermittent owing to the reciprocating motion imparted to the lifter by the cam **5**, so that the gallery passage **6**, shown in FIG. **10**, is sequentially vented to the crankcase only when this purge lifter is fully raised by the cam. Such motion creates a pulsating flow of oil and dirt particles in the passage **6** towards this lifter where these particles eventually are returned to the crankcase. Thus, a portion of the oil including suspended foreign matter in passage **6** is cyclicly returned to the engine crankcase, which is open to the camshaft, as shown in FIGS. **10** and **1**. It is important to note that this pulsation tends to drop the oil pressure in the gallery oil passage **6** only slightly and that there remains sufficient pressure to effect the required functions within all the other lifters in the gallery. A V–8 engine with two valve galleries would require two purge lifters, in contrast to an in-line engine which would require only one lifter equipped with purge groove means.

It should also be noted that the four lubrication embodiments of the invention are related. The purge groove **27** acts to keep the filters **15** in the lifter bodies free and unclogged of foreign matter. The filters in turn keep the orifices **14** and metering valves from clogging. While these lubrication embodiments could alternately be utilized in hydraulic or solid lifter design they are particularly adaptable to the thermo-compensating lifter described herein.

The lifter embodiment illustrated in FIGS. **13–16** is an alternate construction where the tapered bushing **17** has been eliminated and the inner portion of the inner periphery of the body threaded to directly receive the compensating screw **28**.

In this version the compensating screw, unlike the embodiment in FIG. 3, has a non-integral drive shaft 33 attached thereto by a Rollpin 34, which pin serves as a means to couple the compensating screw to its drive shaft 33 and to the bimetal spring 37 for assembly purposes. To assemble the lifter, the tang 39 of bimetal spring 37 is first engaged with base shaft 11 in lifter body 9*b*, as shown in FIG. 3. The slotted drive shaft 33 is then inserted into engagement with the upper tank 38 of the spring. It should be noted that the drive shaft 33 has a predrilled transverse hole 36 in its upper end to receive the Rollpin 34. This hole aligns with the oil inlet aperture or filter 15 in body 9*b*. Next, the oil metering pin 31 is installed in its receptive bore 30 of the screw 28 and the screw threaded into the body 9*b* until approximately flush, as may be seen in FIGS. 14 and 15. The screw is then rotated so that the nearest of one of the three holes 35 in the boss 29 is opposite the oil inlet aperture in the body 9*b*. At this point, the end of the drive shaft 33 will be engaged in the cylindrical bore of the boss 29 and the nearest hole 35 in the boss 29 aligned with the hole 36 in the coaxially contained drive shaft 33. The Rollpin 34 is then installed through the oil inlet aperture of body 9*b*, inserted in the hole 35 and pressed flush with the outside diameter of boss 29. It is important that pin 34 be pressed into place with a punch larger in diameter than the pin so that the pin is not inserted farther than the flush position. The filter 15 and retaining snap ring 16 may now be installed in the oil inlet aperture of body 9*b*. The compensating screw 25 is thus coupled to the bimetal spring and will respond to temperature changes which will produce corresponding rotation of the screw to provide compensation for valve train expansion when the lifter is installed in an engine.

Disassembly of the lifter shown in FIGS. 13, 14, 15 and 16 requires that the filter 15 and ring 16 be first removed and a punch smaller than the Rollpin 34 used to press same forward and thus be centered within the drive shaft 33. Use of an odd number of holes 35 in boss 29 is now obvious for it prevents the Rollpin from being inadvertantly re-engaged with the opposite wall of the said boss. The screw may now be unthreaded from the body so that the drive shaft 33 and spring 37 may be removed.

The metering pin 31, shown in FIG. 15, serves the same purpose as pin 23, shown in FIG. 3. Likewise, the metering orifice 14 for lubricating the cam is the same in FIGS. 3 and 14.

Where the purge groove embodiment has been shown incorporated in the lifter design employing a tapered bushing 17, as in FIG. 11, it is to be understood that purge grooves could be adapted with equal facility to the lifter illustrated in FIGS. 13–16, which employs an internally threaded body 9*b* to eliminate the said tapered bushing.

It is also within the purview of this invention that the embodiments described herein could be adapted to a roller lifter or tappet, which employs a roller on the working face to engage the cam, without departing from the spirit of the invention.

This invention comprehends other modifications in construction that come within the teachings and scope of the above specification.

Having described my invention, I claim:

1. A valve lifter for a valve train in an internal combustion engine comprising a body member having a coaxial bore in one end thereof and terminating at the opposite end thereof in a base for engagement with a cam,

a base shaft extending coaxially from the inner side of said base and integral therewith and having a transverse slot therein,

a bushing having internal screw threads positioned within the outer portion of said bore adapted to be secured therein,

a combination compensating screw and push rod socket having external screw threads mating with said threads in said bushing with said socket in the outer end and a coaxial drive shaft extending from the inner end thereof and having a transverse slot therein,

a bimetal temperature responsive spirally coiled spring positioned in said bore with one end engaged in said slot in said base shaft extending from said base and the opposite end of said spring engaged in said slot in the said drive shaft extending from said compensation screw when the latter is adjustably threaded into said bushing and said bushing secured in said bore whereby predetermined temperature variations of said lifter will rotate said spring and said screw in said bushing predetermined angles for maintaining a corresponding constant clearance between the elements in said valve train.

2. The construction recited in claim 1 wherein said bushing has a predetermined tapered peripheral outer surface and the open end portion of said bore is tapered to mate with said surface for frictionally securing said bushing in said bore.

3. The construction recited in claim 1 wherein the said bimetal spring is formed generally in a coiled volute shape with each end thereof terminating in a flat portion colinear with the axis of said bore.

4. In a valve train of an internal combustion engine a valve lifter means having a passage therethrough for conducting pressurized oil from a receptacle in said engine to the elements of said train comprising an oil inlet and outlet in said lifter means,

a peripheral groove around the periphery of said lifter means positioned to enter the transverse oil passage in said engine when the lifter is reciprocated,

a discharge groove in the side of said lifter means connecting said peripheral groove and open at the lower end of said lifter,

a filter means through the side of said lifter means for conducting oil and preventing impurities and foreign matter from entering said lifter means with the oil whereby said impurities and said foreign matter in said oil passage rejected by said filter means will be purged from said oil by the pressurized oil flowing around said peripheral groove and through said discharge groove into the said receptacle in said engine.

5. A valve lifter for a valve train in an internal combustion engine comprising a cylindrical body member having a coaxial bore in one end thereof and a cam surface on the opposite base substantially normal to the axis of said member,

said body member journalled for reciprocation in a bore in said engine,

a cam in contact with the lower end of said base of said body member for reciprocating the latter,

a bushing having internal screw threads positioned in the outer portion of said bore adapted to be secured therein,

a combination compensation screw and push rod socket threaded into said bushing,

a bimetal spirally coiled spring positioned in said bore with one end thereof secured to the inner end of said compensation screw and the opposite end thereof secured to the inner side of the said base of said body member,

said body member including an undercut of predetermined depth around the outer periphery of the central portion thereof and an oil inlet aperture in said undercut extending through the wall of said body member,

a foraminated filter means secured in said body member over said aperture,

an axial oil bore through said combination compensation screw and push rod socket,

an oil bore through the central axial portion of said base of said body member and terminating in a metering orifice of predetermined diameter,

an oil passage transverse said bore in said engine for conducting oil through said bore for said body member whereby predetermined temperature variations of said lifter will rotate said spring and said screw in said bushing predetermined angles for adjusting said screw corresponding distances for maintaining substantially constant clearance between the elements in said valve train and whereby said oil in said passageway will enter said undercut and be filtered through said aperture and upward through said screw to lubricate said valve train and downward through said metering orifice to lubricate said outer surface of said base and said cam.

6. A valve lifter for a valve train in an internal combustion engine comprising a cylindrical body member having a coaxial bore in one end thereof and a cam surface on the opposite base substantially normal to the axis of said member,

said body member journalled for reciprocation in a bore in said engine,

a cam in contact with the lower end of said base of said body member for reciprocating the latter,

a bushing having internal screw threads positioned in the outer portion of said bore adapted to be secured therein,

a combination compensation screw and push rod socket threaded into said bushing,

an oil inlet aperture extending through the central portion of said body member,

an axial oil bore of predetermined diameter through said combination compensation screw and push rod socket,

said screw having a transverse metering bore therethrough of predetermined diameter and intersecting said axial bore,

a cylindrical metering pin positioned in said metering bore and having a diameter providing predetermined clearance between said pin and said metering bore whereby pressurized oil entering said inlet aperture will flow upward in said axial bore and be metered around said pin for providing predetermined lubrication of said valve train.

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