Feb. 21, 1967 J. E. RHOADS 3,304,925

HYDRAULIC VALVE LIFTER

Filed June 20, 1966 2 Sheets-Sheet 1

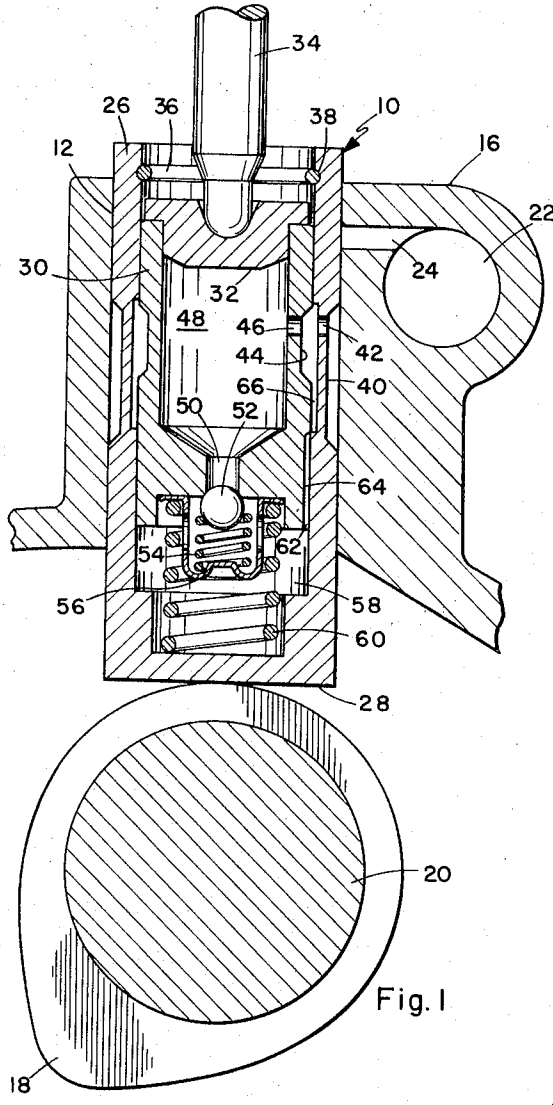


Fig. 1

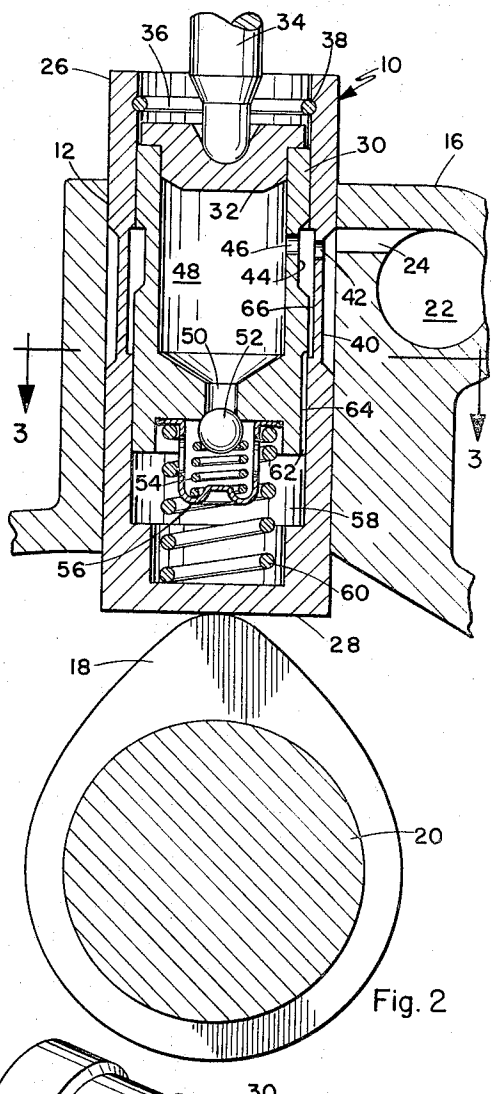


Fig. 2

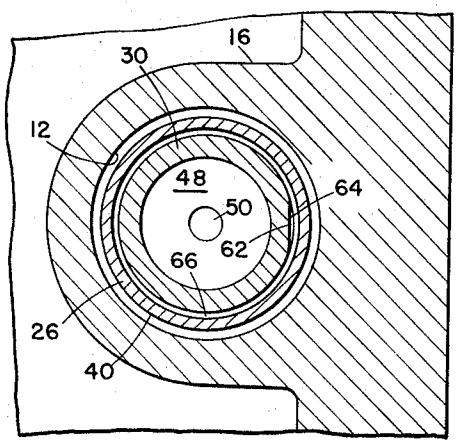


Fig. 3

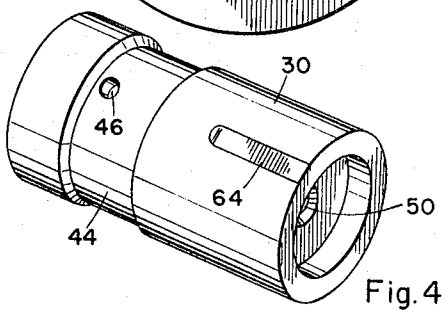


Fig. 4

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HYDRAULIC VALVE LIFTER

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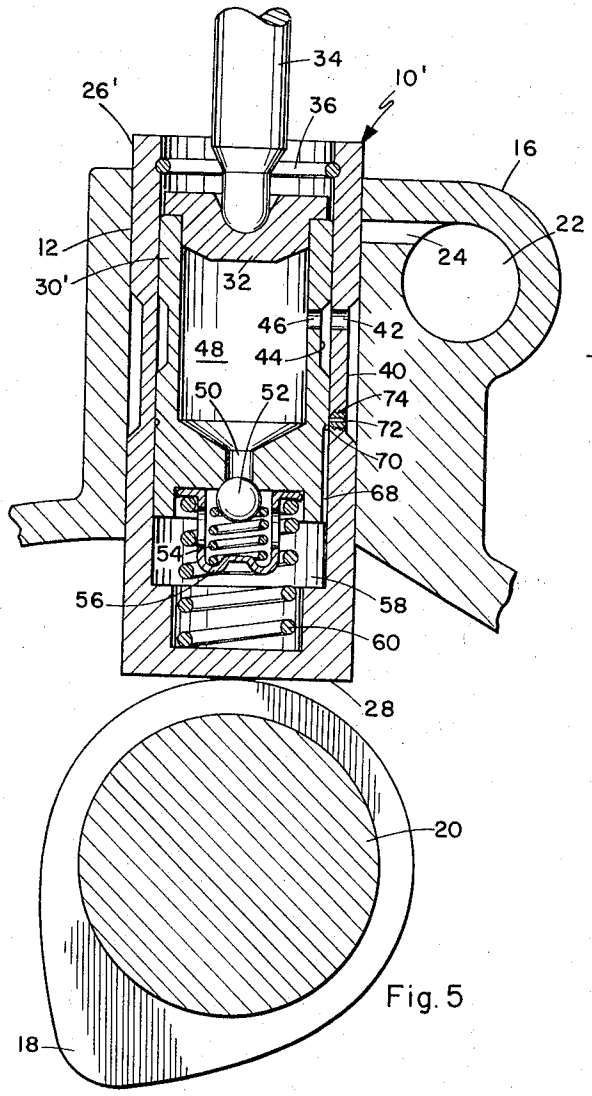


Fig. 5

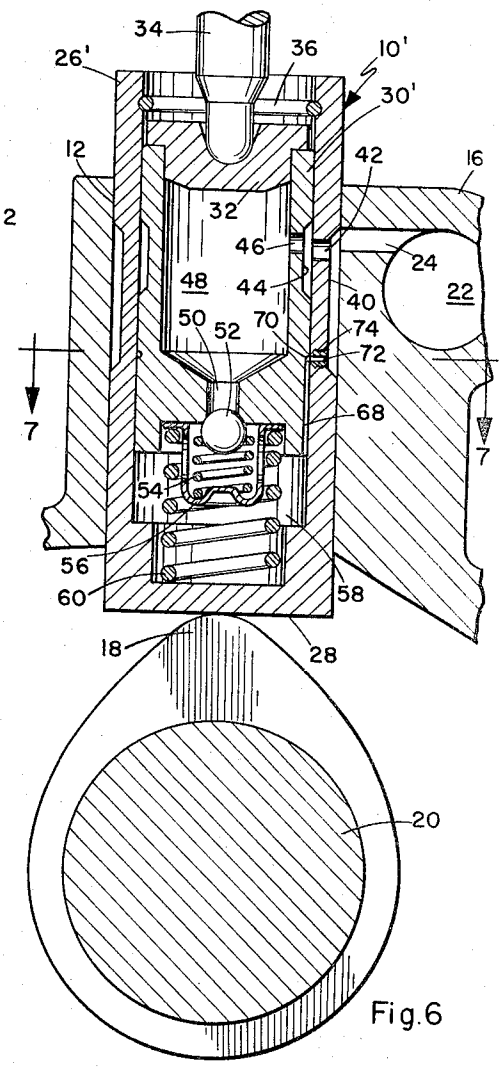


Fig. 6

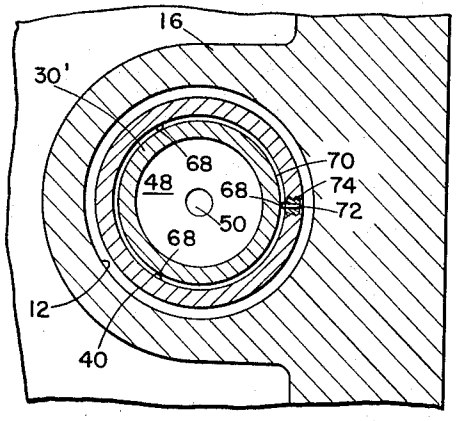


Fig. 7

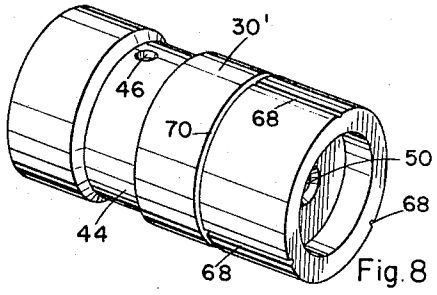


Fig. 8

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HYDRAULIC VALVE LIFTER

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7 Claims. (Cl. 123—90)

The present invention relates to a hydraulic valve lifter which is designed to "pump up" a predetermined amount at a reasonably low speed, which improves the low speed characteristics of a high performance engine without detracting from overall performance.

With conventional types of hydraulic valve lifters, each valve actuating push rod seats in a plunger axially slidable in a lifter body, and the lifter body rides on one lobe of the cam. Oil from the engine lubrication system is introduced under pressure between the body and plunger to expand the valve lifter assembly axially and tighten the linkage in the valve actuating train. The oil pressure, governed by the engine driven oil pump, increases with engine speed, so that at high speed the valve lifters are "pumped up" and become effectively solid. At low speed the pressure is not so high, so the plunger rides lower in the valve lifter body and the valves are not opened as far or as soon. Many lifters are designed to trap oil in the body chamber and pump up to an effectively solid condition at relatively low speed. Some types of hydraulic lifters have been designed with intentional leakage to avoid premature pumping up. However, with high performance cams the valves are timed to have considerable overlap in order to provide for a large flow through the engine. At low speeds this large overlap is not necessary and the engine runs inefficiently, resulting in a loss in low speed horsepower. Basically, increasing the valve lash will shorten valve open duration and reduce overlap, since more crankshaft rotation is necessary to overcome the lash in the valve train. This will result in an improvement in low speed performance. However, excessive lash causes considerable noise and wear at idling and low speeds. Decreasing lash, as by tightening or pumping up the lifters, will lengthen valve duration and improve high speed performance.

The valve lifter described herein is designed to provide favorable characteristics over the entire speed range. At low speed the lifter pumps up rapidly to a predetermined position, set to suit the specific engine and cam, after which a closely controlled oil leak is permitted to prevent pumping up to a fully solid condition at intermediate speeds. In the intermediate speed range the degree of pumping in the lifter is dependent on oil system pressure governed by the oil pump, which is related to engine speed, so the lifter operates generally in proportion to engine speed. At high speeds the motion is so rapid that the oil can no longer escape to any degree through the restricted leak path and the lifter becomes effectively solid.

The valve lifter and its action are illustrated in the drawings, in which:

FIGURE 1 is a sectional view, taken axially along a valve lifter, showing the mechanism in the valve closed position;

FIGURE 2 is a similar sectional view with the mechanism in the valve open position;

FIGURE 3 is a sectional view taken on line 3—3 of FIGURE 2;

FIGURE 4 is a perspective view of the plunger;

FIGURE 5 is a sectional view similar to FIGURE 1, but with a modified form of lifter;

FIGURE 6 is a sectional view similar to FIGURE 2, with the modified lifter;

FIGURE 7 is a sectional view taken on line 7—7 of FIGURE 6; and

FIGURE 8 is a perspective view of the modified plunger.

Similar characters of reference indicate similar or identical elements and portions throughout the specification and throughout the views of the drawing.

The preferred form of the valve lifter, illustrated in FIGURES 1–4, shows the valve lifter **10** axially slidably mounted in a bore **12** in a portion of the engine head casting **16**. A single valve lifter is shown, there being one lifter for each valve in the engine, with each lifter operated by a lobe **18** on a camshaft **20**. In the head **16** is an oil gallery **22** with a supply duct **24** leading to bore **12** to supply oil to the lifter from the pressure side of the engine oil system.

Valve lifter **10** comprises a cylindrical body **26** having a closed lower end **28**, and axially slidable within the body is a hollow cylindrical plunger **30**. In the upper end of plunger **30** is a cup **32** in which is seated the end of a push rod **34**, the push rod being coupled to a conventional rocker arm and valve, not shown. Plunger **30** is retained by a snap ring **36** in a groove **38** within the upper end of body **26**. Body **26** has an external peripheral collecting channel **40** which registers with the supply duct **24** when the lifter is moved to the raised position by cam lobe **18**, as in FIGURE 2. A port **42** communicates from channel **40** to the interior of body **26** and plunger **30** has a peripheral channel **44** which registers with port **42** at all times. From channel **44** a port **46** leads to the interior of plunger **30**, so that oil is admitted into the inner chamber **48** of the plunger.

At the lower end of plunger **30** is a small outlet **50**, the lower end of which is closed by a ball check valve **52** held in place by a seating spring **54**, the spring and valve being held in place by a perforated retaining cage **56**. The space between plunger **30** and the lower end of body **26** comprises a pressure chamber **58** and in this chamber is a return spring **60** which biases the plunger upwardly out of the body, until stopped by the snap ring **36**. In normal assembly the plunger **30** is pressed down against return spring **60** by the push rod **34**, which is loaded by the much stronger valve spring, not shown.

The structure thus far described is conventional and representative of hydraulic valve lifters, which may vary somewhat in porting and check valve arrangements. In operation the plunger chamber **48** receives oil under pressure at each upward stroke of the lifter, the oil being forced down through check valve **52** into pressure chamber **58**. At low pressure the plunger rides low in the body and is raised by increasing pressure to tighten the valve train. With no return leakage, or only that which may occur through the normal sliding clearance of plunger **30** in the body **26**, the oil in chamber **58** is pumped up rapidly and the lifter becomes effectively solid.

The novel action is provided by a bleed duct **62** formed by a flat portion **64** ground along the outer surface of plunger **30** from the lower end upwardly. In FIGURE 3 the flattening is exaggerated to simplify illustration, the

actual proportions being closer to that shown in FIGURE 4. Body **26** has an internal return channel **66** extending axially to port **42** and flat portion **64** extends along the plunger to a point just short of said return channel when the oil pressure in chamber **58** is at minimum, as in FIGURE 1.

As the pressure in chamber **58** increases, with the engine running, the lifter will pump up and plunger **30** will rise until bleed duct **62** communicates from chamber **58** to the return channel **66**. Oil can now leak from the pressure chamber back to the source and delay further pumping action. The depth and length of the bleed duct **62** are critical to proper engine operation. If the bleed duct is too large oil will leak too fast and the lifter will not pump up in accordance with engine speed. If the bleed duct is too small the oil will not be able to escape sufficiently and excessive pumping up will occur. The size of the bleed duct **62** must be such that oil will leak sufficiently to prevent rapid pumping up but not so much that the plunger will not rise beyond a certain point. At high speeds it is necessary that the bleed duct is not large enough to pass oil at a flow rate sufficient to relieve pressure in chamber **58**. In other words, at high speeds the motion is so rapid in the lifter action that oil does not have time to escape through the bleed duct and the lifter becomes effectively solid.

It has been found in tests that a flat portion **64** ground off to provide a bleed duct having a depth on the order of from two to five thousandths of an inch will provide the required characteristics in the engine of a passenger automobile. The exact amount will depend on the normal oil pressure in the engine, the cam design with regard to valve timing and duration and to the overall performance range of the engine. In racing engines it would be possible to enlarge the bleed duct to as much as ten or fifteen thousandths of an inch. An oil bleed of this magnitude would result in considerable valve lash and noise at idle speeds, but this can be tolerated in a racing engine.

The length of the flat portion **64** governs low speed lash and determines the point at which the rapid initial pumping up becomes more proportional to engine speed. If the flat portion is short the plunger must be pumped higher in the lifter body before leakage can occur and low speed performance will not be improved over that available with a non-leaking lifter. But if the flat portion **64** is too long only a slight pumping up will take place before leakage begins and undue valve lash may occur in the low to medium speed range. Again, the precise length depends on the cam, the engine performance and the speed at which it is determined to begin pressure bleed to obtain the most desirable overall characteristics. Actual dimensions cannot be given since the position of the return channel **66** must also be take into account.

A modified form of valve lifter **10'** is illustrated in FIGURES 5–8, in which all the conventional structure is identical to that described above and is correspondingly numbered. The only differences are in the bleed duct and oil return arrangement.

In the plunger **30'** instead of a flat portion, oil bleed is provided by circumferentially spaced, axially extending bleed grooves **68**, three being shown as an example. The bleed grooves **68** extend from the lower edge of plunger **30'** to a circumferential ring groove **70**, the axial position of which determines the upper end limit of the bleed grooves. Body **26'**, instead of an inner channel, has a single return port **72** from the interior thereof to the collecting channel **40** to return bleed oil to the source.

Before pump up the ring groove **70** is below return port **72** and no leakage occurs. When the plunger is pumped up to a predetermined position the ring groove **70** registers with return port **72** and leakage occurs. Beyond a certain speed the oil can no longer escape at a sufficient rate and the lifter becomes effectively solid, the overall action being as described above. The total cross sectional area of the bleed grooves **68** will, of course, be in the same proportion as that provided by the flat portion **64** and ring groove **70** will be of appropriate size to carry the combined flow from the bleed grooves, but the size is not especially critical since flow is governed by the size of the return port **72**. To facilitate precise control of the flow the return port **72** is contained in a screw-in plug **74** which seats firmly in the wall of body **26'**, the element being similar to a replaceable jet as used in a carburetor. By using plugs with return ports of different sizes the lifters can be set up for specific engines and performance ranges.

In each form of the lifter, oil from the pressure chamber **58** escapes or bleeds through a restricted channel, formed in one instance by a flat portion on the plunger and in the other instance by grooves. At a particular position of the plunger in the lifter body the oil can escape to the source through a return opening, which in one instance is a combination of channel **66** and port **42** and in the other instance a port **72**. In each form the return opening leads to the conventional collecting channel **40**.

The arrangement is adaptable to a variety of engines and can be incorporated into many existing types of valve lifters, without requiring any changes in the engines. In fact existing lifters already in use can be modified in accordance with this disclosure.

It is understood that minor variation from the form of the invention disclosed herein may be made without departure from the spirit and scope of the invention, and that the specification and drawings are to be considered as merely illustrative rather than limiting.

I claim:

1. In a hydraulic valve lifter having a hollow cylindrical body with a closed lower end for engagement with a cam; a hollow cylindrical plunger axially slidable in said body and enclosing a pressure chamber in the lower end of the body; an external collecting channel on said body to receive oil from a pressurized source; a port opening into said body from said channel; a port in said plunger communicating with said first mentioned port to admit oil into the plunger; and a one-way valve in said plunger opening into said pressure chamber;

the improvement comprising:

at least one restricted oil bleed channel extending from said pressure chamber along the outside of said plunger;

an oil return opening from the interior of said body to said collecting channel;

said bleed channel terminating short of said return opening when pressure in said pressure chamber is low and moving into registration therewith when said plunger is raised to a predetermined level by pressure in the pressure chamber;

the cross sectional area of said bleed channel being insufficient to sustain oil bleed beyond a predetermined flow rate at high engine speed.

2. The structure according to claim **1**, wherein said bleed channel comprises a flat portion on the outer surface of said plunger.

3. The structure according to claim **1**, wherein said return opening includes an internal channel in said body communicating with said first mentioned port.

4. The structure according to claim **1**, wherein said bleed channel comprises a flat portion on the outer surface of said plunger, and said return opening includes an internal channel in said body communicating with said first mentioned port.

5. The structure according to claim **1**, wherein said bleed channel comprises a plurality of grooves extending from said pressure chamber along the outer surface of said plunger.

6. The structure according to claim **1**, wherein said bleed channel comprises a plurality of grooves extending from said pressure chamber along the outer surface of

said plunger, and a circumferential ring groove interconnecting said grooves;

and said return channel comprises a restricted port opening from the interior of said body to said collecting channel.

7. The structure according to claim 6, wherein said restricted port is contained in a replaceable plug element removably inserted in said body.

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