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HYDRAULIC VALVE LIFTER

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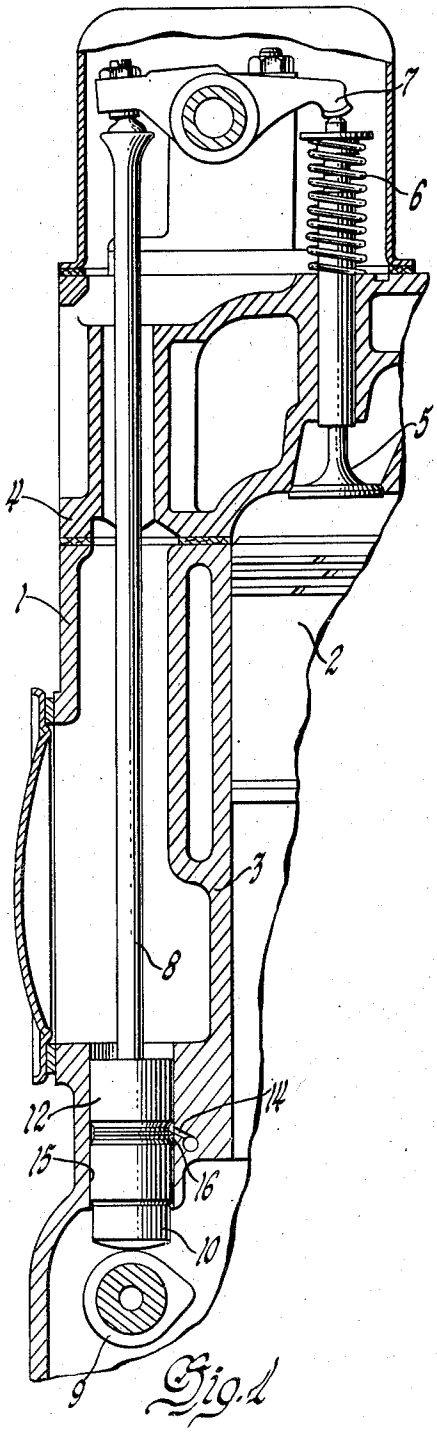


Fig. 1

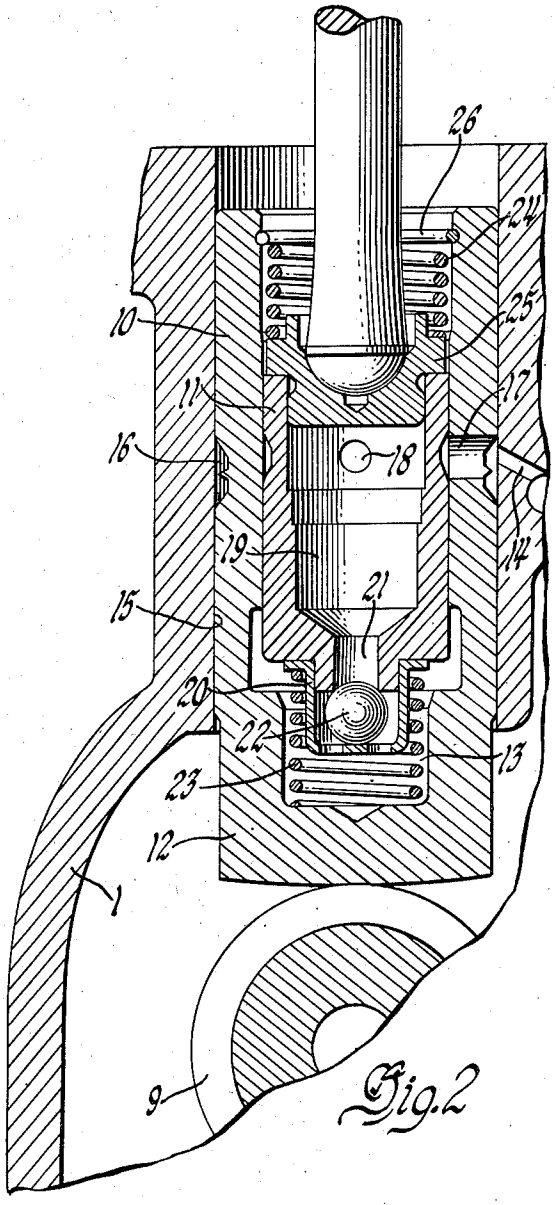


Fig. 2

INVENTOR.
Louis J. Van Slooten
BY
L. C. Thorpe
ATTORNEY.

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HYDRAULIC VALVE LIFTER

Louis J. Van Slooten, Holland, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to valve trains for internal combustion engines and the like, and is more particularly concerned with hydraulic lash adjusters of the type which automatically regulate the clearance and play in such trains to maintain zero lash between the cam shaft and valves of such engines.

In their most common form, such adjusters (also known as tappets, valve lifters, clearance regulators, etc.) consist essentially of a vertical cup-shaped cylinder closed at its upper end by a piston or plunger telescopically slidable and supported therein on a column of oil or other incompressible fluid confined in the bottom of the cylinder. The cylinder is slidably supported in the engine frame for longitudinally reciprocable movement in following one of the lobes on the cam shaft, the piston moving therewith under the action of the oil column and effecting through suitable linkage a corresponding movement of the engine valve which is biased to closed position by a relatively stiff spring. The piston is provided with a passage extending longitudinally therethrough which is closable by a check valve sensitive to pressure within the chamber below the piston but which opens upon removal of that pressure to permit a flow of oil into the chamber from a reservoir above the piston, thereby tending to keep the pressure chamber filled at all times. A light spring is provided to bias the piston upwardly in the cylinder end thereby expanding the adjuster to take up the valve lash during the interval between lifting strokes when the engine valve is unstressed. Such lash adjusters when used in internal combustion engine valve trains which include valves normally urged closed by relatively stiff valve springs are subject to what is known as valve lifter "pump-up," particularly during so-called valve spring "surge."

Valve spring "surge" is a term used to describe high frequency less-than-normal oscillatory movements of the valve springs which occur at certain engine speeds usually spaced by definite increments in an engine-speed scale.

One of the results of valve spring "surge" is to increase the amount of lash in the valve train. To compensate for this increase in lash the lash adjuster "pumps-up," i. e., the spring of the adjuster further separates the cylinder and piston to increase the column of oil acting therebetween. If, for example, the engine speed is passing through a valve spring "surge" range to perhaps a higher speed range where there will be no valve spring "surge" and the lash adjusters are "pumped-up" to compensate for the increased lash caused by the "surge" the valves will no longer seat, resulting in severe losses of engine power as well as other extremely undesirable conditions such as valve burning, etc.

It is therefore an object of this invention to delay "pump-up" of such lash adjusters during valve spring "surge" so that the ranges of engine speeds at which valve spring "surge" occurs may be passed through without lash adjuster "pump-up" occurring under such conditions.

It is a further object of this invention to provide means for delaying lash adjuster "pump-up" so that it occurs at higher engine speeds than would otherwise be the case without such means.

For a clearer understanding of the invention and the objects thereof, the invention will now be described in detail with reference to the accompanying drawing, in which:

Figure 1 is a transverse sectional view through a portion of an internal combustion engine whose valve-operating train includes a hydraulic valve lifter incorporating the novel means for delaying "pump-up" of the lash adjuster in accordance with the invention; and,

Figure 2 is an enlarged fragmentary view of the engine and the hydraulic valve lifter of Figure 1 showing the parts in greater detail.

Referring now to the drawing, in Figure 1 the engine is illustrated as having a cylinder block and crankcase **1** in which a power piston **2** operates in a cylinder **3**. The numeral **4** designates the engine cylinder head in which is reciprocably mounted a poppet valve **5** biased to its closed position by a return spring **6** and movable in the opening direction by a cylinder head mounted valve rocker **7** in response to upward movement of a push rod **8** operatively connecting the push rod to an engine-driven cam **9** through a hydraulic lash adjuster or valve lifter **10**.

The valve lifter **10**, as best seen in Figure 2 comprises a pair of telescopically slidable cup-shaped members **11** and **12**. The outer member **12** has its bottom end resting on the operating surface of the cam **9** and forms a cylinder in which the inner member **11** constitutes a piston or plunger. Within the cylinder **12** below the plunger **11** is an oil cushion chamber **13** in which a body of incompressible fluid is contained. In the particular arrangement illustrated this fluid is oil which is supplied from the engine-lubricating system by an oil gallery **14** in the block communicating with the bore **15** in which the cylinder is slidably reciprocable. The oil delivered by the gallery **14** to the bore **15** passes through the side walls of the plunger and cylinder via the cylinder external groove **16** and cylinder and plunger ports **17** and **18**, respectively, into the reservoir **19** formed by the hollow interior of the plunger **11**. This supply of oil to the reservoir is for the purpose of replenishing that which is regularly lost from the chamber **13** during operation by leakage between the plunger and cylinder side walls with each lift stroke of the cam **9** in opening the engine valve **5**. A passage **21** extending through the bottom of the cup-shaped plunger serves to connect the reservoir **19** and the cushioning chamber **13** for this purpose. To insure against backflow through passage **21** during the lift stroke there is provided a check valve in the form of a ball **22** which is retained in proximity to the lower port of passage **21** by a small retaining cup **20**. A plunger spring **23** is also placed in the chamber **13** to effect re-lengthening of the lifter **10** through successive lift strokes of the cam **9** and further serves to maintain the ball check valve cup **20** in place against the bottom of piston or plunger **11**. During each interval between lift strokes the engine valve **5** is closed and the plunger spring **23** acts against plunger **11** to take up clearance or lash between it and the engine valve, while causing the lifter cylinder to remain in contact with the operating surface of the cam. In so doing, and immediately upon closure of the engine valve **5**, the lifter cylinder moves downward toward the cam axis relative to the lifter plunger **11** and effects an enlargement of the oil cushion chamber **13**, producing a consequent drop in pressure therein and unseating of the check valve **22**.

With the structure so far described if the engine speed should be such that the valve spring **6** is "surging," valve **5** will tend not to seat thereby increasing the lash in the valve train between the cam **9** and the rocker **7** engaging the stem of valve **5**. As a result of this increase in lash the spring **23** will act against the plunger **11** to take up

this added clearance or lash between it and the engine valve while causing the lifter cylinder **12** to remain in contact with the operating surface of the cam. In so doing, the column of oil in the chamber **13** increases or "pumps-up" the valve lifter so that when the engine speed passes through the range at which valve spring "surge" occurs the valve lifter will have so increased the length of the valve train as to maintain the valve **5** off its seat throughout entire engine cycles. This, of course, results in a severe loss of power which may even prevent further acceleration of the engine. If the speed range at which the valve spring "surge" occurs should also happen to be the range in which, say, a shift in an automatic transmission is normally made, such "surge" and "pump-up" may prevent the shift from taking place due to the loss of power and inability of the engine to further accelerate. To alleviate this condition and prevent its occurrence, the present invention has been proposed which upon reference to Figure 2 primarily comprises inserting resilient means (in this instance in the form of a helical coil spring **24**) between the cylinder and the piston which yieldingly opposes the action of spring **23** tending to cause "pump-up." The usual hydraulic lifter normally includes a plug **25** closing the upper end of the piston **11** and a retaining ring **26** which holds the plug and the piston in the cylinder **12** and more or less maintains the valve lifter assembly intact. Spring **24**, then, as shown by Figure 2, is positioned so as to abut the retaining ring **26** at its upper end and the upper side of the plug **25** at its lower end which in turn rests against the upper end of the piston **11**. The characteristic of the spring **24** is such that it yieldingly opposes the action of spring **23**, i. e., spring **23** is somewhat stiffer than spring **24**.

The effect of spring **24**, then, is to offer increasing resistance to the action of spring **23** as valve lifter "pump-up" begins to take place. By proper selection of the characteristic of spring **24** "pump-up" can be retarded or delayed so as to allow the engine to pass through the ranges of engine speed at which valve spring "surge" occurs before valve lifter "pump-up" takes place. The springs **23** and **24** preload each other to some extent in their initial state. When valve spring "surge" occurs in the valve train it causes the lower spring and the lifter to expand upward to take up the clearance in the valve train caused by valve spring "surge." Due to the lower spring expanding it begins to lose its initial load while the upper spring is being compressed and its load is increased. Because of these opposing spring forces the lifter assembly will react slower in taking up valve train clearance when valve spring "surge" occurs. Due to the slower reaction on the part of the valve lifter the engine speed at which "pump-up" occurs will be greater than without such spring. From the foregoing it will be appreciated, of course, that both valve spring "surge" and valve lifter "pump-up" are extremely undesirable conditions and that the latter is often the direct result of the former. If, however, valve lifter "pump-up" can be suppressed or delayed, as is accomplished by the present invention, then even though valve spring "surge" does occur at various points in the speed range of the engine, the valves will

continue to seat at proper intervals in the engine cycle throughout the speed range of the engine resulting in better engine performance.

I claim:

1. A hydraulic valve lifter having a cylinder with a slidably fitted piston defining an oil cushion chamber and an oil reservoir therein below and above the piston respectively, said piston having a passage for flow of oil from said reservoir to said chamber, a check valve adapted to prevent reverse flow through said passage, resilient means acting between said piston and cylinder to urge its movement within the cylinder in the direction to enlarge said chamber, and resilient means acting between said piston and cylinder opposing said movement.

2. In a hydraulic lash adjuster having two telescopically associated members in thrust-transmitting relation with a body of fluid therebetween and a check valve controlling a passage in one of said members communicating with said body, resilient means acting between said members urging movement of said members to increase the space therebetween wherein said body is located and further resilient means acting between said members yieldingly opposing such movement.

3. A hydraulic tappet comprising a cylinder having one end closed and the other open, a piston in the cylinder defining an oil cushion chamber and an oil reservoir therein below and above the piston respectively, a first spring acting between said piston and cylinder normally urging the piston out of the cylinder, said piston having a passage connecting the chamber and reservoir on opposite sides of the piston, a non-return valve permitting flow into the chamber beneath the piston, and a second spring acting between said piston and cylinder tending to urge the piston into the cylinder, said first spring effecting a greater initial biasing on said piston than said second spring.

4. In a valve train including a valve and spring therefor, a hydraulic valve lifter having means tending to retard "pump-up" of said lifter during "surge of said valve spring comprising a cylinder having one end closed and the other open, a piston in the cylinder defining an oil cushion chamber and an oil reservoir therein below and above the piston respectively, a first spring in said chamber acting between said piston and cylinder normally urging the piston out of the cylinder, said piston having a passage connecting the chamber and reservoir on opposite sides of the piston, a non-return valve preventing flow into the chamber beneath the piston, retaining means in the open end of the cylinder above the piston preventing its removal from the cylinder, and a second spring between the piston and the retaining means yieldingly opposing the action of said first spring.

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