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HYDRAULIC VALVE TAPPET

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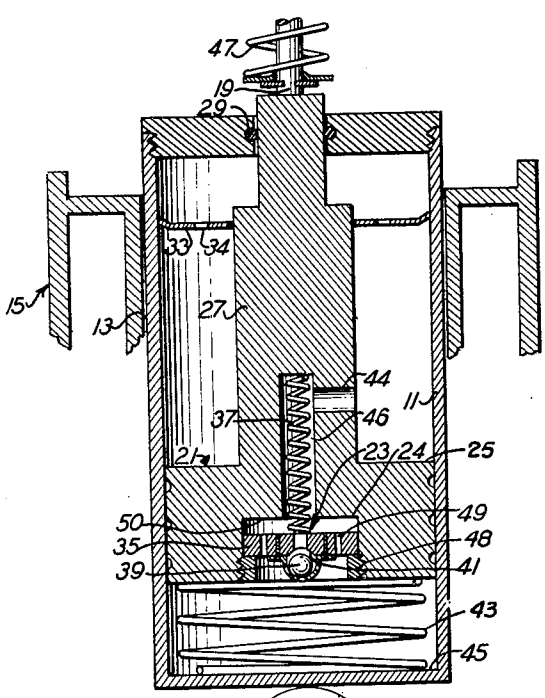


FIG. 1

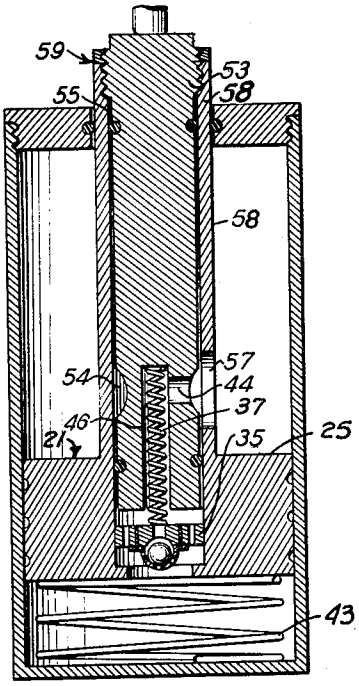
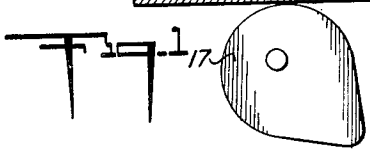


FIG. 2



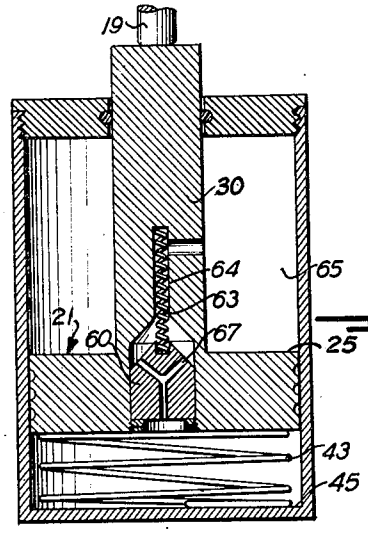


FIG. 3

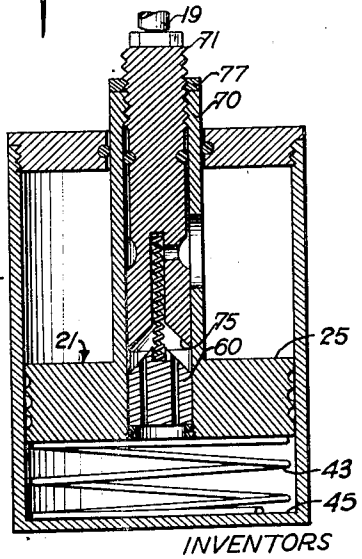


FIG. 4

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HYDRAULIC VALVE TAPPET

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13 Claims. (Cl. 123—90)

This invention relates generally to hydraulic tappets for internal combustion engines and more specifically to hydraulic tappets intended to replace mechanical tappets in existing engines.

The prime object of this invention is to provide a self-contained hydraulic valve tappet which is self-adjusting in service and at the same time does not deleteriously affect the engine timing.

The hydraulic valve lifter or tappet of the prior art is normally a unit which self-adjusts its length to a condition of zero lash in the valve lifting train.

The timing of the opening and closing of the valves in an engine with respect to piston position is critical, and is determined by both the cam shape and the tappet lash. For example, a tappet lash or clearance may be .014 inch in order to obtain the best performance from an engine having a given geometrical arrangement of parts in the combustion chamber, and an induction system of selected geometry. If, in such an engine, a zero-lash type of hydraulic tappet is substituted in the valve lifter train for the mechanical tappet which had been adjusted to the selected clearance, the corresponding valve will open earlier and close later in the engine cycle with resulting deterioration in engine performance.

On the other hand, due to wear mainly, the mechanical tappet does not stay in adjustment for extended periods and furthermore the impact between the tappet and other parts of the valve lifter train causes undesirable noise.

Accordingly, it is desirable to provide a hydraulic tappet which is self-adjusting and at the same time has a built-in selected, or adjustable lash of fixed amount.

Therefore, it is the prime object of this invention to provide a valve tappet which is self-adjusting at all times in service to a selected optimum condition.

It is a further object of this invention to provide a hydraulic tappet of the self-adjusting type which has built-in lost-motion or lash of selected fixed amount and maintains this fixed amount of lost-motion at all times.

It is a further object of this invention to provide a hydraulic tappet having built-in lost-motion of adjustable amount.

It is still another object of this invention to provide a self-contained hydraulic tappet having built-in lash for application to engines designed for mechanical valve lifters.

Other objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawing which is made a part of this specification.

In the drawing:

Figure 1 is a view in section of a self-contained hydraulic valve tappet constructed in accordance with this invention and having fixed selected lash;

Figure 2 is a view in section of a hydraulic valve tappet basically similar to that of Figure 1 and in which the amount of lash is adjustable;

Figure 3 is a view in section of another embodiment constructed in accordance with this invention;

Figure 4 is a view of the embodiment of Figure 3 in which the amount of lash is adjustable.

Referring to the drawing, Figure 1, the valve lifter or tappet includes a cylindrical housing or barrel **11** which reciprocates vertically in guide bearings **13** in an engine shown as the fragment **15**. The bottom surface of the cylindrical tappet barrel rides upon a cam **17**. The upper end of the tappet rests against the bottom of the valve stem **19**. Normally, if the engine were built to utilize

mechanical tappets, the lash selected for best performance when the tappet is resting on the cam bottom exists as a selected clearance between the upper end of the tappet and the lower end of the valve stem. This lash is a necessity for best performance: therefore because the hydraulic tappet adjusts itself to zero clearance with the valve stem, this invention provides for lash in the internal mechanism of the hydraulic tappet itself.

To the end that these characteristics are obtained, the lash in the hydraulic tappet of this invention is obtained by a unique valve assembly **23** in the piston member **21**.

The piston member **21** includes a cylindrical piston portion **25** which is slidingly supported on the inside of the tappet housing **11** with a substantially fluid tight fit and a stem portion **27** which is reduced in diameter at the upper end. The reduced upper end extends through the upper end of the tappet housing to cooperate with the lower end of the engine valve. Provision is made as by, for example, an O-ring seal **29** to prevent leakage of fluid between the piston member stem and the tappet housing.

The tappet housing both below and above the piston member piston portion **25** is substantially filled with a suitable fluid. In order to permit expansion and contraction of the fluid volume due to temperature changes and also due to the retraction of the piston member into the housing under operating conditions, an air space is provided at the upper portion of the tappet housing. To prevent surging of the fluid and the possible intermixture of air therein, a diaphragm **33** having a small aperture **34** therein is affixed to the inside wall of the housing near the top as by a press fit. The tappet is filled with fluid to just above the level of the diaphragm.

The piston assembly is provided with a valve assembly **23** which is situated in a bore **24** entering the bottom of the piston. The valve assembly includes a sliding plunger **35**, a spring **37** and a ball-check assembly comprising ball **39** and seat **41**.

An axial passage or duct **46** leads from the valve assembly to a portion of the piston assembly stem **27** which is above the piston portion **25**. A radial passage **44** connects the exterior of the stem portion of the axial passage.

A tappet elongating spring **43** is provided between the piston and the tappet housing closed end wall **45**. This spring is of considerably less tension than the engine valve spring **47** but is sufficient to keep the tappet stem portion against the end of the valve stem **19** at all times.

The valve plunger **35** has one or more small apertures **49** therethrough. The upper surface of the plunger is flat and the end wall of the piston bore is also flat so as to provide a valve seat **50** so that when the plunger is against the end wall the apertures **49** are closed.

Operation of the tappet is as follows: Assume the tappet has been installed in an engine. If the engine is running, each time the bottom of the cam faces the tappet barrel bottom the stem **27** is extended out of the housing against the end of valve stem **19** under the action of spring **43** against the bottom of piston portion **25**. The stroke of valve plunger **35** is selected so that its displacement equals the displacement of piston **25** in moving a distance equal to the desired lash. The plunger **35** is stopped at the bottom end of its stroke by ring **48** which engages a threaded portion of the cylindrical wall of bore **24**. During the upward adjustment of the position of piston **25** in barrel **11** to remove the lash between the stem **27** and the valve stem **19**, the ball **39** is off its seat and in addition spring **37** urges valve plunger **35** to the end of its travel. Upon further rotation of the cam so that barrel **11** is moving upward, the piston portion **25** and stem **27** do not move upward until valve plunger **35** is moved up against its seat **50**. In this position the ball **39** is against its seat and the plunger ports **49** are closed. The barrel and piston assembly then move as a unit. The purpose of ball check **39** in addition to the plunger apertures **49** is to permit the plunger apertures to be relatively small so that the upward motion of plunger **35** due to initial upward motion of the barrel **11** will be positive and substantially independent of the speed of the engine. The ball check enables a large quantity of fluid to pass from the upper chamber into the lower chamber when the cam is bottomed after the tappet has become accidentally

depressed due to long standing of the engine with the tappet in raised position. The apertures **49** in valve plunger **35** can be quite small because the amount of fluid passing therethrough is minute at any one time.

The operation of valve assembly **23** in maintaining constant lash is as follows:

Assuming the valve stem **19** elongates as a result of warming up of the engine. The effect of this action is most readily understood by assuming for the moment that the valve plunger **35** is not provided with apertures **49**. It will be seen then that the piston will assume a slightly lower position in barrel **11** than it has previously. Therefore, the volume below the piston is reduced slightly so that the plunger **35** can not extend a full stroke to the stop ring **47**. With a consideration of the apertures **49**, it is seen that the remaining portion of the plunger stroke depends on fluid passing therethrough until the plunger can again reach the stop ring. Therefore, as a result of elongation of the valve stem, fluid is permitted to migrate from below the piston to above the piston so that the full lash obtained from a full stroke of plunger **35** is again obtained.

The hydraulic tappet thus far described is capable of a preselected lash. Thus, for example, for those engines which utilize 0.008 an inch lash for the intake valve and 0.013 for the exhaust valve the tappets would be accordingly adjusted prior to assembly.

In view of the fact that many tappets are of standard diameter, and can be utilized in a variety of engines, each of which may necessitate different valve tappet lash, the embodiment of Figure 2 incorporates an adjustable lash feature. The parts of the hydraulic valve assembly in this embodiment are similar to those described in Figure 1 with the exception of the piston stem portion. The stem portion in this case is hollow and threaded near the outer extremity. An elongated core element **53** is supported inside the hollow stem. The upper portion of the core element is threaded to engage the threaded portion of the hollow stem **58**. The lower end of the core element is a flat surface for coacting with the upper surface of the valve plunger **35** to provide valve action. In order to prevent any loss of fluid an O-ring seal **55** is provided between the core element and the inside surface of the hollow stem. The core element has an annular groove which coacts with the outer portion of the duct **44** and an aperture **57** in the hollow stem **58** which coincides with the annular groove of the core element. It follows that the length of the stroke of the valve plunger **35** is now adjustable by turning the core element **53** with respect to stem **58**. The lash of the tappet is therefore adjusted by adjusting the stroke of plunger **35** and the core element is locked from turning with respect to stem **58** by tightening jam nut **59**.

A simplified version of the instant invention is illustrated in Figure 3. In this version, initial adjustment of the tappet to zero lash may take longer than the embodiment of Figures 1 and 2. In this embodiment, a single valve plunger **60** is utilized to permit the adjustment of piston position so as to obtain zero clearance between the piston stem portion and the valve stem and also to obtain the desired lash. A spring **63** is provided to urge the valve plunger **60** to the end of its stroke. The plunger **60** has a substantially fluid tight slide fit in the counter bore in piston **25**. In the event of lash between the piston stem portion **30** and the valve stem **19**, when the cam is bottomed, spring **43** adjusts the piston **25** upward and valve **60** being open, permits fluid to flow from the upper chamber **65** through fluid port **64** and plunger aperture **67** to the bottom chamber. Upon the up-stroke of cam **17**, the tappet barrel is urged upward thereby causing an increase in pressure against plunger **60** which overcomes the tension of spring **63** thereby forcing the plunger up against its seat and causing the piston assembly **21** and the barrel to move as a unit. The length of the stroke of plunger **60** is such as to give the desired lash. The elongation due to heating of the valve stem **19** in any one cycle of the engine will be less than the selected lash. Therefore, there will be a duration in each revolution of the engine cam in which the fluid pressure is removed from valve plunger **60** thereby permitting spring **63** to move plunger **60** off its seat and toward the stop ring. The amount of fluid in excess below the piston **25** which would prevent the valve plunger from obtaining a full stroke, passes from the lower chamber to the upper chamber. Consequently, the action of plunger **60** is such as to automatically cause the selected amount of lash to be maintained.

It is desirable to provide for adjustment in the amount of lash. To this end the embodiment of Figure 4 incorporates an adjustable tappet stem **71**. This stem has provided on its lower end a valve seat and at a point along its length a thread. This thread engages a thread in the hollow piston stem **70** whereby the position of the piston valve seat **75** and therefore the stroke of plunger **60** can be adjusted for the desired lash. A lock nut **77** is provided to maintain fixed adjustment of lash to the selected value.

The action of this hydraulic tappet is quiet due to the shock absorbing action of the fluid when the valve plunger closes against its seat. Therefore the advantages of lash in the valve train are maintained with the absence of noise.

In all the examples shown, the cross section of the apertures or passages in the piston valve plunger are very small i. e., of the order of capillaries. Consequently, the amount of fluid passing through the plunger on an upstroke of the tappet is negligible.

Herein has been shown and particularly described certain embodiments of the invention and the respective methods of their operation for the purpose of explaining the principles of operation and application, but it is understood by those skilled in the art that many modifications and variations are possible and that the invention is to be considered limited only by the scope of the appended claims in the light of the prior art.

In the claims:

1. A hydraulic tappet having a hollow body, closed at its lower end, a piston slidingly supported in a substantially fluid tight fit in said body, a fluid chamber above and below said piston in said body, a stem affixed to said piston and projecting out of the upper end of said body, an axial bore extending upwardly from the bottom surface of the piston, a fluid passage extending from the inward end of the bore to the fluid chamber above the piston, a plunger slidingly supported with a substantially fluid tight fit in said piston bore, at least one aperture extending vertically through said plunger, the inner end of the piston bore being of the same shape as the upper surface of the plunger so as to provide a seat therefore and so as to effect a fluid tight seal when the plunger is against the said seat of the piston bore, means for resiliently urging said plunger off its seat, means for resiliently urging said piston away from the lower end of said hollow body, and means for limiting the extent of the downward stroke of said plunger.

2. The device recited in claim 1 wherein the aperture in the plunger is off-center and a ball-check valve opening in the direction of the lower fluid chamber is provided in the center of the lower surface of the said plunger and communicates with the said fluid passage.

3. The device recited in claim 2 in which a transverse baffle having a small aperture therethrough is affixed inside the upper portion of the upper fluid chamber.

4. A hydraulic tappet having a hollow body closed at its lower end, a piston slidably supported with a substantially fluid tight fit in said body, a stem affixed to said piston and extending out of the upper end of said body, said stem having an axial bore extending therethrough and having a portion of said bore provided with a thread, an axial bore extending through said piston communicating with the stem bore, a plunger slidably supported in the lower end of said axial bore, means for limiting the downward travel of said plunger, an axial passage passing through said plunger, a ball check valve opening downwardly supported on said plunger and in communication with said plunger axial passage, a stem core having an axial passage extending from its lower end to an intermediate portion thereof, supported in said stem and having a threaded portion, for engaging the stem bore threaded portion, the upper surface of the plunger being of the same contour as the lower end of the stem core so as to provide a fluid tight seat therebetween, at least one aperture passing vertically and off-center through said plunger, means for resiliently urging said plunger downwardly with respect to the stem core, means for resiliently urging the piston upwardly away from the bottom of the tappet hollow body, an annular reduced portion on said stem core communicating with said axial passage, an aperture through the wall of the stem communicating with the stem core reduced portion, means for rotating said stem core and means for locking said stem core from rota-

tion with respect to the hollow stem whereby the stroke of said plunger and therefore the tappet lash can be adjusted and fixed.

5. A hydraulic tappet having a hollow body closed at its lower end, a piston slidably supported with a substantially fluid tight fit in said body, a stem affixed to said piston, and extending out of the upper end of said body, an axial bore in said piston extending upwardly from the bottom thereof, an axial passage in said stem extending from the piston axial bore to an intermediate portion of said stem, a radial passage extending from the surface of said stem to said axial passage, a fluid chamber in said body above and below said piston, a plunger slidably supported with a substantially fluid tight fit in said piston bore, the inner end of the piston bore and the inner surface of the plunger having the same contour so as to provide a fluid tight valve when the plunger is seated, said plunger having at least one aperture therethrough off-center of the stem axial passage, means for resiliently urging said plunger off its seat, means for urging said piston away from the bottom of said tappet body, and fluid filling the lower fluid chamber and filling most of the space of the upper fluid chamber.

6. The hydraulic tappet of claim 5 in which a diaphragm having an aperture therethrough is affixed transversely of the interior of said tappet body proximate the top thereof.

7. A hydraulic tappet having a hollow body closed at its lower end, and having a closure member with a centrally located bore therethrough, a piston slidably supported with a substantially fluid tight fit in said hollow body, a hollow stem affixed to said piston and extending out of the top of said hollow body through said closure member bore, said piston having an axial bore extending thereinto from its lower surface, said hollow stem having an internally threaded portion, a stem core extending through said hollow stem, a plunger slidably supported in said piston bore and having a vertical aperture therethrough, said stem core having an end surface of the same contour as the upper surface of the plunger to provide a valve seat therefore, a vertical fluid passage extending in said stem core from the lower end thereof to an intermediate portion, a radial passage extending from the surface of said stem core to said vertical fluid passage, and an annular relief on the exterior of said stem core communicating with the outer end of the radial passage, a radial aperture through the hollow stem communicating with the stem core annular relief, fluid filling the space between the piston and the lower end of the tappet body and fluid nearly filling the space between the piston and the upper end of the tappet body whereby said hydraulic tappet is completely self-contained.

8. The hydraulic tappet described in claim 7 in which a septum having an aperture therethrough is affixed transversely of said tappet body near the top thereof.

9. A hydraulic tappet having a hollow body, closed at its lower end, a piston slidingly supported in a substantially fluid tight fit in said body, a fluid chamber above and below said piston in said body, a stem affixed to said piston and projecting out of the upper end of said body, a bore extending upwardly from the bottom surface of the piston, a fluid passage extending from the inward end of the bore to the fluid chamber above the piston, a plunger slidingly supported with a substantially fluid tight fit in said piston bore, at least one aperture extending through said plunger from top to bottom thereof, the inner end of the piston bore having an annular portion thereof of the same shape as the upper surface of the plunger so as to provide a seat therefore and so as to effect a fluid tight seal when the plunger is against the said seat of the piston bore, means for resiliently urging said plunger off its seat, means for resiliently urging said piston away from the lower end of said hollow body, and means for limiting the extent of the downward stroke of said plunger.

10. The device recited in claim 9 wherein the aperture in the plunger is off-center and a ball-check valve opening in the direction of the lower fluid chamber is provided in the central portion of the lower surface of the said plunger and communicates with the said fluid passage.

11. A hydraulic tappet having a hollow body closed at its lower end, a piston slidably supported with a substantially fluid tight fit in said body, an elongated stem affixed, to said piston and extending out of the upper end of said body, said stem having a bore extending therethrough in the direction of its elongation and having a portion of said bore provided with a thread, a bore extending through said piston from top to bottom thereof communicating with the stem bore, a plunger slidably supported in the lower end of said bore, means for limiting the downward travel of said plunger, a passage passing through said plunger from top to bottom thereof, a ball check valve opening downwardly supported on said plunger and in communication with said plunger passage, a stem core having a passage extending from its lower end to an intermediate portion thereof, supported in said stem and having a threaded portion for engaging the stem bore threaded portion, the upper surface of the plunger being of the same contour as the lower end of the stem core so as to provide a fluid tight seat therebetween, at least one aperture passing off-center through said plunger from top to bottom thereof, means for resiliently urging said plunger downwardly with respect to the stem core, means for resiliently urging the piston upwardly away from the bottom of the tappet hollow body, an annular reduced portion on said stem core communicating with said passage extending in the direction of elongation of the stem, an aperture through the wall of the stem communicating with the stem core reduced portion, and means for locking said stem core from rotation with respect to the hollow stem whereby the stroke of said plunger and therefore the tappet can be fixed in a selected condition of lash.

12. A hydraulic tappet having a hollow body closed at its lower end, a piston slidably supported with a substantially fluid tight fit in said body, a stem affixed to said piston, and extending out of the upper end of said body, a vertical bore in said piston extending upwardly from the bottom thereof, a vertical passage in said stem extending from the piston bore to an intermediate portion along the length of said stem, a passage extending from the surface of said stem to said vertical passage, a fluid chamber in said body above and below said piston, a plunger slidably supported with a substantially fluid tight fit in said piston bore, the inner end of the piston bore and the inner surface of the plunger having the same surface contour so as to provide a fluid tight valve when the plunger is seated, said plunger having at least one aperture therethrough offset of the stem vertical passage, means for resiliently urging said plunger off its seat, means for urging said piston away from the bottom of said tappet body, and fluid filling the lower fluid chamber and filling most of the space of the upper fluid chamber.

13. A hydraulic tappet having a hollow body closed at its lower end, and having a closure member with a centrally located bore therethrough, a piston slidably supported with a substantially fluid tight fit in said hollow body, a hollow stem affixed to said piston and extending out of the top of said hollow body through said closure member bore, said piston having a vertical bore extending thereinto from its lower surface, said hollow stem having an internally threaded portion, a stem core extending through said hollow stem, a plunger slidably supported in said piston bore and having a vertical aperture therethrough, said stem core having an end surface of the same contour as the upper surface of the plunger to provide a valve seat therefore, a vertical fluid passage extending in said stem core from the lower end thereof to an intermediate portion, a transverse passage extending from the surface of said stem core to said vertical fluid passage, and an annular relief on the exterior of said stem core communicating with the outer end of the said transverse passage, an aperture in the hollow stem communicating with the stem core annular relief, fluid filling the space between the piston and the lower end of the tappet body and fluid nearly filling the space between between the piston and the upper end of the tappet body whereby said hydraulic tappet is completely self-contained.

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