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VARIABLE STROKE HYDRAULIC VALVE LIFTER

Filed July 13, 1967

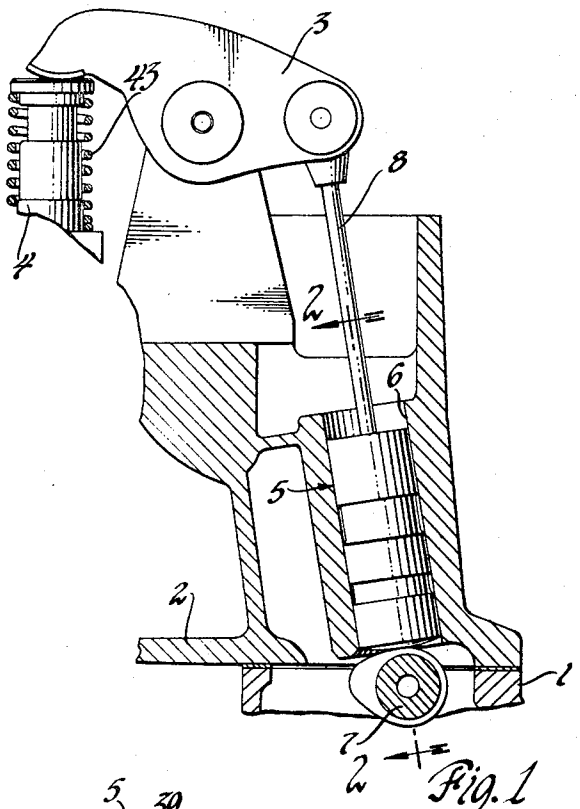


Fig. 1

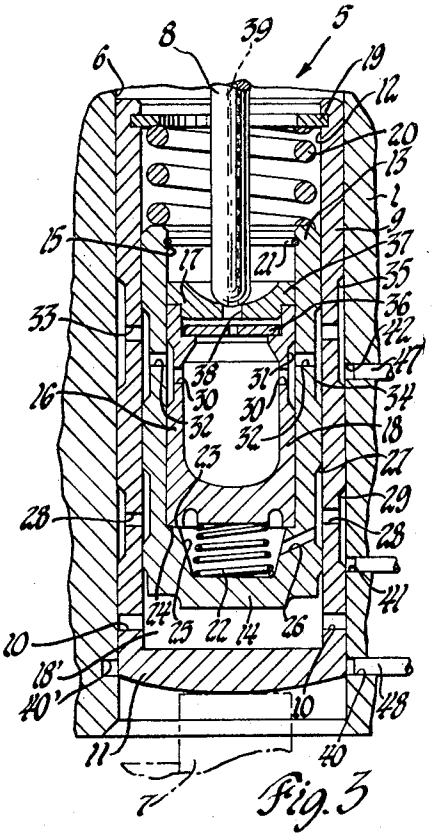


Fig. 3

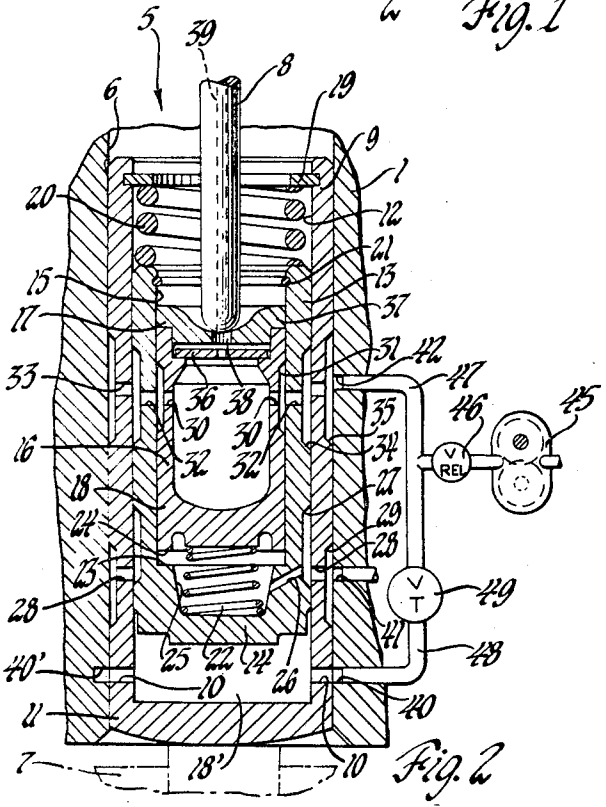


Fig. 2

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VARIABLE STROKE HYDRAULIC VALVE LIFTER

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5 Claims. (Cl. 123—90)

ABSTRACT OF THE DISCLOSURE

A spring-returned, cam-actuated push rod and rocker mechanism having a variable stroke hydraulic tappet interposed between the push rod and cam, the tappet having a plunger drivably abutting the push rod and drivable in turn by a piston-like inner member resting on a column of hydraulic fluid contained in an outer cylinder-like member which drivably engages the cam, the hydraulic fluid being supplied under adjustably controlled pressure from a pump to a port in the outer member which is open only between lift strokes of the tappet, i.e. during the dwell and lower portions of the cam lift cycle.

Background of the invention

Our invention relates to hydraulic lifters or tappets such as are used, for example, in maintaining substantially zero lash in the valve operating mechanisms of internal combustion engines, and particularly to such a device whose lift stroke can be regulated by a control oil pressure.

Fixed lift stroke hydraulic tappets have been in wide commercial use for many years, one example being that shown in the U.S. Patent No. 2,818,050 to Papenguth. Also, variable lift of a hydraulic tappet, through provision of a bleed port in the pressure chamber whose duration of registry with a return port in the tappet guide member varies with operating speed, is disclosed in U.S. Patents Nos. 2,484,109 and 2,614,547 to Meinecke. The use of engine lubricating oil pressure to control the length of a hydraulically extensible tappet, as distinguished from control of its lift stroke, is taught by U.S. Patent No. 2,997,994 to Falberg. Variable lift of an engine valve hydraulically coupled to a tappet, by adjustably controlling the fluid input to the hydraulic coupling chamber, is shown in U.S. Patent No. 2,011,864 to Lundh. In U.S. Patent No. 2,393,793 to Meth, such a hydraulic coupling chamber is in the form of a drilled or cored longitudinal passage extending through a side wall of a cam actuated cylinder from a chamber in its lower end to an upper chamber therein in which a movable piston is slidably fitted for actuating the valve, there being also a similarly cored supply passage in the cylinder wall connecting at its upper end with a gallery port in the cylinder guide and closable during lift of the cylinder by a fixed piston between the two chambers.

Summary of the invention

The hydraulic tappet of our invention combines the functions of maintaining substantially zero lash in the valve train under all operating conditions, and of enabling the effective lift stroke of the tappet to be adjusted without interfering with the normal operation of the tappet. This latter feature, of course, has the obvious utility of making self-adjusting hydraulic tappets usable in extra-performance engines whose valve lift requirements are different at high operating speeds from those at low speed and idle. This desired result is accomplished by a unique and compact arrangement of simply constructed parts basically comprising three mutually telescoping relatively movable members and resilient means biasing

the innermost and outermost of these members in one direction relative to the intermediately associated member. By suitably porting the outermost member and the tappet guide to a source of fluid pressure such as the engine lubricating oil system, and employing a pressure control between such pressure source and the guide port, the relative movement between the intermediate and outermost members during the cam lift stroke is controlled. This serves to regulate the lift of the engine valve by the innermost member since relative movement between the latter and the intermediate member is limited by cooperating abutment or stop means on those members. Also by additionally porting each of the members to the engine lubricating system, oil may be introduced into the innermost member for metered supply to the engine's rocker bearing surfaces or other parts requiring lubrication.

Brief description of the drawing

FIGURE 1 shows a portion of an internal combustion engine in transverse section, illustrating application of a tappet embodying the invention, the parts being shown in their relative positions prior to start of cam lift.

FIGURE 2 is an enlarged view of the tappet, in longitudinal section along line **2—2** of FIGURE 1, and schematically showing the tappet fluid supply and control means.

FIGURE 3 is a view similar to FIGURE 2 but showing the parts in their relative positions of approximately maximum lift.

Description of preferred embodiment

Referring now in detail to the drawing and first to FIGURE 1, the upper portions of an engine cylinder block **1** is shown, having a cylinder head **2** on which is mounted a rocker **3** for operating a spring closed valve **4** or other reciprocably driven element. The tappet, designated generally by the numeral **5**, is reciprocable in guide means formed by a tappet bore **6** in the cylinder head directly above the engine driven cam **7**. A push rod **8** interconnects the tappet and the rocker **3**. The parts are shown in FIGURE 1 in their relative positions prior to the start of the lift stroke of the cam **7**.

As shown in FIGURE 2, the tappet comprises an upwardly open outer cylinder member **9** having one or more side ports **10** extending thereinto adjacent its closed end **11** which rests on the cam **7**. This cylinder member slidably engages the tappet bore **6**, and its bore **12** is slidably fitted with an inner cylinder member **13**. This inner cylinder member has a closed end **14** adjacent but normally spaced above the closed end **11** of the outer cylinder member to form a hydraulic fluid chamber **18'**. Slidably fitting the bore **15** of the inner cylinder member is a hollow plunger **16**. The open upper end of this plunger carries a push rod seat member **17**, and its lower closed end **18** is spaced from the closed end **14** of the inner cylinder member to form a spring chamber **25**.

Adjacent the upper end of the outer cylinder member is a suitable abutment in the form of a snap ring **19**, and between this and the upper end of the inner cylinder member **13** is spring means in the form of a coil compression spring **20** which biases relative movement between the two cylinder members in the direction to bring their closed ends **14** and **11** toward each other. A generally similar retainer ring **21** is mounted in the upper end of the inner cylinder member to retain the push rod seat **17** therein when the push rod or tappet assembly is removed from the engine. Other spring means in the form of a coil compression spring **22** is provided between the closed ends **18** and **14** of the plunger and inner cylinder member, and acts to bias the plunger against the push rod and the inner cylinder member toward the closed end **11** of the outer

cylinder member. Stop means formed by opposing shoulders 23 and 24 on the inner cylinder member and plunger serve to limit compression of this spring 22. The chamber 25 for this spring is vented by a passage 26 to an external groove 27 in the outer periphery of the member 13. Opposite this groove are one or more side ports 28 extending through the outer cylinder member 9 to an external groove 29 in its outer periphery. Groove 27 is of sufficient width to communicate with cooperating side vent ports 28 extending through the outer cylinder members 9 to an external groove 29 in the outer periphery of the member 9. As shown, the interior of the plunger 16 is connected by one or more ports 30 to an external groove 31 on its outer periphery, and communicating therewith are similar side ports 32, 33 and external grooves 34, 35 formed in the inner and outer cylindrical members 13 and 9. An apertured plate-like valve 36 is provided between an internal shoulder 37 on the plunger and the bottom face of the piston rod seat 17, with limited freedom to move therebetween in controlling oil flow to a longitudinal passage 39 which extends through the push rod 8. By suitably shaping the upper surface of this plate valve and the lower face of the push rod seat, variable flow rate of oil from the plunger through the push rod may be obtained for lubricating the rocker 3 in the manner disclosed by the aforesaid Papenguth patent.

The tappet guide bore is provided with a supply port 40 and connecting internal groove 40' for communication with the lower side ports 10 in the outer cylindrical member, irrespective of axial rotation of this member, between lift strokes of the tappet, i.e. during the dwell and lower portions of the left cycle of the cam 7. The plunger and inner cylinder member 31 and grooves 34 are of sufficient width to maintain registry with the inner the inner and outer cylindrical ports 32 and 33, respectively, throughout the range of relative axial movement of the plunger and members 13 and 9. Ports 41 and 42 are provided in the tappet guide bore opposite the grooves 29 and 35, and these grooves in the outer cylinder member of sufficient width to maintain registry with these ports throughout the range of cam-induced vertical movement of the outer cylinder member. Tappet-induced movement of the push rod 8, rocker 3 and engine valve 4 is opposed by the usual valve return spring 43.

Shown schematically in FIGURE 2 is a source of hydraulic fluid pressure in the form of a pump 45, such as the engine lubricating pump which draws oil from the engine crankcase or other suitable sump (not shown). The output of this pump is shown connected by suitable conduit means 47 through conventional pressure relief or regulating valve 46 to the upper port 42 in the tappert guide bore. Other conduit means 48 incorporating pressure control means, such as a throttling valve 49, connects the regulated oil pressure to the port 40 and groove 40' in the tappert guide bore. It will be appreciated that the throttling valve 49 may be manually controlled or made automatically responsive to a desired input signal (not shown) responsive to engine speed or power demands.

During operation, oil from the pump 45 is fed to the conduits 47 and 48 at some suitable and reasonably constant pressure, say 35 lbs. per square inch, as set by the relief valve 46. From the conduit 47 this oil enters the plunger 16 through the ports 42, 33, 32, 30 and is metered by the plate-like valve 36 to flow through the push rod seat opening 38 and push rod passage 39 to lubricate the valve rocker 3. Simultaneously, the conduit 48 delivers oil, at the pressure adjustably controlled by the throttling valve 49, to the port 40 and groove 40' in the tappet guide bore. While the outer cylinder member 9 is resting on the base circle of the cam 7, and until the lower ports 10 move out of registry with this groove 40', such throttled oil pressure eners the outer cylinder member and fills the chamber 18'. The upper spring 20 is relatively stiffer than the lower spring 22 and is strong enough to prevent the force of such oil pressure from moving the inner cylinder member upwardly far enough to bring its shoulder 23 into abutment with the plunger shoulder 24, execpt when the throttle valve 49 is set at its wide open position. At this time, the lower spring 22 acts against the plunger and push rod seat to take up all lash between it and the engine valve 4. As the cam 7 begins its lift stroke, the outer cylinder begins to move upwardly relative to the inner cylinder member, forcing the oil displaced therebetween out through the ports 10, groove 40', port 40 and conduit 48 until the ports 10 move out of registry with the groove 40'. The oil which is thereafter trapped between the two cylinder members acts during continued lifting action of the cam to cause the inner cylinder member to move therewith relative to the plunger, compressing the lower spring 22. Such oil as is displaced from the chamber 25 during compression of the spring 22 is vented by the ports 26, 28, 41 and grooves 27, 29 back to the sump or return side of the pump 45. Such compression of the spring 22 continues until the stop shoulders 23, 24 abut each other, whereupon continued lifting action of the cam is transmitted to the plunger and opening of the engine valve 4 commences. FIGURE 3 shows the relative positions of the parts at the maximum cam lift and engine valve open position.

On the downstroke, the engine valve spring 43 forces the parts to follow the surface of the cam back to its base circle. During this action the push rod seat, plunger and inner and outer cylinder members move in unison until separation occurs between the stop shoulders 23 and 24 on the inner cylinder member and plunger. Following this, the upper and lower springs 20 and 22 continue to force the inner cylinder member downwardly against the oil trapped in the chamber 18' in the outer cylinder member, causing the latter to also move downwardly until the lower ports 10 therein again register with the groove 40' in the guide bore. At this point the oil pressure in the conduit 48 again acts to fully return the outer cylinder member to the base circle of the cam, taking up any foreshortening or lash which may have developed in the mechanism during the proceeding lift stroke of the cam.

By controlling the oil pressure to the chamber 18' through regulation of the throttle valve 49, the effective lift stroke of the tappet, hence the extent of opening of the engine valve 4, may be controlled. The lower this oil pressure, the less compression of the springs 20 and 22 occurs, and consequently the greater is the spacing between the stops shoulders 23 and 24 prior to the outer cylinder member 11 moving upwardly on its lift stroke to the point of cut-off of its port 10 from the port in the guide. Conversely, the higher this oil pressure is adjusted by the throttle valve the more the springs 20 and 22 are compressed and the closer is the spacing between the stop shoulders 23 and 24 when such registration of ports 10 and 40 is cut-off. Thus, regulation of the throttle valve 49 controls the effective lift stroke of the tappet by varying the lost motion provided by spacing between the stop shoulders 23 and 24.

It will be appreciated that various changes in the design and arrangement of the parts may be made without departing from the spirit and scope of our invention as defined in the following claims.

We claim:

1. A hydraulic tappet comprising an outer cylinder member closed at one end and having a side port extending thereinto adjacent said closed end, an inner cylinder member within and slidably supported by the outer member for relative longitudinal movement toward and away from the closed end of the outer member, said inner member having a closed end adjacent the closed end of the outer member, spring means reacting against one of the members and biasing movement of the other in the direction to bring their closed ends toward each other, a plunger within and slidably supported by the inner member for relative movement toward and away from the closed end of the inner member, stop means on said plunger and inner member limiting their said relative

movement toward the closed end of the inner member, guide means slidably supporting said outer member for longitudinal reciprocation and having a port registrable with said side port only between lift strokes of the tappet, and spring means reacting against the plunger and biasing movement of the inner member toward said closed end of the outer member.

2. A hydraulic tappet comprising inner and outer cylinder members in slidably interfitting relation, each having a closed end adjacent that of the other, said closed ends defining therebetween a hydraulic fluid chamber within said outer member, guide means slidably supporting said outer member for longitudinal reciprocal movement and having a hydraulic fluid supply port closable by said outer member, a plunger slidable longitudinally in said inner member, stop means on said plunger and inner member limiting relative movement of the plunger toward said closed end of the inner member, spring means biasing relative movement of the plunger and inner member in the opposite direction, other spring means biasing relative movement of the inner member toward said closed end of the outer member, and a side port in said outer member connected to said chamber and registrable with said supply port only between lift strokes of the tappet.

3. The invention of claim 2, including a source of hydraulic fluid pressure, conduit means connecting said source to said supply port, and means for adjusting the hydraulic fluid pressure in said conduit means.

4. The invention of claim 2, wherein said plunger is hollow and has an inlet and an outlet for hydraulic fluid, said guide means has a second port, said outer member has a second port communicating with said guide means second port, and said inner member has a port communicating with said plunger inlet and said outer member second port.

5. The invention of claim 4, including a source of hydraulic fluid pressure connected to said guide means second port, conduit means connecting said source to said supply port, and means for controlling the fluid pressure in said conduit means.

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AL LAWRENCE SMITH, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,385,274 May 28, 1968

Rudolph C. Shunta et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 34, "portions" should read -- portion --. Column 3, lines 10 and 11, "mem-bers" should read -- member --; line 16, "cylindrical" should read -- cylinder --; line 20, after "flow" insert -- through a central opening 38 in the push rod seat --; line 32, "left" should read -- lift --; line 34, cancel "the inner", second occurrence; line 39, after "member" insert -- are --; lines 50 and 53, "tappert", each occurrence, should read -- tappet --; line 71, "eners" should read -- enters --. Column 4, line 1, "execpt" should read -- except --; line 46, "stops" should read -- stop --.

Signed and sealed this 7th day of October 1969.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents