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POPPET VALVE ACTUATION

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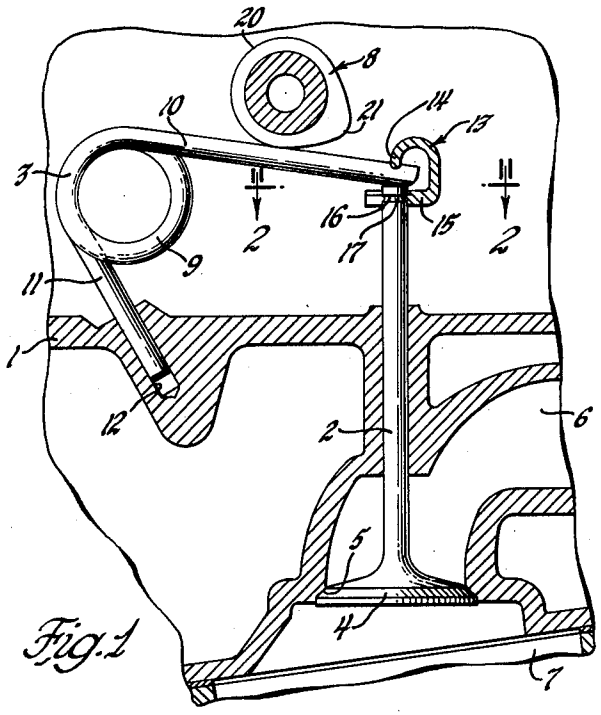


Fig. 1

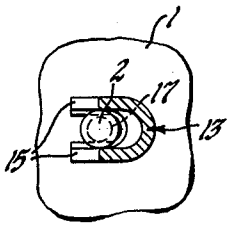


Fig. 2

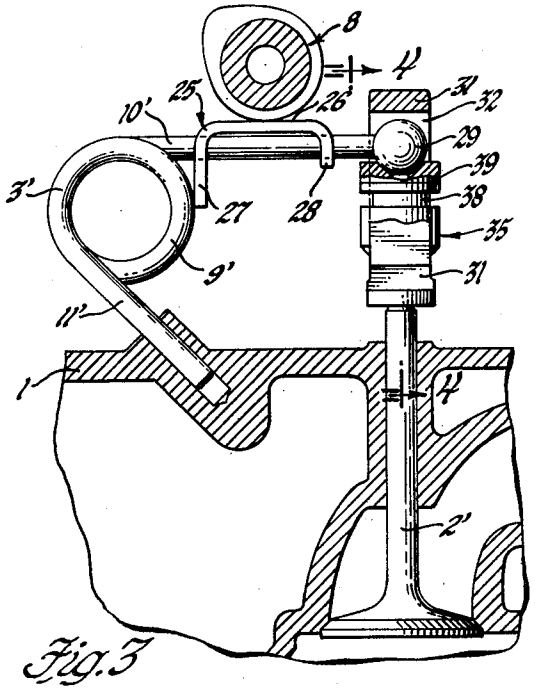


Fig. 3

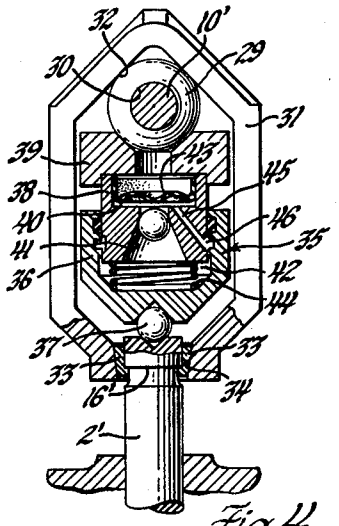


Fig. 4

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POPPET VALVE ACTUATION

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This invention relates to valve operating mechanisms, and particularly to the actuation of poppet valves.

Among the principal objects of the invention are to simplify such actuating mechanisms requiring a greater or lesser degree of valve opening travel relative to the cam lift stroke. Such prior art mechanisms commonly employ a pivoted rocker for transmitting the cam motion to the stem of the poppet valve, either directly or via a push rod and tappet extending between the rocker and the cam. My invention not only eliminates the need for such push rods and tappets but also, through use of a novel valve return spring arrangement, enables elimination of need for any such rocker. However, all the functional requirements of such prior art mechanisms are retained, including the adaptability to provisions for automatically taking up operating lash or clearance in the valve train where such is desired.

The usual valve rocker is eliminated by employing a cantilever spring, preferably in the form of an arm extending from the free end of a torsion spring, which arm is connected to the valve and serves as a follower for the cam. The invention will be more clearly understood from the following description, having reference to the drawing, wherein:

FIGURE 1 shows a section of an internal combustion engine of the overhead cam type, embodying the features of my improved poppet valve actuating mechanism.

FIGURE 2 is a fragmentary sectional view taken substantially along the line 2—2 of FIGURE 1, showing a detail of the connection between the poppet valve stem and the cam follower spring arm.

FIGURE 3 is a view similar to FIGURE 1 but showing a modified form of the invention in which valve lash is automatically taken up during operation and wherein the follower arm of the spring is insulated from direct wearing engagement with the cam.

FIGURE 4 is a fragmentary sectional view taken substantially along the line 4—4 of FIGURE 3.

Referring now in detail to the drawing, and first to FIGURES 1 and 2, an engine cylinder head 1 is shown which forms a slidable support for the stem 2 of a poppet valve and also forms the reaction support for a valve return spring 3. The head 4 of the valve is movable downwardly from its position shown, away from the valve seat 5, to open the port passage 6 in the head for communication with a working cylinder 7 of the engine in the usual manner. A conventional engine-driven cam 8 cooperates with the spring 3 in effecting reciprocation of the poppet valve. For this purpose, the spring 3 is of the torsion type having one or more coiled convolutions 9 whose opposite ends terminate with tangentially extending arms 10 and 11. The arm 11 serves as the reacting arm and is suitably fixed at its extended end to the cylinder head 1, as by means of a press fit in a hole 12 in the head. The other arm 10 serves as the spring loading arm and as a follower for the cam 8. At its extended end this arm 10 overlies the upper end of the valve stem 2 and is retained in abutment therewith by a generally L-shaped clip 13, one leg 14 of which overlies the arm and the other leg 15 of which is bifurcated to underlie a shoulder 16 at the upper end of an annular groove 17 in the valve stem. It will be seen that the arm 10 operates in the manner of a cantilever spring whose free end is connected to the valve and whose opposite end is resiliently supported from the cylinder head through the convolutions 9 and the reaction arm 11.

The bias of the spring 3 is such as to urge the valve toward its closed position, shown, at all times, with only sufficient clearance (not shown) existing between the spring arm 10 and the base circle 20 of the cam to insure freedom for the valve to fully close irrespective of whatever thermal elongation may occur in the valve stem during engine operation. As the cam 8 rotates in a clockwise direction from its position shown the lobe 21 of the cam forces the arm 10 to swing downwardly in a clockwise direction about the torsional axis defined by the spring convolutions 9. The poppet valve is correspondingly moved in the opening direction, with the amount of such movement being greater than the degree of cam lift in accordance with the ratio of effective distances from the spring axis with which the arm 10 engages the valve stem and the cam, respectively. As the cam continues its rotation until the lobe 21 has passed out of contact with the spring arm 10 this arm returns to the cam base circle 20, allowing the valve to reclose.

The modified form of the invention shown in FIGURES 3 and 4 is similar to the first form just described, except an anti-wear pad 25 is carried by the spring loading arm 10', and the connection of the free end of this arm to the valve stem includes means for taking up operating lash or clearance so that no such clearance between the arm 10' or pad 25 with the cam is required. The elimination of such necessity for clearance serves, of course, to reduce operating noise and wear between abutting surfaces of the arm, pad, cam and valve stem.

The spring 3' in this modified arrangement is similarly secured by a reaction arm 11' to the cylinder head 1, and the free end of the loading arm 10' extends opposite the end of a poppet valve stem 2', as in the previous embodiment. The anti-wear pad 25 is in the form of a U-shaped member whose yoke portion 26 bears against the surface of the cam 8, and whose legs 27 and 28 are coaxially drilled to receive the arm 10' with a press fit so as to retain the yoke portion 26 in proper position for engagement with the cam. The leg 27 of the pad is extended so as to bear tangentially against the spring convolutions 9', and thereby render stability to the spring against twisting other than about its torsional axis.

At its free end (FIGURE 4) the arm 10' carries a ball 29 with a drilled opening 30 therein having a slip fit on the arm 10'. A link 31 interconnects this ball 29 with the upper end of the valve stem 2' so as to effect return movement of the valve with upward movement of the free end of the spring arm 10'. A seat 32 is provided for this purpose in the upper end of the link 31, and the lower end of the link is suitably secured to the valve stem as by means of conventional split retainer locks 33 whose lower portions underlie the valve stem shoulder 16' and whose outer periphery is tapered to engage a correspondingly tapered socket 34 in the lower end of the link.

Disposed between the ball 29 and the upper end of the valve stem 2' is a lash take-up device designated generally by the numeral 35. This device is of the self-contained hydraulic type comprising an upright, generally cup-shaped cylinder member 36 whose lower end pivotally rests on a ball 37 abutting the upper end of the valve stem. Slidably fitting within the side walls of the cylinder member 36 is a hollow plunger 38 whose upper end carries a centrally apertured plate 39 seated against the ball 29. A reservoir chamber 40 is provided in the upper portion of the plunger, and this chamber communicates via a check valved passage 41 through the lower end of the plunger with the interior of the cylinder member 36 below the plunger. This lower interior portion of the cylinder member constitutes a pressure chamber 42 which

is completely filled with oil or other hydraulic fluid, and a quantity of like fluid is initially provided in the reservoir chamber 40 of the plunger. A flexible diaphragm 43 of rubber or other resilient material is located in the upper portion of this reservoir to retain the fluid therein and prevent admixture of air. A spring 44 is provided in the pressure chamber 42 to normally bias the plunger outwardly thereof. A drilled passage 45 interconnects the portion of the reservoir 40 below the diaphragm 43 with an external groove 46 on the plunger adjacent its lower end.

During operation of this embodiment of my invention, rotation of the cam is transmitted via the wear pad 25 to the arm 10', and the ball 29 on the free end of this arm re-transmits the movement to the plate 39 and plunger 38. The inertia of the cylinder 36 and the engine valve 2' causes them to lag behind such downward movement of the plunger, resulting in hydraulic pressure developing in the pressure chamber 42 in excess of that existing in the reservoir chamber 40, and this pressure difference acts upwardly on the check valve to close it, following which the cylinder member of the lash adjuster is forced downward to transmit the valve opening movement through the ball 37 to the stem 2'. The high fluid pressure developed in the chamber 42 results in a minute amount of the fluid therein escaping between the plunger and cylinder walls to the groove 46, from which it is returned via the passage 45 to the plunger reservoir 40. A slight foreshortening or "leak-down" of the lash take-up device, therefore, occurs during each valve opening stroke. On the return stroke, as the wear pad 25 returns to the base circle of the cam 8 and the arm 10' and link 31 relieve the thrust force on the valve, the plunger return spring acts to force the plunger upwardly relative to the cylinder member 36 to maintain abutment of the plate 39 with the ball 29. The resultant release of fluid pressure in the chamber 42 thereupon enables the check valve to open and admit from the reservoir chamber 40 whatever quantity of fluid is required to maintain the pressure chamber 42 filled.

As the result, all operating clearance between the cam 8, wear pad 25, ball 29, plate 39, plunger 38, cylinder member 36, ball 37 and the valve stem 2' is taken up during each valve return stroke in preparation for the next actuating stroke of the cam.

While only two embodiments of the invention have been described, it is appreciated that various minor changes in the arrangement of the parts may be made without departing from the spirit and scope of the invention as set forth in the following claim.

I claim:

In combination with a poppet valve having a stem, valve reciprocating means including a cam and a spring, a support slidably guiding said stem during valve reciprocation, said spring having one end reacting against said support and having a free end movable relative to said support, a follower for said cam in the form of an arm fixed at one end to said free end of the spring, and means including a hydraulic lash take-up device connecting the arm to the valve stem, transmitting cam actuated movements from the arm to the valve in opposition to the spring, said means also including a rigid link secured to the valve stem and having a seat engaged by the arm during spring returned movements of the arm, whereby spring returned movements of the arm are transmitted to the valve.

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