

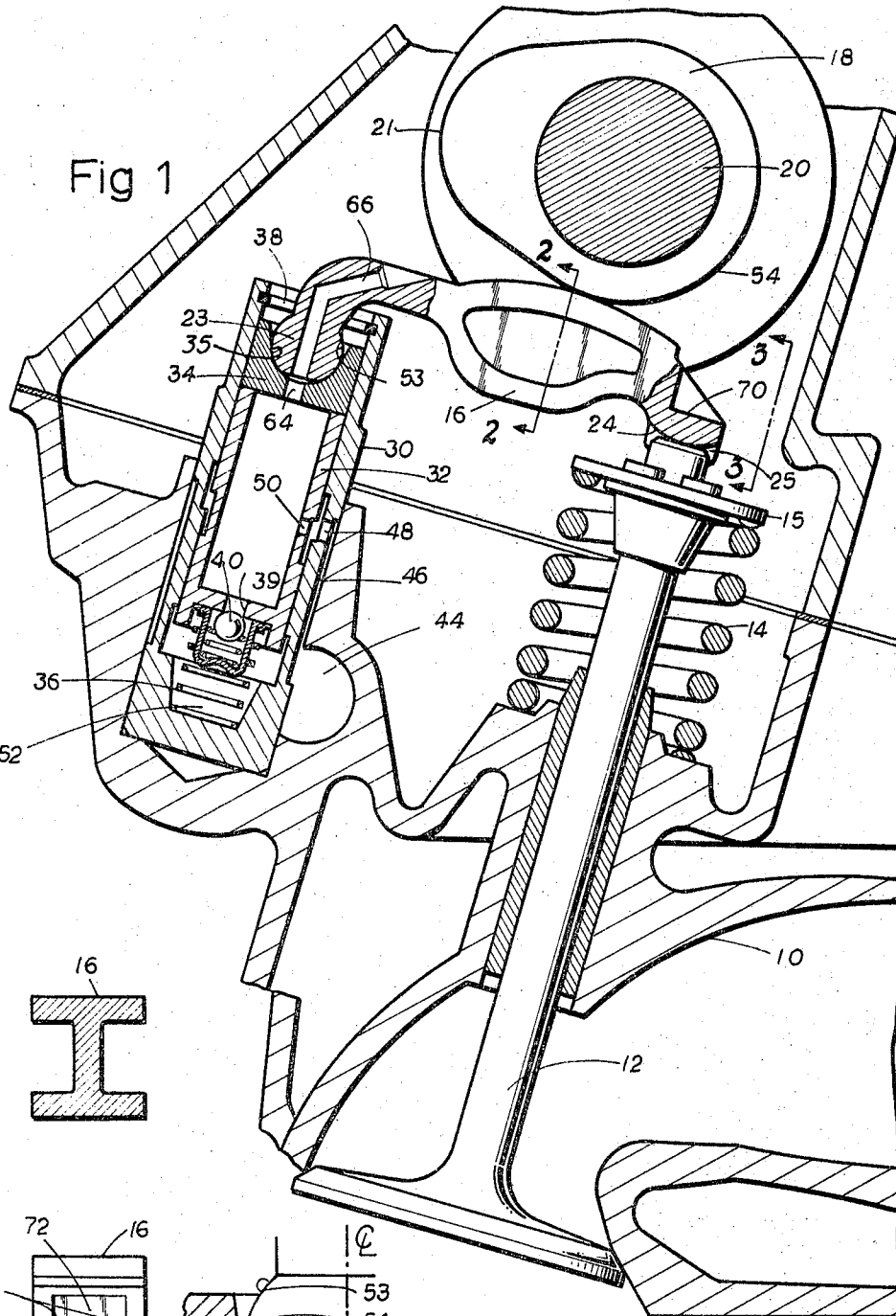
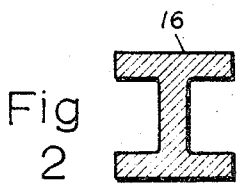
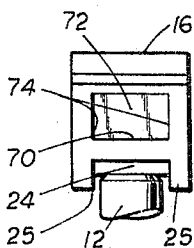
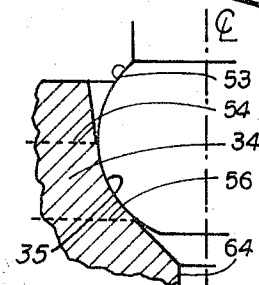
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E. A. THOMPSON

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ENGINE VALVE OPERATING MECHANISM

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INVENTOR.
Earl A Thompson
BY
J. L. Chisholm
Attorney

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ENGINE VALVE OPERATING MECHANISM

Earl A. Thompson, Bloomfield Hills, Mich.

(1300 Hilton Road, Ferndale, Mich. 48220)

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This invention relates to mechanisms for operating the poppet valves of internal combustion engines.

In such engines, it is customary to have the camshaft operate the valves through pivoted rocker arms, each bearing on a valve. An example of such general arrangement is shown in U.S. Patent 2,763,250 to Bensinger et al. dated Sept. 18, 1956. It is also customary to provide an automatic lash adjuster, called a hydraulic tappet, to take up lost motion in the valve train or valve actuating mechanism. Such a tappet customarily includes an assembly which is constantly urged to expand to take up slack when the valve is closed. When the valve is being opened, the tappet is urged to collapse by the force of the cam opening the valve against the force of the valve closing spring, but the collapse is retarded so that the tappet becomes substantially rigid, and the cam can be effective to open the valve.

An example is shown in my U.S. Patent 2,935,059, May 3, 1960. Such devices often have a plunger sliding in a cup-shaped guide called the tappet body, a spring constantly urging the plunger out of the body and toward the pivot end of the rocker arm, and an oil trap between the plunger and the body to retard collapse. The plunger carries a fulcrum for supporting the pivot end of the rocker arm, variously called a push rod seat or a rocker arm seat.

When such devices are used in engines having overhead camshafts, the camshaft bears directly on the rocker arm. In such devices the only useful force of the cam in opening the valve is that component of force which produces motion of the rocker arm in the direction of the axis of the valve stem. While the customary rotary cam does provide this motion of the rocker arm, it also provides an undesirable force. Because as the cam rotates, its surface rubs along the length of the rocker arm, it applies thrust to the rocker arm back and forth in the direction of its length which is transverse to the direction of reciprocation of the plunger. Because the load between the cam and the rocker arm is periodically heavy, this thrust is large. This causes side thrust on the seat, which in turn produces side thrust between plunger and body, which in turn causes destructive wear of the plunger or body or both. Even a small amount of such wear is serious because the fit, or clearance, between the plunger and body must be maintained within critical limits in order to control the rate of escape of oil from the oil trap, which controls the rate of collapse of the tappet, and thus controls the amount and timing of the valve opening.

One of the objects of this invention is to provide an improved and simplified valve train in which it is impossible to develop side thrust between the plunger and body of the tappet.

Another object is to provide an improved simple and effective arrangement of rocker arm and lash adjuster especially suited to overhead camshaft engines, and which has a minimum of parts.

These and other objects and advantages of the invention will be apparent from the following description and from the accompanying drawings, in which:

FIG. 1 is a transverse vertical section through an engine, showing partly in section and partly in elevation a valve train embodying one form of the invention.

FIG. 2 is a section of the rocker arm on the line 2—2 of FIG. 1.

FIG. 3 is an end elevation of the rocker arm as seen from the right of FIG. 1 showing the relationship of the rocker arm to the valve stem, and

FIG. 2 is an enlarged diagram of one form of the relationship between the pivot end of the rocker arm and its seat.

Referring to FIG. 1, 10 is an engine head in which is mounted a valve 12 normally closed by a valve spring 14 acting on a spring retainer 15. The valve is opened against the force of this spring by a rocker arm 16 when the rocker arm is depressed by the cam 18 fixed to a camshaft 20 mounted in the engine head. The rocker arm is of I-shaped section, to combine rigidity with light weight, as shown in FIG. 2. The left hand end 23 of the rocker arm includes a ball or a portion of a ball which is pivoted so that the right end swings down to open the valve when the lobe 21 of the cam engages the rocker arm. The rocker arm is constantly urged counter-clockwise about its pivot end 23 by the valve spring 14 which pushes the valve stem 12 against a rocker bearing surface 24 in a pocket 25 in the right end of the rocker arm. The pivot end 23 of the rod is automatically urged upward, to hold the rocker arm against the face of the cam. This is accomplished by an automatic lash adjuster or hydraulic valve tappet of generally known arrangement, which known construction however, is modified as herein explained to carry out the invention.

The tappet or automatic valve lash adjuster may include a cup-shaped body or guide 30 closed at its lower end. Slidable in the tubular portion of the cup is a plunger 32 which supports at its upper end a rocker arm seat 34 having generally spherical internal surface 35 which seat acts as a fulcrum for the pivot end of the rocker arm. The fulcrum is piloted in the bore of the cup, for a purpose to be explained. The plunger is constantly urged upward or out of the cup by a compression spring 36 and it is positively retained in the cup by a snap ring 38. The plunger is also cup-shaped and has in its bottom or lower wall an oil passage 39 controlled by a spring seated ball check valve 40. The body 30 is rigidly secured in a bore 42 in the engine head 10. Oil from the engine pump is supplied to the bore by a gallery 44 which is a source of oil under pressure. From the gallery 44 oil flows into an annular chamber 46 formed between the bore 42 and a portion of reduced diameter of the tappet body 30, then into the cup through passage 48 through its wall, and to the inside of the plunger through passage 50 in the plunger wall. Oil can flow out of the plunger through passage 39 into the oil trap or lower chamber 52 formed between the bottom of the plunger 32 and the bottom of the body 30.

Oil can also flow out of the plunger through the seat 34 to lubricate the cam 18 as will be explained. When the cam lobe 21 has turned past the pad 22, the tappet spring 36, in moving the plunger upward to hold the rocker arm in engagement with the base circle or dwell surface 54 of the cam, reduces the pressure of the oil in the chamber 52. Consequently oil supplied at higher pressure by the engine pump to the inside of the plunger opens the check valve 40 and replaces any oil which may have leaked from the chamber 52. When the lobe 21 depresses the rocker arm it urges the plunger 32 down. This closes the check valve and traps oil in the chamber 52 which tends to hold the plunger in fixed position so that the seat 34 tends to act as a fixed pivot for the rocker arm, which then swings clockwise to open the valve as is known.

Under the force of the cam, oil leaks out of the chamber 52 between the plunger and the body and enters the inside of the plunger through the opening 50. This arrangement automatically takes oil from the inside of the plunger into the chamber 52 and subsequently expresses excess oil from the chamber 52 back into the inside of the plunger during each revolution of the cam. This automatically takes up all lost motion or lash in the valve train, as is known, and holds the pivot end of the rocker arm within a small limit of motion throughout the cycle. It also automatically compensates for wear.

It is known that it is essential to prolonged and reliable operation of the tappet that the clearance between the plunger 32 and the body 30 be small and that it be maintained substantially constant over long periods of time. This clearance controls the leak-down rate or rate of escape of oil from the trap 52 into the plunger on the opening strokes of the valve. Heretofore it has been the practice to pilot or support the fulcrum or rocker arm seat in the bore of the plunger and to have this seat serve as the pivot bearing for the rocker arm. As the cam rotates clockwise it urges the rocker arm along its length toward the left as FIG. 1 is seen and this force along the length of the rocker arm becomes particularly severe when the rocker arm is under load from the rising face of lobe 21. In previous constructions these forces urged the plunger strongly against the side of the body 30 and this caused excessive wear of the body or plunger or both, which wear destroyed the accurate fit between the plunger and the body required for reliable operation.

When the receding face of the lobe engages the rocker arm the severe force along the rocker arm changes toward the right, as FIG. 1 is seen.

I prevent any lateral thrust from the cam on the plunger by piloting the seat 34 directly in the upper end of the bore in the body 30. This allows the rocker arm to rock about the seat and transmits all of the lateral thrust from the cam directly to the engine head through the fixed cup or body 30. The bearing zone between the seat and the body 30 is beyond the plunger 32, and since no lateral force is transmitted to the plunger, no amount of wear here can affect the clearance between the plunger and body at the escape path from the oil trap.

The pivot end 23 of the rocker arm is a ball including a bearing surface 53 which includes an approximate zone of a sphere. The top of the ball is necessarily missing where the pivot end joins the neck of the arm. The bottom of the ball is cut off, as shown in FIGS. 1 and 4 to provide for an oil passage. The ball is supported in the cup shaped surface 35 which includes an approximate internal zone of a sphere between planes 54 and 56. Above plane 54 and below plane 56 the surface 35 is tangent to the spherical surface between. The plane where the bottom of the ball is cut off is slightly below plane 56 and within the lower conical part of the surface 35 so that there is no edge oscillating in contact with the surface 35. The plane 54 is well below the top of the seat and preferably near its center. Above the plane 54 the surface 35 may be cylindrical, but is preferably conical and tangent to the spherical surface between planes 54 and 56. This spherical part of the surface 35 must not extend above the center of the spherical surface on the ball.

In order to lubricate and cool the surfaces 35 and 53 and the bearing between the cam and the rocker arm I prefer to supply lubricant, which is also a coolant, to these surfaces at a substantially constant, metered or measured rate. This may be done through a lubricating passage 64 in the seat and a continuing conduit 66 formed in the pivot end of the rocker arm and discharging adjacent the cam. Oil under pressure is squirted onto the cam and rocker arm, being supplied from the source of pressure 44 through annular chamber 46, openings 48, 50 and 64 and passage 66.

On the face of the rocker arm opposite to the cylindrical valve-operating surface 24 is formed a back-up surface

70 which is preferably flat and parallel to the axis of the cylinder forming the surface 24. Preferably the surface 24 is accurately formed by coining and the surface 70 forms a bearing for a back-up abutment to receive the force by which the surface 24 is coined. The surface 70 can be formed in a pocket 72 between side walls 74 which provide the necessary strength for the end of the rocker arm.

I claim as my invention:

1. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external ball-shaped surface pivoted in a cup-shaped surface on an elongated fulcrum member which is reciprocable within a guide fixed in the engine, the center of each of the surfaces being between the ends of the fulcrum member and within the guide, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the engine components of force from the cam in the direction of the length of the rocker arm.

2. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm member bearing on the valve and pivoted to a fulcrum member which is reciprocable within a guide fixed in the engine, one of said members having an external spherical surface bearing on a cup-shaped surface on the other member, the center of each of said surfaces lying within the guide, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum member including a plunger slidable in the guide and supporting the fulcrum member, the fulcrum member being piloted in the guide independently of the plunger to transmit directly to the engine components of force from the cam in the direction of the length of the rocker arm.

3. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external ball-shaped surface pivoted in a cup-shaped surface on a fulcrum which is reciprocable within a guide fixed in the engine, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the engine components of force from the cam in the direction of the length of the rocker arm.

4. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external surface including a zone of a sphere pivoted in a cup shaped fulcrum which is reciprocable within a guide fixed in the engine, the internal surface of the cup including a zone of a sphere of less axial extent than the zone on the pivot and having a conical surface at each end of the last mentioned zone diverging from the spherical surface on the pivot, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the guide components of force from the cam in the direction of the length of the rocker arm.

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5. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external surface including a zone of a sphere pivoted in a cup shaped fulcrum which is reciprocable within a guide fixed in the engine, the internal surface of the cup including a zone of a sphere of less axial extent than the zone on the pivot and having a conical surface at each end of the last mentioned zone tangent to the spherical surface and diverging from the spherical surface on the pivot, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the guide components of force from the cam in the direction of the length of the rocker arm.

6. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external surface including a zone of a sphere pivoted in a cup shaped fulcrum which is reciprocable within a guide fixed in the engine, the internal surface of the cup including a zone of a sphere of less axial extent than the zone on the pivot, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the guide components of force from the cam in the direction of the length of the rocker arm.

7. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external spherical surface pivoted in a cup-shaped surface on a

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fulcrum which is reciprocable within a guide, a cam rotatable against the rocker arm for operating the valve, the cam producing components of force on the rocker arm in the direction of its length and perpendicular to its length, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the guide components of force from the cam in the direction of the length of the rocker arm.

8. An internal combustion engine comprising in combination a reciprocable valve supported in the engine, a rocker arm bearing on the valve and having an external spherical surface pivoted in a cup-shaped surface on a fulcrum which is reciprocable within a guide, a cam bearing against the rocker arm for operating the valve, and an automatic lash adjuster for the fulcrum including a plunger slidable in the guide and supporting the fulcrum, the fulcrum being piloted in the guide independently of the plunger to transmit directly to the guide components of force in the direction of the length of the rocker arm.

References Cited by the Examiner

UNITED STATES PATENTS

25	1,792,836	2/1931	Handwerker	123—90
	2,763,250	9/1956	Bensinger et al.	123—90
	2,785,666	3/1957	Evans	123—90
	2,833,257	5/1958	Lengnick	123—90
30	3,045,657	7/1962	Sampietro	123—90
	3,153,404	10/1964	Van Slooten	123—90
	3,170,446	2/1965	Dolza	123—90

FOREIGN PATENTS

35	866,872	5/1961	Great Britain.
	952,247	3/1964	Great Britain.

MARK NEWMAN, *Primary Examiner.*

A. L. SMITH, *Assistant Examiner.*