HYDRAULIC TAPPETS FOR INTERNAL COMBUSTION ENGINES

Inventors: Aurelio Lampredi, Turin; Aldo Leoni, Cavoretto; Francesco Ghilardi, Turin; Francesco Degiorgis, Turin; Luigi Joli, Turin, all of Italy

Assignee: FIAJ Societa per Azioni, Turin, Italy

Filed: Dec. 13, 1971

Appl. No.: 207,068

Foreign Application Priority Data
Dec. 22, 1970 Italy..........................71258 A/70

U.S. Cl...........................123/90.56, 123/90.57
Int. Cl..........................F01N 1/24
Field of Search..........................123/90.56, 90.55, 123/90.57, 90.49

References Cited
UNITED STATES PATENTS
1,062,580 5/1913 Fils..........................123/90.55 X
2,175,467 10/1939 Johnson..........................123/90.55
2,880,710 4/1959 O'Neill..........................123/90.55 X
3,301,240 1/1967 Presada..........................123/90.56 X

FOREIGN PATENTS OR APPLICATIONS
1,241,634 8/1971 Great Britain..........................123/90.56
1,251,366 12/1960 France..........................123/90.56

Primary Examiner—Al Lawrence Smith
Attorney—Richard C. Sughrue et al.

ABSTRACT

A hydraulic tappet comprising two cup shaped parts one inside the other. The outer cup slides in a bore in a housing which may be the cylinder head. The bore has a groove connected to a source of hydraulic pressure and the groove is connected to a cooperating groove in the inner cup via holes in the outer cup. The two end walls of the cups define a chamber within which there is a non-return valve formed of a flat spring plate held in the middle so that its edges can flex to uncover the openings to passageways which communicate with the groove in the inner cup to admit hydraulic fluid which acts to automatically adjust the separation of the two end walls of the chamber to adjust the height of the tappet for automatic clearance adjustment.

6 Claims, 2 Drawing Figures
HYDRAULIC TAPPIES FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention relates to a hydraulic tappet having means for the automatic adjustment of clearance and suitable for overhead camshaft engines.

In particular, the present invention relates to a hydraulic tappet of the type comprising a first cup shaped member slidably mounted in a substantially cylindrical bore in a housing, and formed as a cylindrical wall closed at one end by a substantially flat end wall one face of which, in use of the tappet, is in contact with one cam of a camshaft assembled on the cylinder head of the engine, a second cup shaped member slidably mounted within the first and comprising a cylindrical wall closed at one end by a flat end wall located adjacent the said end wall of the first cup shaped member, a first annular groove around the bore in the said housing, the groove communicating with a source of fluid under pressure, a second annular groove on the outer surface of the cylindrical wall of the second cup shaped member and a plurality of radial apertures extending through the first cup shaped member and communicating, in an operating position, with the two said grooves.

In known hydraulic tappets of the type described above, (see for example U.S. Pat. No. 3,301,240) the open end of the second cup shaped member is closed by a cap against the outer surface of which there engages the end of the stem of a camshaft operated valve. This cap therefore defines, on the inside of the second cup shaped member, a closed cylindrical chamber which generally communicates with the second annular groove by means of radial apertures in the cylindrical wall of the said second cup shaped member.

Upon the end wall of the second cup shaped member there is generally formed a central axial aperture which allows the above mentioned closed chamber to communicate with a second chamber which is axially defined by the end walls of the two cup shaped members. This axial aperture is generally controlled by a ball valve mounted in the said second chamber which also contains a helical spring compressed between the two said end walls.

A tappet of the type described above has considerable disadvantages when it is used for automatic clearance adjustment in overhead camshaft engines.

In fact, the tappet described above has a considerable axial length which, although it does not involve any great disadvantage when the tappet is installed in an engine cylinder block does, on the other hand, means that the tappet extends above the engine when it is located on the cylinder head.

It is also necessary to stress that, assuming the lift of the valve operated by tappets to be the same, the accelerations to which a tappet mounted in the cylinder block is subjected are very much below those to which a tappet which is mounted in the cylinder head and directly operated by a camshaft cam is subjected. In fact, the axial movement of a tappet linked to a camshaft by an arrangement of push rods and rockers and due to the action of the cam, is amplified by the ratio of the arms of the control rocker of the valve; this amplification is absent when the cam controls the valve directly.

Consequently, whilst a hydraulic tappet of the type above described can be satisfactorily linked to a camshaft by a push-rod and rocker arrangement, it is not capable of withstanding for long the accelerations to which it would be subjected, even at a relatively low speed, in an overhead camshaft engine. Moreover, at high speeds both the helical spring between the two cup shaped members and the non-return valve, no longer operate correctly, thereby rendering the hydraulic tappet useless. The non-return ball valve, for example, fails to function correctly at high speeds owing to the inertia of the ball which, at high velocities, renders the said valve completely useless.

OBJECTS OF THE INVENTION

One object of this invention is to effect suitable modifications to an hydraulic tappet of the type described above so as to render its length approximately the same as that of a mechanical tappet assembled upon an overhead camshaft engine, and which therefore can replace the latter without the need for major alterations to the cylinder head.

Another object of this invention is to provide a hydraulic tappet for an overhead camshaft engine which will operate satisfactorily even at high speeds and which is capable of automatic clearance adjustment.

SUMMARY OF THE INVENTION

According to the present invention there is provided a hydraulic tappet for an internal combustion engine, of the type comprising a first cup shaped member slidably mounted within a bore in a housing, the first cup shaped member having a cylindrical wall closed at one end by a substantially flat end wall which, in use of the tappet, is arranged in contact with a cam of the engine, a second cup shaped member, slidably within the first and comprising a cylindrical wall closed at one end by a substantially flat end wall which is arranged adjacent the end wall of the first socket casing, a first annular groove extending around the bore in the housing and communicating with a source of fluid under pressure, a second annular groove in the outer surface of the cylindrical wall of the second cup shaped member and a plurality of radial apertures in the first cup shaped member through which the two grooves communicate, characterised in that the end walls of the cup shaped member define a cylindrical chamber within which there is located a cup spring, the chamber communicating with the second annular groove by means of a plurality of substantially axial passageways in the cylindrical wall of the second cup shaped member, fluid flow through the said passageways being controlled by non-return valve means at least partly held in position by the said cup spring, the inside face of the end wall of the second cup shaped member being arranged, when the tappet is in use, in contact with the end of the stem of a valve having return springs one end of which extends into the second cup shaped member. The housing may conveniently be the cylinder head itself formed with bores in positions corresponding to the valves to be operated by the camshaft.

In one embodiment of the invention the non-return valve means comprise a substantially flat and substantially circular metal plate located within the said cylin-
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3. Cylindrical chamber in engagement with the end wall of the second cup shaped member against which it is pressed by the cup spring, the diameter of the metal plate being substantially equal to the diameter of the cylindrical chamber.

From the above it will be appreciated, in the first place, that the end of the stem of the valve rests upon the inner surface of the end wall of the second cup shaped member which therefore fits over the said stem and surrounds the return springs of the valve. Consequently, the axial extent of the tappet above the valve is not, as in known tappets, equal to the whole of the axial extent of the first cup shaped member, but is substantially equal only to the height of the cylindrical chamber defined between the end walls of the two cup shaped members. Moreover, the height of this cylindrical chamber is less than the height of the corresponding cylindrical chamber of known hydraulic tappets of this type as the non-return ball valve has been replaced by a flat metal plate, the thickness of which is considerably less than the height of the ball valve previously used.

This flat plate operates satisfactorily as a non-return valve, particularly if it is made of steel, since, then, its resonance frequency is very high and therefore does not interfere with the operation of the valve even at very high speed. The same thing is true of the cup spring the reduced height of which contributes further to reducing the axial extent of hydraulic tappets constructed as embodiments of this invention.

Since the second socket casing has to receive within it the return springs of the camshaft valve, the diameter of the socket casing, and hence, the diameter of the cylindrical chamber must be relatively large, and generally greater than the corresponding diameter of known hydraulic tappets. Because of this the fluid within the cylindrical chamber of a tappet constructed as an embodiment of this invention is subjected, during operation of the engine, to substantially lower pressures than those to which the fluid in the corresponding chamber of known hydraulic tappets is subjected. Consequently, a tappet constructed as an embodiment of this invention operates under less stress than hydraulic tappets of known type and hence improved reliability can be expected.

Embodiments of this invention are also well suited to being operated directly by a cam such as occurs with camshafts located on the cylinder head of an engine; because of its substantial diameter, the surface area of contact with such a cam is of adequate size for satisfactory operation without requiring the tappet to be fitted with separate head caps which would increase the axial extent of the tappet. It is necessary, in fact, to consider that the cams of an overhead camshaft such as a camshaft located on the cylinder head of an engine has an active (developed) surface greater than that which, for equal height of the valve, is required of a cam assembled upon a camshaft placed in the engine block. This arises from the fact that the latter cam can make use, of the ratio of the lengths of the arms of the drive rocker of the valve to achieve the appropriate raising of the relative valve.

Two embodiments of the invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an axial section of a hydraulic tappet constructed as one embodiment of the invention, shown in the rest position; and

FIG. 2 is an axial section of a tappet constructed as a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown the stem 1 of a valve near to the upper end of which there is formed an annular groove 2. This groove 2 operates to retain two cotter 3 over which there is fitted an annular cap 4. The lower surface of the cap 4 is shaped with a number of shoulders which engage against the upper end of two coaxial return springs 5 and 6 which act on the said valve.

The valve is driven, via a hydraulic tappet, generally indicated 7, by a cam 8 of a camshaft 9 pivotally mounted upon supports, not illustrated, on a cylinder head 10 of the engine.

The valve stem 1 is associated with an opening in the cylinder head 11 with which the stem 1 of the valve is arranged to be coaxial. Within the opening 11 there is slidingly assembled the hydraulic tappet 7.

The hydraulic tappet 7 comprises inner and outer coaxial cup-shaped members, respectively 12 and 13.

The outer cup shaped member 12 consists of a cylindrical side wall 14 closed near one end by flat end wall 15 so as to form a short cylindrical recess 16 at the outer face of the closed end of the member 12. Within the recess 16 there is located a cylindrical pad 17, the upper surface of which is arranged to be in contact with the profile of the cam 8.

The inner cup shaped member 13, in its turn, comprises a cylindrical side wall 18 closed at one end by a flat end wall 19. The two cups 12 and 13 are positioned so that the two end walls are adjacent each other so as to define a short cylindrical chamber 20 within which there is a cup spring 21 which is arranged coaxially with respect to the cylindrical chamber 20. The cup spring 21 is substantially frusto-conical in shape and it is arranged so that the rim pressed against the inner surface of the end wall 19 of the cup shaped member 12.

At approximately half way along the length of the bore 11, there is an annular groove 22 which communicates with a substantially radial passageway 23 in the cylinder head 10; the passageway 23 leads to a pressure fluid induction pipe 23 which carries the lubricating oil of the engine.

Upon the outer surface of the cylindrical side wall 18 of the member 13 there is formed an annular groove 25 located opposite the groove 22. The annular grooves 22 and 25 are placed in communication by means of a number of radial apertures 26 in the side wall 14 of the cup shaped member 12. These two grooves 22 and 25 are wider than the diameter of the apertures 26 so as to allow communication between the two grooves 22 and 25 in the normal position of the tappet 7.

The annular groove 25 also communicates with the cylindrical chamber 20 by means of a number of passageways 27 which extend substantially axially on the inside of the wall 18.
Each of the passageways 27 comprises a first part 28 which opens into the upper edge of the annular groove 25 and is inclined from the said annular groove, towards the axis of the chamber 20, and a second portion 29, connected to the portion 28, and having an axis parallel to that of the chamber 20. The portion 29 opens into the chamber 20 through an aperture 30. The apertures 30 are uniformly distributed around the outer edge of the upper surface of the end wall 19 of the member 13.

Extending around the outer surface of the lateral cylindrical wall 18 there are, in addition to the annular groove 28, a number of relatively small annular grooves 31 which are uniformly distributed over that part of the outer surface of the lateral wall 18 not occupied by the groove 25.

In the embodiment illustrated in FIG. 1 the end wall 19 is provided with a boss 32 which extends into, and is coaxial with, the said chamber 20. The boss 32 engages into a centre opening 33 in a metal plate 34 placed in contact with the outer surface of the end wall 19 and the outer diameter of which is substantially equal to that of the said wall 19, the centre boss also extends through a central hole in the cup spring 21 to centrally located the spring 21 in the chamber 20. The metal plate 34 is held in contact with the upper surface of the end wall 19 by the cup spring 21 which presses against the upper surface of the said plate 34. Thus, at least the areas of the plate 34 immediately surrounding the aperture 33 are kept rigidly in contact with the end wall 19 whilst the outer periphery of the plate 34 is able to bend upwards, thereby separating itself from the end wall 19.

The outer portion of the metal plate 34 covers the apertures 30 so that the plate 34 constitutes in effect a non-return valve for simultaneously controlling all the passageways 27.

Since the force exerted by the fluid pressure in the passageways 27 has to bend the plate 34, the required diameters of the passageways 30 will be calculated in relation to the thickness of the metal plate 34, which, in its turn, will be calculated in relation to the greatest speed of rotation of the engine.

The function of the cup spring 21 is to keep the inner surface of the end wall 19 in contact with the upper end of the stem 1. This latter is mounted, by means of the cap 4, at the upper end of the springs 5 and 6, on the inside of the cup shaped member 13. When the valve is closed the cup spring 21 extends, drawing fluid into the chamber 20 through the apertures 30. The metal plate 34 is flexed upwards by the inflow of fluid to allow the chamber 20 to fill. As the valve is opening, the member 12 tends to move under the thrust of the cam 8 towards the member 13, therefore tending to compress the fluid inside of the cylindrical chamber 20. This fluid, presses upon the upper surface of the metal plate 34 thereby closing it against the upper surface of the end wall 19 of the socket casing 13, to securely shut the apertures 30 and prevent the outflow of fluid from the cylindrical chamber 20.

While the valve is open a small part of the fluid compressed in the cylindrical chamber 20 trickles out between the inner surface of the side wall 14 and the outer surface of the side wall 18. This small amount of fluid is, however, replaced when the valve 1 is next shut, by the fluid which is re-admitted to the inside of the cylindrical chamber 20 through the apertures 30.

While the valve is opening, the fluid bearing formed by the fluid under pressure within the cylindrical chamber 20, has a substantially infinite rigidity and it therefore permits correct transmission of movement from the cam 8 to the valve stem 1, whilst any slackness is automatically taken up by the cup spring 21.

In an alternative embodiment, shown in FIG. 2, the non-return valve consists of a plate 34' in the form of a ring floatingly assembled in the chamber 20; this plate is centred on the inner diameter of the first cup shaped member 12 and moves freely in the axial direction in dependence on the pressures acting on its surfaces. A cup spring 21 is again engaged onto the boss 32 of the wall 19, and it rests upon an annular shoulder 32a coaxial with the boss 32.

Naturally the principle of the invention remaining the same, the details of construction can be widely varied in regard to what has been illustrated and described purely by way of non-restrictive example, without nevertheless departing from the spirit and scope of this invention.

We claim:
1. In a hydraulic tappet of the type comprising: a housing having a substantially cylindrical bore therein,
a first cup shaped member slidably mounted within said bore in said housing, said first cup shaped member comprising a substantially cylindrical wall closed at one end by a substantially flat end wall which, in use of the tappet, is arranged in contact with a cam of said engine,
a second cup shaped member slidably mounted within said first cup shaped member and comprising a substantially cylindrical wall closed at one end by a substantially flat end wall, said flat walls at said one end of said first and second cup shaped members being located adjacent each other to define a cylindrical chamber therebetween,
a first annular groove extending around said bore in said housing, said annular groove communicating with a passageway in said housing which leads to a source of fluid pressure,
a second annular groove in the outer surface of said cylindrical wall of said second cup shaped member, and
a plurality of radial apertures in said cylindrical wall of said first cup shaped member said first and second annular grooves communicating with each other through said plurality of radial apertures, the improvement wherein:
a cup spring is located in said cylindrical chamber defined by said end walls of said first and second cup shaped members,
a plurality of axially extending passageways linking said cylindrical chamber to said second annular groove are formed in said cylindrical wall of said second cup shaped member,
non return valve means controlling said plurality of axially extending passageways are located in said cylindrical chamber and at least partly held in position by said cup spring, and
said tappet is arranged such that, in use, the inside face of said end wall of said second cup shaped
member contacts the end of a valve stem having return springs one end of which extends into said second cup shaped member.

2. The hydraulic tappet of claim 1 wherein said non-return valve means comprise:
a substantially flat, circular metal plate having a diameter substantially equal to the diameter of said cylindrical chamber, said plate being located in said cylindrical chamber in engagement with said end wall of said second cup shaped member,
said cup spring pressing said metal plate into engagement with said end wall of said second cup shaped member.

3. The hydraulic tappet of claim 2 wherein,
said end wall of said second cup shaped member is formed with a boss extending into said cylindrical chamber,
said cup spring is formed with a central aperture the same size as said boss, said boss extending into said central aperture.

4. The hydraulic tappet of claim 1 wherein said non-return valve means comprise a flat metal ring having an outer diameter substantially equal to the inner diameter of said cylindrical chamber, said metal ring being floatingly assembled in said cylindrical chamber.

5. The hydraulic tappet of claim 2 wherein said housing for said tappet is said cylinder head of said engine, each of said plurality of axially extending passageways between said cylindrical chamber and said second annular groove comprise,
a first part inclined to the axis of said second cup shaped member and communicating with said second annular groove,
a second part connected to said first part and opening into said cylindrical chamber, the diameter of said second part being greater than the diameter of said first part, said diameter of said second part being determined by the thickness of said metal plate forming said non-return valve means.

6. The hydraulic tappet of claim 4, wherein said housing for said tappet is said cylinder head of said engine, each of said plurality of axially extending passageways between said cylindrical chamber and said second annular groove comprise,
a first part inclined to the axis of said second cup shaped member and communicating with said second annular groove,
a second part connected to said first part and opening into said cylindrical chamber, the diameter of said second part being greater than the diameter of said first part, said diameter of said second part being determined by the thickness of said metal ring forming said non-return valve means.

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