

[54] **HYDRAULIC TAPPET**

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[22] Filed: **Aug. 6, 1973**

[21] Appl. No.: **386,067**

[52] U.S. Cl. **123/90.55; 123/90.35; 123/90.57**

[51] Int. Cl. **F01I 1/14**

[58] Field of Search..... **123/90.35, 90.55, 90.56,
123/90.57; 184/6.9**

[56]

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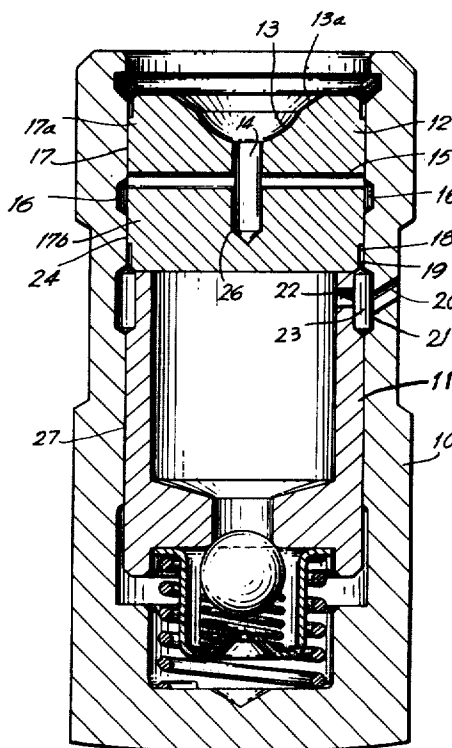
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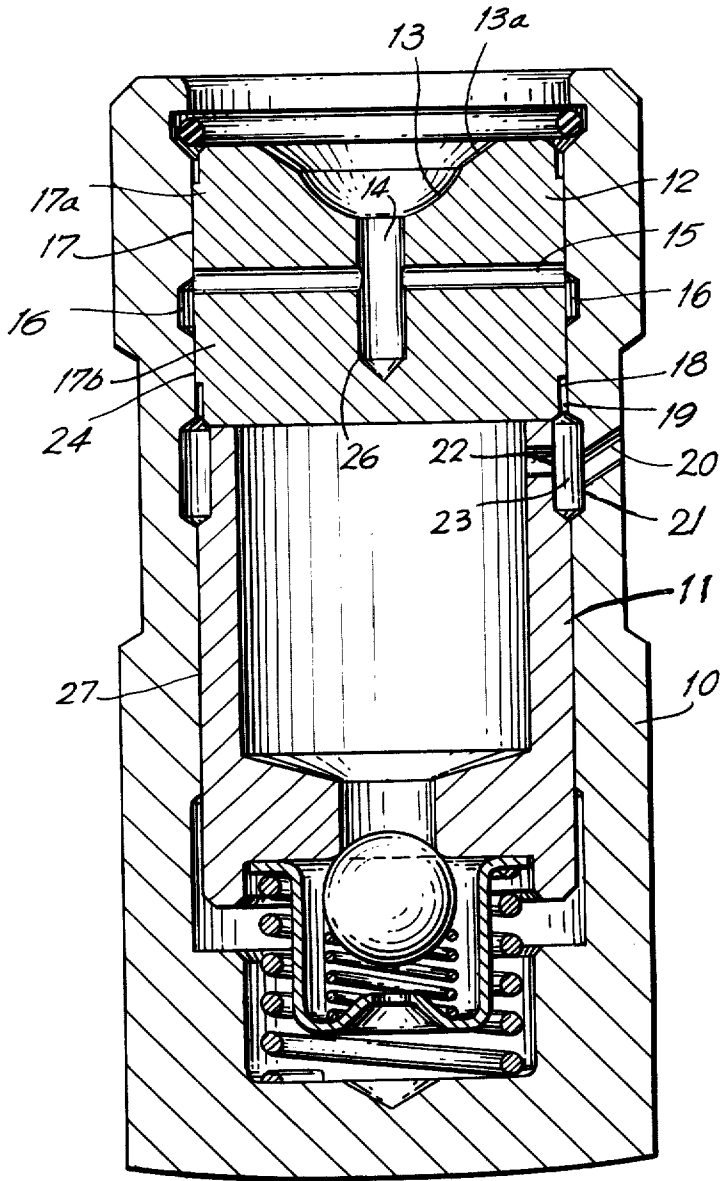
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ABSTRACT

A hydraulic tappet is so constructed that the socket for the hollow pushrod is of two diameters, the lower portion being of smaller diameter and thereby providing a clearance space of increased radial width and bounding an intermediate reservoir space with the body wall between the larger oil entry reservoir and the radially narrower clearance space about the upper part of the socket of larger diameter. The clearance space about the upper part of the socket immediately above the lower part of reduced diameter leads to a collecting groove, the axial height of such clearance varying throughout the cycle. The central bore of the socket leading from the pushrod seat extends a considerable distance below the transverse bore leading from the collecting groove to provide an oil reservoir which supplies the hollow pushrod immediately upon start of the engine. The central bore stops short of the bottom of the socket, and the tappet is devoid of a disc valve at said socket bottom.

12 Claims, 1 Drawing Figure





HYDRAULIC TAPPET

The present invention relates to hydraulic tappets and has for its general object the provision of a hydraulic tappet of simplified construction, improved efficiency, and reduced cost.

More specifically, the invention relates to the type of hydraulic tappet which is devoid of a disc or other valve controlling or metering the flow of lubricating oil into a central hole in the socket leading to the seat of a hollow pushrod through which oil is fed to the rocker arm controlling a valve of the engine.

In the U.S. Pat. to Abell, No. 3,448,730 issued June 10, 1969, there is disclosed a hydraulic valve lifter or tappet devoid of a valve such as that referred to above and in which the overlap between the socket member and what is termed a "land" on the inner surface of the body or on the outer surface of the socket, and disposed between two vertically or axially spaced grooves in the body and socket assembly, that is, the axial height of the clearance, is maintained constant through the relative movement of body and socket, for the purpose of metering the oil flow to the push rod seat in the socket (by way of a transverse bore in the socket) at a constant rate. The clearance between the lower end of the plunger and the inner wall of the body is stated to be of the order of 0.0002 and 0.0003 inch, while that between the fixed length land and the opposite surface is of the order of 0.0012 to 0.0022 inch (column 3, lines 35 to 41).

I have found that this small clearance above referred to between the bottom portion of the socket (i.e. the portion below the transverse bore) and the inner wall of the body and extending over the full relative axial movement of the socket, presents a high resistance to the flow of oil from the port in the body into which the oil is introduced, to the transverse bore in the socket leading to the central axial hole in the socket. Because of this high resistance, the feed of oil to the hollow push rod, and hence to the rocker arm, is retarded, especially when the engine is started from the cold condition.

According to the present invention there is provided a substantial intermediate oil reservoir about a reduced lower portion of the socket from which the oil flows into a clearance space of variable and reduced axial height above such reduced socket portion and thence to an annular groove within the wall of the body or socket which communicates directly with the transverse bore in the socket. Despite the variability of the height of such axial clearance, its radial enlargement about the bottom, rabbeted portion of the socket acts to cause the feed of oil to the collecting groove that communicates with the transverse bore satisfactorily uniform and reliable.

I have found that by reducing the resistance to the flow of oil around the socket by reducing the diameter of the lower portion of the socket for part of the distance from the bottom of the socket to the collecting groove, while at the same time providing a much smaller radial clearance between the portion of the socket above the transverse bore and the inner wall of the body, a highly reliable metering of the oil into the transverse bore of the socket and thence into the hollow push rod is obtained. I have found that suitable dimensions of the clearances about the socket are as follows: About the upper portion of the socket, that is, be-

tween the socket wall and the interior surface of the body, the radial dimension of the clearance should be between 0.0008 inch and 0.0015 inch. About the reduced lower end of the socket the total radial dimension of the clearance should be between 0.0058 inch and 0.0090 inch, the clearance tolerance, i.e. the preferred maximum clearance measured in the radial direction, about the lower end of the socket, being the sum of the maximum radial reduction at the rabbeted lower end of the socket (0.0075 inch) plus the maximum radial clearance between the upper part of the socket and the body (0.0015 inch). The size of the diameter at the lower portion of the socket will, of course, be reduced by twice the added radial clearance of 0.0075 inch.

I prefer also to deepen the central axial bore or hole in the socket (which does not extend to the bottom surface of the socket) below the transverse bore beyond that heretofore provided. I prefer to make the vertical dimension of the cylindrical portion of the vertical bore measured below the bottom edge of the transverse bore about 0.093 inch to 0.115 inch.

The present invention also reduces the danger of clogging and resulting reduction in the flow of oil by eliminating the tortuous path inherent in hydraulic tappets of the disc valve type, such as that shown in Reissue U.S. Pat. No. 25,974 to Morris V. Dadd, wherein the oil must flow through holes in a disc valve restricting the flow to a central axial bore extending to the bottom of the socket, the oil making a 90° turn from the holes, located at a distance from the mouth of the central bore, into a narrow clearance of small radial extent immediately about the mouth of the central axial bore (FIG. 3), or a narrow channel in the socket bottom (FIG. 7), and then making a second 90° turn to enter the mouth of the central bore. In the tappet of the present invention, on the other hand, the oil flows freely along the whole outer circumference of the socket into an annular collecting groove of relatively large cross-section and into the transverse bore which is likewise of relatively large cross-section, so that there is little opportunity for a suspended solid particle to become lodged along the path of oil flow in a manner to impede such flow. Even if an entrained solid particle should become lodged, as in the reduced clearance immediately below the transverse bore, it can do no harm in view of the extensive annular path available to the oil. The danger of lodgment of a solid particle within the annular space about the socket and in advance of the collecting groove is considerably reduced by the increased radial clearance about the lowest portion of the socket; while capillary action probably causes retention of oil in the clearance space above the reduced or rabbeted bottom end of the socket.

The invention will be further described in detail by reference to the accompanying drawing which shows a hydraulic tappet constructed in accordance with the invention in central vertical section with the socket in its uppermost position relative to the body.

Referring to the drawing, there is shown at 10 the body of the tappet within which there reciprocates a plunger 11 as the body is periodically raised by a cam on a camshaft and returned by the action of the valve spring (not shown) in the manner and for the purpose well understood in the art. Above the plunger there is disposed a socket member 12 having a seat 13 for a hollow push rod (not shown). The hollow push rod has an

opening at its bottom communicating with a central axial hole 14 which receives lubricating oil by way of a transverse bore 15 which, during the limited reciprocation of the body relative to the socket, is at all times in communication with an annular collecting groove 16 in the inner wall of the body.

The socket is composed of an upper part 17a and a lower part 17b which have the same clearance with respect to the inner wall of the body 10 except that, in accordance with the invention, the bottom end portion of the part 17b of the socket is of reduced diameter, as indicated at 18, thereby providing an annular space 19 of increased radial width for the accumulation of oil which is delivered from the gallery of the engine block into the port 20 in the wall of the body. The port debouches into an enlarged annular space 23 formed by an annular groove 21 in the inside wall of the body and an annular groove 22 at the top of the plunger 11. The seat 13 may be formed of a single radius or it may have a more or less conical extension 13a.

As will be evident from the drawing, the degree of overlap between the inner wall of the body below groove 16 and the part 17b of the socket, i.e. the axial height of the clearance space about part 17b, varies with the relative reciprocating movement of the socket and body. The enlarged clearance space 19 serves as a transition between the large reservoir space 23 formed by the grooves 21 and 22 and the radially narrower clearance 24 between the outer wall of the socket part 17b and the inner wall of the body below groove 16. The provision of the radially enlarged annular space 19 as compared with the clearance 17 about the rest of the socket acts to reduce the throttling of the flow of oil into the clearance space 24. The flow of oil through the clearance 24 will keep the collecting groove 16 filled since oil enters it throughout the whole circumference of the socket, so that oil will be fed continuously into transverse bore 15.

The flow of oil from the annular chamber 19 into the clearance space 24 is promoted by making the volume of the annular chamber 19 considerably smaller than the space 23 but at the same time considerably larger than the clearance space 24. In my preferred construction the clearance spaces 17 and 24 are given a width in the radial direction ranging from 0.0008 inch to about 0.0015 inch, while the radial width of the annular chamber 19 ranges from about 0.0058 inch to 0.0090 inch. The reduction in the radius of the bottom portion 18 of the socket ranges from about 0.0050 inch to about 0.0075 inch.

In a further development of the invention, the central hole 14 in the socket is made to extend a considerable distance below the transverse groove 15 to provide a residual reservoir for oil which will not leak away during non-operating periods of the engine. This body of oil on start of the engine, is immediately projected toward the seat 13, and although I do not wish to be committed to this theory, it is likely that the flow of oil upwardly through bore 14 more quickly induces flow from groove 16 and into transverse bore 15. Consequently lubrication is begun even at the start of operation of the engine. I prefer to have the hole 14 extend for at least about 0.093 inch to 0.115 inch below the bottom of bore 15 (excluding the usual conical bottom end portion), to provide a substantial reservoir of oil which is projected toward the pushrod seat immediately on starting of the engine from the cold condition.

The bottom portion of the plunger is provided with the usual check valve which permits flow of oil under pressure from the interior of the plunger to a space at the bottom of the body. As this portion of the tappet can take various known forms, one of which is illustrated, and does not form part of the invention, it has not been considered to be necessary to describe the same in detail. The clearance between the lower part of the plunger, that is, the part below reservoir 23 (which feeds oil into the interior 28 of the plunger) and the body may be somewhat greater than the clearance 17, say, by 0.0005 inch measured in the radial direction, to provide for rapid "leakdown."

The outside diameter of the main portion of the socket may be 0.625 inch while the reduced portion 18 of the socket has a diameter which is about 0.015 inch smaller. The height of this reduced or rabbeted socket portion can be 0.06 inch. ± 0.005 inch, but may range from 0.05 inch to 0.08 inch. A still further accumulation and retention or trapping of oil when the engine stops can be provided by drilling the inlet port 20 of the body of the tappet at a downwardly inclined angle, such port opening into the space between the inner wall of the body and the reduced upper end of the plunger, as shown in the drawing. This further provides an immediate feed of oil toward the pushrod seat of the socket upon starting of the engine, as flow is induced in the space about the rabbeted end of the socket, and throttling in the clearance 24 is reduced by reason of the reduced axial height of such clearance.

These three reservoirs, namely, about the rabbeted end of the socket, the deepened axial bore 14 in the socket and the inclined passageway 24 from the gallery through the wall of the body make bodies of oil immediately available for lubrication of the pushrod and valve train and tend to reduce noise.

It will be of advantage in many instances to provide the bottom surface of the socket with a narrow and shallow diametral groove, or two such grooves at right angles to each other, to promote uniform flow and equalization of oil pressure.

Although I have shown the transverse bore 15 as extending for the whole diameter of the socket, it may be sufficient, in certain designs of the tappet, for it to extend only to the axial bore 14, i.e., for it to extend for only a single radius.

Tests have indicated a substantially uniform flow of oil to the collecting groove 16, despite the fact that the axial height of the clearance between the body and the part of the socket of larger diameter varies as the tappet contracts and expands under the action of the cam on the camshaft, and the return spring of the engine valve. This unexpected result may be due to the sudden increase of pressure on the oil in the main reservoir as the socket drops relative to the body — and thereby compensates, at least in large part, for the increase in the axial height of the clearance, followed by a relaxation of pressure as the socket rises and the axial height of the clearance diminishes.

Although I have shown the annular collector groove in the drawing as being located in the body of the tappet, it may instead be located about the socket at the level of the transverse bore 15, in which case it may be of smaller axial extent than the groove 16.

I claim:

1. A hydraulic tappet comprising a hollow cylindrical body, a hollow plunger within the body, a socket having

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a seat for a hollow push rod and supported on said plunger for reciprocatory movement therewith in said body, a central axial bore in the socket debouching into the seat, a transverse bore in the socket leading to the axial bore and opening in the outer surface of the socket, there being an annular collector groove in the interior wall of the body in communication with the transverse bore through-out the movement of the socket, a port in the body for the reception of lubricating oil, and an annular groove on the inside surface of the body communicating with said port and forming with the outer surface of the plunger an oil reservoir, said socket being of reduced diameter at its lower end opposite an unbroken inner surface of the body above the second-mentioned groove when the socket is in its upper position relative to the body, the clearance between the socket portion of larger diameter and the inner wall of the body being sufficient for the passage of oil into the first-mentioned groove, the region of the socket of reduced diameter providing an annular space for a body of oil immediately below said clearance, the axial length of the socket portion of reduced diameter being of such extent that for a substantial portion of the travel of the socket, the overlap between the inner wall of the body and the unreduced portion of the socket below the transverse bore and hence the length or axial height of the clearance about said unreduced portion, is variable.

2. A tappet according to claim 1, wherein the bottom edge of the lower part of the socket of reduced diameter is approximately on a level with the upper edge of the second-mentioned groove when the socket is in its uppermost position.

3. A tappet according to claim 1, wherein the radial clearance about the reduced bottom portion of the socket is at least 0.005 inch greater than that about the upper portion of the socket.

4. A tappet according to claim 3, wherein the height of the bottom portion of the socket of reduced diameter is of the order of 0.060 inch.

5. A tappet according to claim 1, wherein the clearance about the upper portion of the socket of larger diameter ranges between 0.0008 inch and 0.0015 inch measured radially.

6. A tappet according to claim 5, wherein the radial clearance between the bottom portion of the socket of reduced diameter and the opposing wall of the body is

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between 0.0058 inch and 0.0090 inch.

7. A tappet according to claim 1, wherein the radial clearance about the upper portion of the socket of larger diameter ranges between 0.0008 inch and 0.0015 inch, and wherein the radial clearance between the bottom portion of the socket of reduced diameter and the opposing wall of the body is between 0.0058 inch and 0.0090 inch.

8. A tappet according to claim 1, wherein the cylindrical portion of the central bore of the socket extends for about 0.093 inch to 0.115 inch below the bottom of the transverse bore.

9. A tappet according to claim 1, wherein the clearance about the reduced bottom end of the socket had a radial width in the range of 0.0058 inch to 0.0090 inch, while the clearance about the upper part of the socket above the reduced bottom end is in the range of 0.0008 inch to 0.0015 inch measured radially, and the axial height of the reduced bottom end of the socket is in the range of 0.05 inch to 0.08 inch.

10. A tappet according to claim 9, wherein the cylindrical portion of the central bore of the socket extends below the transverse bore for a distance of 0.093 inch to 0.115 inch.

11. A tappet according to claim 1, wherein the oil entry port in the body extends at a downwardly directed angle into the said oil reservoir to limit drainage of oil from the tappet when the engine is not running.

12. A hydraulic tappet having a body and a socket providing a seat for a hollow pushrod and having a transverse bore, said socket having also a central axial bore leading from the pushrod seat and extending below the transverse bore, said central bore communicating with the transverse bore, a hollow plunger on which the socket rests for conjoint movement therewith, an oil entry port in the body communicating with an oil entry port in the plunger, means for reducing the resistance to the flow of oil about the socket comprising a rabbet at the lower end of the socket and extending for a portion of the distance between the bottom of the socket and the transverse bore, said central bore terminating short of the bottom of the socket, the rabbeted portion being of such axial height that it comes into overlapping relation with an unbroken portion of the wall of the body to increasing extents during the upward stroke of the socket.

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