Jan. 27, 1959 E. L. DAYTON 2,870,755

HYDRAULIC VALVE TAPPET

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FIG.1.

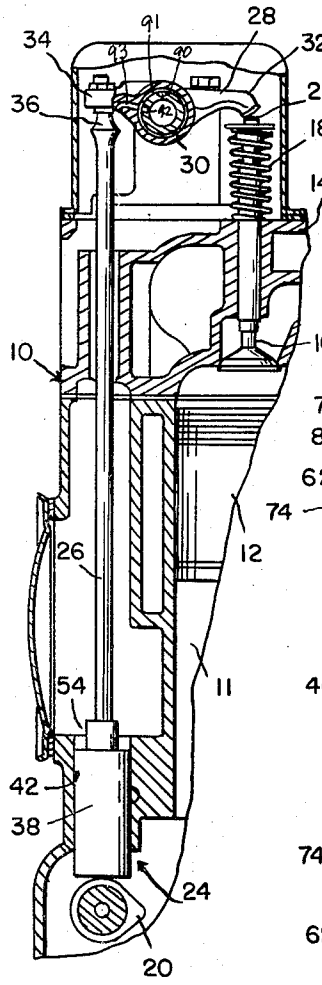
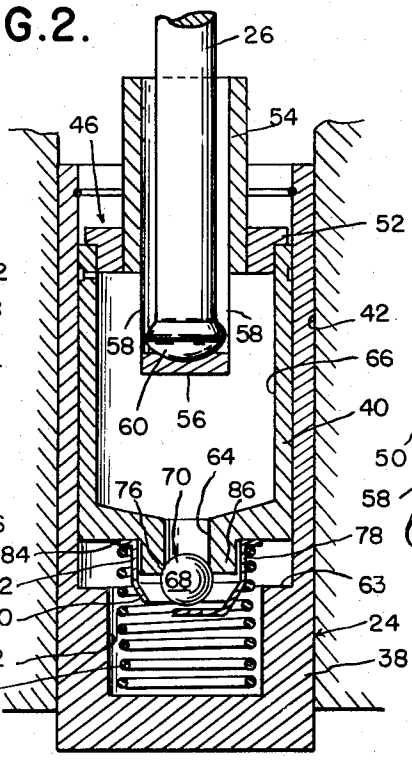


FIG.2.



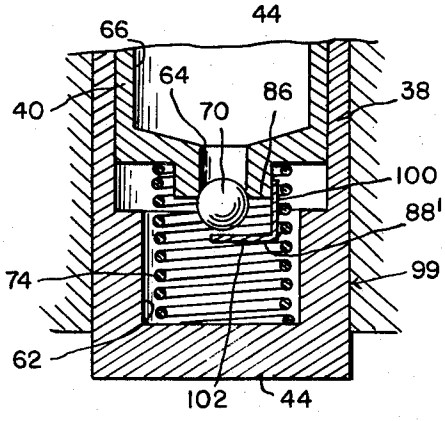


FIG.5.

FIG.3.

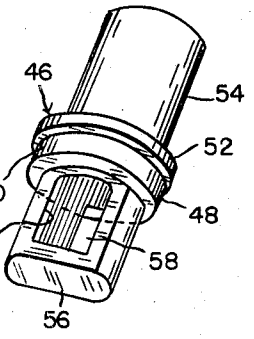
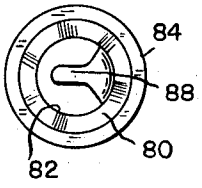


FIG.4.



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HYDRAULIC VALVE TAPPET

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10 Claims. (Cl. 123—90)

This invention relates to an improved hydraulic valve tappet assembly of the type suitable for use in connection with internal combustion engines.

Hydraulic tappet assemblies, as used in internal combustion engines are usually supplied with oil supplied from the lubricating system of the engine and function to take up clearance between the valve push rods and tappets automatically as soon as such clearance exists. The specific structure of hydraulic valve tappets varies considerably but, in general, comprises a cylinder and a tubular plunger or piston slidably supported in the cylinder. When installed, the bottom of the cylinder is usually engaged by a cam on the camshaft of the engine and the top of the piston is closed by a plug which ordinarily engages the valve operating push rod of the engine.

Also, an adjusting chamber is normally provided in the cylinder below the piston and the bottom of the piston has a valve controlled port communicating with the adjusting chamber. Hydraulic fluid, such as oil, is admitted to the adjusting chamber through the valve controlled port in the piston and the clearance between the piston and push rod is taken up by the column of oil below the piston.

One object of this invention is to provide a hydraulic tappet assembly that incorporates a gravity system for supplying oil thereto to replenish the column of oil in the adjusting chamber.

Another object of the invention is to provide a tappet assembly in which the plug closing the upper end of the piston is provided with an opening therein into which the push rod extends for engagement with an abutment within the piston, and in which the oil is gravity fed to the assembly by running down along the push rod and into the hollow interior of the piston.

The tappet assembly ordinarily will rotate at a very high speed about its axis due to the engagement of the cam with the bottom of the cylinder. This occurs because it is practically impossible to arrange the parts so that the cam always engages the bottom of the cylinder precisely at its center. As a result, the oil entering the piston via the push rod is apt to be thrown radially outwardly by the rapidly rotating assembly so that only a small fraction of the oil actually enters the hollow piston. Accordingly, a further object of the invention is to provide a gravity fed tappet assembly in which provision is made for preventing the oil from being thrown off laterally by the rotating tappet assembly.

There is also a tendency for oil within the piston to be thrown out through the opening in the upper end of the piston as a result of the longitudinal reciprocation of the tappet assembly by the cam. Still another object of the invention is to provide means for preventing the oil within the piston from being thrown out by the reciprocation of the tappet assembly.

Other objects of the invention will become apparent as the following description proceeds, especially when considered with the accompanying drawing, wherein:

Figure 1 is a sectional view of a portion of an internal combustion engine showing a valve operating linkage including the tappet assembly, constructed in accordance with the invention.

Figure 2 is an enlarged longitudinal sectional view of the tappet assembly.

Figure 3 is a detailed perspective view of the plug for closing the upper end of the piston.

Figure 4 is a detailed plan view of the ball valve retainer.

Figure 5 is a fragmentary longitudinal sectional view illustrating a modification.

Referring now more particularly to the drawings, and especially to Figures 1–4 thereof, the numeral **10** designates generally the frame of an internal combustion engine having one or more cylinders **11** in each of which is fitted a reciprocating piston **12**. Reciprocably mounted in the cylinder head **14** above the piston **12** is a poppet valve **16** which, in conventional manner, controls the inlet or exhaust for the cylinder **11**. The valve **16** is normally held in the closed position illustrated by the valve spring **18**, and during engine operation is intermittently moved downwardly to its open position in opposition to the spring by the valve operating cam **20** whose motion is transmitted to the upper end **22** of the valve through the hydraulic tappet assembly **24**, push rod **26** and valve rocker **28**. The valve rocker **28** is rotatably supported on the shaft **30** and has an arm **32** bearing upon the upper end **22** of valve **16**, and a second arm **34**. The arm **34** carries a depending part **36** which may be of non-circular cross-section and which fits into a recess in the upper end of the push rod **26**, the recess having a similar non-circular cross-section. Thus, the part **36** is removably received in the recess of the push rod and the push rod cannot rotate relative to the projection due to the non-circular cross-section of the interconnecting parts. The part **36** is rigidly connected to the arm **34** of the rocker so that it cannot rotate.

The tappet assembly **24** comprises a cylinder **38** and a piston **40** supported within the cylinder for sliding movement. The cylinder **38** is, in turn, slidably mounted in a vertically extending bore **42** of the engine frame **10**, and the bottom of the cylinder is closed by a wall **44**. The bottom surface of the wall **44** forms a bearing for engagement with the cam **20**. The top of cylinder **38** is open for receiving the push rod **26**, and, of course, the piston is assembled in the cylinder by inserting it through the open top of the cylinder.

The piston **40** is tubular in cross section and the top of the piston is closed by a plug **46**. The plug **46** comprises an annular body member **48** having a skirt portion **50** which extends into the upper end of the piston in a close sliding fit. The body member **48** has an annular flange **52** above the skirt portion which extends laterally outwardly therefrom and rests upon the upper end of the piston. A tubular sleeve **54** extends through the body member and is rigidly secured therein. The sleeve has an internal diameter somewhat greater than the diameter of the push rod and it extends upwardly from the body member for a substantial distance, as seen in Figure 2. The sleeve extends for a considerable distance below the body member **48** and the lower end of the sleeve is closed by a transverse wall **56**. The sleeve is formed with a pair of diametrically opposite apertures **58** between the body member and the transverse wall **56**. The lower end **60** of the push rod is rounded and bears upon a concave recess in the upper surface of the transverse wall **56**, the transverse wall thus providing an abutment for the lower end of the push rod. The plug **46** and sleeve **54** can be of one-piece construction if desired.

The internal diameter of the cylinder **38** is reduced at the bottom to provide an adjusting chamber or oil reser-

voir 62 and also to provide an internal annular shoulder 63 for engaging the bottom of the piston 40 in the leak-down or collapsed position of the piston within the cylinder. As shown in Figure 2, the bottom of the piston has a port 64 which establishes communication between the adjusting chamber 62 and the space or chamber 66 within the piston.

The transfer of oil through the port 64 is controlled by a check valve 68 at the bottom of the piston 40. The check valve 68 comprises a ball member 70, a retainer 72 and a coil spring 74.

The ball member 70 is of a diameter to engage an annular seat 76 surrounding the port 64 at the bottom of the piston and the retainer 72 holds the ball normally to enable movement of the ball by the action of gravity to its open position. The retainer 72 is cup-shaped and has a cylindrical wall 78 and a frusto-conical wall 80 extending beneath the cylindrical wall in continuation thereof which defines a central opening 82. The upper end of the tubular wall portion 78 is turned radially outwardly to provide a flange 84 engageable with the underside of the piston and also engageable by the upper end of the coil spring 74 which has its lower end seated on the bottom wall 44 of cylinder 37. The piston has an annular extension 86 which surrounds the port and loosely receives the cylindrical portion of the retainer to center it. The coil spring 74 is held under compression between the flange 84 and wall 44 and is of sufficient strength to hold the retainer 72 in place on the piston 40 throughout the extent of movement of the latter. The coil spring 74 also tends to maintain the piston in the extended position of Figure 2, in which the ball 70 is firmly seated by the pressure of oil beneath the piston, during normal operation of the tappet, but is not of sufficient strength to prevent movement of the piston to its lowermost or leak-down position in which the lower end of the piston engages the shoulder 63 within the cylinder when operation of the engine is discontinued.

The ball member 70 is held in assembled relation with the retainer 72 and prevented from dropping through the opening 82 in the lower end by a bar 88 which is integrally connected to the lower end of the frusto-conical portion 80 of the retainer at one edge of the opening 82. The bar is sufficiently narrow so that it does not restrict the flow of lubricant through the retainer. The axial spacing between the bar 88 and the seat 76 is accurately predetermined with respect to the diameter of the ball member 70. In practice, the bar is located so as to afford a predetermined maximum clearance between the seat 76 and the ball member 70 in the open position of the latter. It is important to the satisfactory operation of the tappet assembly to limit the clearance between the ball member and seat to approximately five to seven thousandths of an inch. It will be noted that the bar extends transversely of the opening 82 and is located slightly beneath the latter so that the bar may be properly positioned by inserting a feeler gauge or pin between the ball and the bar 88 and thereafter adjust the bar until the ball is firmly engaged with the seat. Since the bar 88 is connected at one end only, the feeler gauge may be inserted from a great many angles without difficulty and much more conveniently than if the bar were connected at both ends to the retainer.

The valve rocker 28 is formed with a through passage 90 for receiving the hollow shaft 30 and has an internal annular groove 91 surrounding the shaft. A port 92 in the shaft connects its hollow interior with the groove so as to lubricate the valve rocker with oil supplied from the lubricating system of the engine to the passage through the hollow shaft 30. A passage 93 in the valve rocker extends from the annular groove and opens in a position adjacent to the projecting part 36 to supply oil from the groove to the connection between the part 36 and the recess in the upper end of the push rod. The oil thus applied will not only lubricate the joint at the upper end of the push rod but will run down the outer surface of the push rod during the operation of the engine and will flow into the piston chamber 66 through the sleeve 54 and apertures 58 therein. Thus, a reservoir of oil will be maintained in the piston chamber 66 to be supplied to the adjusting chamber 62 in the cylinder to replenish the column of oil therein as required. While it is preferred to have the oil run down the exterior surface of the push rod, the push rod might also be formed to have a longitudinal passage with a port at the upper end having a lip or the like to receive oil from passage 93 and a port at the lower end beneath plug 46 for delivering the oil to the piston chamber.

Due to the fact that it is practically impossible to obtain a precise dead center engagement of the cam 20 with the lower end of the cylinder, the cylinder and hence the piston 40 and plug 46 will ordinarily be caused to rotate at very high speeds depending upon the speed of the engine. There is a tendency for the oil, as it flows down the push rod, to bridge the gap between the opening at the upper end of the sleeve and flow in a thin film across the upper end of the rotating sleeve and to be thrown laterally outwardly by the rotation thereof. This tendency is increased by the viscosity of the oil, the speed of rotation of the tappet assembly and the size of the opening in the upper end of the sleeve relative to the push rod through which the latter extends. However, I have found that by providing the sleeve 54 of substantial length to elongate the opening through the plug, the oil flowing along the push rod within the sleeve will form a cohesive tubular column which, by reason of its weight will flow downwardly within the sleeve and draw with it the oil on the push rod above the sleeve and thereby resist any tendency of the oil to escape. The effectiveness of the annular column of oil to perform this function depends in part at least upon the length of the sleeve. It is apparent that if the sleeve were omitted, the effectiveness of the annular column of oil to perform this function would be greatly diminished due to the fact that the opening through the plug would be relatively short, and thus a great deal of oil would be lost. Moreover, the transverse surface at the upper end of the elongated sleeve 54 is of a relatively small radial dimension as compared with the transverse surface at the top of the body member 48. Accordingly, any oil that might splash onto the upper end of the sleeve and thrown radially outwardly thereby will have little or no tendency of drawing other oil from the push rod with it. Assuming no sleeve and the push rod extending through the body member opening, any oil splashing on the upper surface of the body member would tend strongly to draw other oil with it due to its extended radial dimension and also to the greater peripheral speed of the radially outer portions of this surface.

There is also a tendency for the oil within the piston to splash about during the reciprocation of the tappet when the motor is in operation. However, by providing the transverse abutment wall 56 and the lateral apertures 58, the abutment surface being disposed directly beneath the opening into which the push rod extends, oil cannot pass from the piston chamber through the sleeve in a direct line and, hence, little or no oil is lost by splashing within the piston chamber during reciprocation of the tappet assembly.

The push rod will not rotate with the tappet assembly because of its non-rotatable connection with the part 36 on the valve rocker. However, sometimes a rotatable connection is provided between the push rod and valve rocker so that the push rod may be rotated by the tappet assembly. However, even if the push rod does rotate, there is little tendency to throw oil because of its relatively small diameter, and hence its relatively low peripheral speed.

Figure 5 illustrates a modification. The tappet assembly 99 of Figure 5 differs from that previously described in that the retainer 72 is omitted and the bar 88' is car-

ried directly by the piston. The bar **88'** has a depending part **100** the upper end of which is welded to or otherwise permanently secured to the annular extension **86**, and a transverse part **102** disposed beneath the ball **70**. The part **102** is located so as to permit the desired clearance between the ball and seat in the leak-down position while at the same time retaining the ball is assembled relation with the piston. Otherwise, the tappet assembly **99** is exactly like the one shown in Figures 1–4 and may be substituted therefor in the arrangement of Figure 1.

What I claim as my invention is:

1. A hydraulic tappet assembly for a valve comprising a generally upright cylinder having a closed lower end providing a chamber for hydraulic fluid and having an open upper end, a piston mounted in said cylinder for longitudinal sliding movement between a collapsed position adjacent the lower end of said cylinder and an extended position spaced axially from the lower end of said cylinder, a chamber within said piston, a port in the lower end of said piston connecting said piston chamber with said cylinder chamber, an opening into said piston chamber through the upper end of said piston, means providing a connection between said valve and said piston including an upright push rod having its lower end extending into the open upper end of said cylinder and through said opening into said piston chamber, said push rod being substantially smaller in cross section than said opening and spaced inwardly from the boundary thereof, means within said piston chamber providing an abutment for the lower end of said push rod, means within said chamber providing a lateral aperture above said abutment and opposite the lower end portion of said push rod for passage of fluid through said opening into said piston chamber, and means for supplying hydraulic fluid to said push rod above said piston for gravity flow down said push rod into said piston chamber through said lateral aperture, said abutment being spaced directly beneath said opening to substantially prevent hydraulic fluid in said piston chamber from passing out through said opening along a straight path during reciprocation of said tappet assembly.

2. The tappet assembly defined in claim 1 in which the hydraulic fluid is supplied to the exterior surface of said push rod by said supplying means, and a sleeve surrounding said opening and extending upwardly from the upper end thereof loosely receiving said push rod to prevent the loss of hydraulic fluid flowing down said push rod.

3. A hydraulic tappet assembly for a valve comprising an upright cylinder having a closed lower end providing a chamber for hydraulic fluid and having an open upper end, a piston mounted in said cylinder for longitudinal sliding movement between a collapsed position adjacent the lower end of said cylinder and an extended position spaced axially from the lower end of said cylinder, said piston being hollow to provide a chamber and having a port in the lower end thereof connecting said piston chamber with said cylinder chamber, valve means controlling the flow of fluid through said port, a cap closing the upper end of said piston and having an opening therethrough into said piston chamber, means providing a connection between said valve and said piston including an upright push rod having its lower end extending into the open upper end of said cylinder and through said opening into said piston chamber, said push rod being substantially smaller in cross-section than said opening and spaced inwardly from the boundary thereof, said cap having a depending part extending into said piston chamber, said part being formed with a transverse abutment at the lower end engageable by the lower end of said push rod, said abutment being spaced directly beneath said opening to substantially prevent hydraulic fluid in said piston chamber from passing out of said piston chamber through said opening in a straight path during reciprocation of said tappet assembly, said part also having lateral apertures above said abutment and opposite the lower end portion of said push rod for the passage of fluid through said opening into said piston chamber, and means for supplying hydraulic fluid onto the exterior surface of said push rod above said piston for gravity flow along said push rod into said piston chamber through said lateral apertures.

4. The tappet assembly defined in claim 3 in which said connection between said piston and the valve includes a valve rocker engaging the upper end of said push rod, and said hydraulic fluid supplying means includes a passage in said valve rocker opening adjacent to said push rod for supplying hydraulic fluid to the latter.

5. The tappet assembly defined in claim 3 including an elongated sleeve on said cap surrounding said opening and extending upwardly from the upper end thereof loosely receiving said push rod to prevent the loss of hydraulic fluid flowing down said push rod.

6. The tappet assembly defined in claim 3 in which said valve means includes an annular valve seat surrounding said port at the side thereof facing the closed end of said cylinder, a ball valve member supported in a position to engage said valve seat in response to an increase in pressure in said cylinder chamber, and a retainer for said ball valve member including a bar extending across said ball valve member beneath the latter and attached at least at one end for movement as a unit with said piston, said bar being located beneath all portions of said piston to enable the lateral insertion of a feeler gauge between said ball valve member and bar without interference with said piston.

7. The tappet assembly defined in claim 6 in which one end only of said bar is attached to further avoid interference during lateral insertion of a feeler gauge, said one end being attached directly to said piston.

8. The tappet assembly defined in claim 3 in which said valve means includes an annular valve seat surrounding said port at the side thereof facing the closed end of said cylinder, a ball valve member supported in a position to engage said valve seat in response to an increase in pressure in said cylinder chamber, and a retainer for said ball valve member, said retainer comprising a generally cup-shaped annular member having an opening in the bottom and movable as a unit with said piston, said ball valve member being located in said annular member and the opening through the latter being of greater diameter than said ball valve member, and a bar extending partway across the opening through said annular member in a position to engage and retain said ball valve member in said annular member, one end only of said bar being integrally connected to said annular member at the edge of the opening therethrough, the remaining portions of said bar being free from connection with and spaced from said annular member said bar being located beneath all portions of said piston and beneath the bottom of said annular member to enable the lateral insertion of a feeler gauge between said ball valve member and bar without interference with said piston or annular member.

9. A hydraulic tappet assembly for a valve comprising a cylinder closed at one end to a chamber for hydraulic fluid, a piston mounted in said cylinder for longitudinal sliding movement between a collapsed position adjacent the closed end of said cylinder and an extended position spaced axially from the closed end of said cylinder, a passage in said piston, a port in the end of said piston adjacent the closed end of said cylinder connecting said passage and chamber, means for supplying hydraulic fluid to said passage, valve means controlling the flow of hydraulic fluid through said port including an annular seat surrounding said port at the side thereof facing the closed end of said cylinder, a ball member supported in a position to engage said seat in response to an increase in pressure in said chamber, and a retainer for said ball member, said retainer com-

prising a generally cup-shaped member having an opening in the bottom and movable as a unit with said piston, said ball member being located in said annular member and the opening through the latter being of greater diameter than said ball member, and a bar extending partway across the opening through said annular member in a position to engage and retain said ball member in said annular member, one end only of said bar being integrally connected to said annular member at the edge of the opening therethrough, the remaining portions of said bar being free from connection with and spaced from said annular member, said bar being located beneath all portions of said piston and beneath the bottom of said annular member to enable the lateral insertion of a feeler gauge between said ball valve member and bar without interference with said piston or annular member.

10. A hydraulic tappet assembly for a valve comprising a generally upright cylinder having a closed lower end providing a chamber for hydraulic fluid and having an open upper end, a piston mounted in said cylinder for longitudinal sliding movement between a collapsed position adjacent the lower end of said cylinder and an extended position spaced axially from the lower end of said cylinder, a chamber within said piston, a port in the lower end of said piston connecting said piston chamber with said cylinder chamber, an opening into said piston chamber through the upper end of said piston, means

providing a connection between said valve and said piston including an upright push rod having its lower end extending into the open upper end of said cylinder and through said opening into said piston chamber, said push rod being substantially smaller in cross section than said opening and spaced inwardly from the boundary thereof, means within said piston chamber providing an abutment for the lower end of said push rod, means within said piston chamber providing a lateral aperture above said abutment and opposite the lower end portion of said push rod for passage of fluid through said opening into said piston chamber, means for supplying hydraulic fluid to the exterior surface of said push rod above said piston for gravity flow down said push rod into said piston chamber through said lateral aperture, and an elongated sleeve surrounding said opening and extending upwardly from the upper end thereof loosely receiving said push rod to prevent the loss of hydraulic fluid flowing down said push rod.

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