

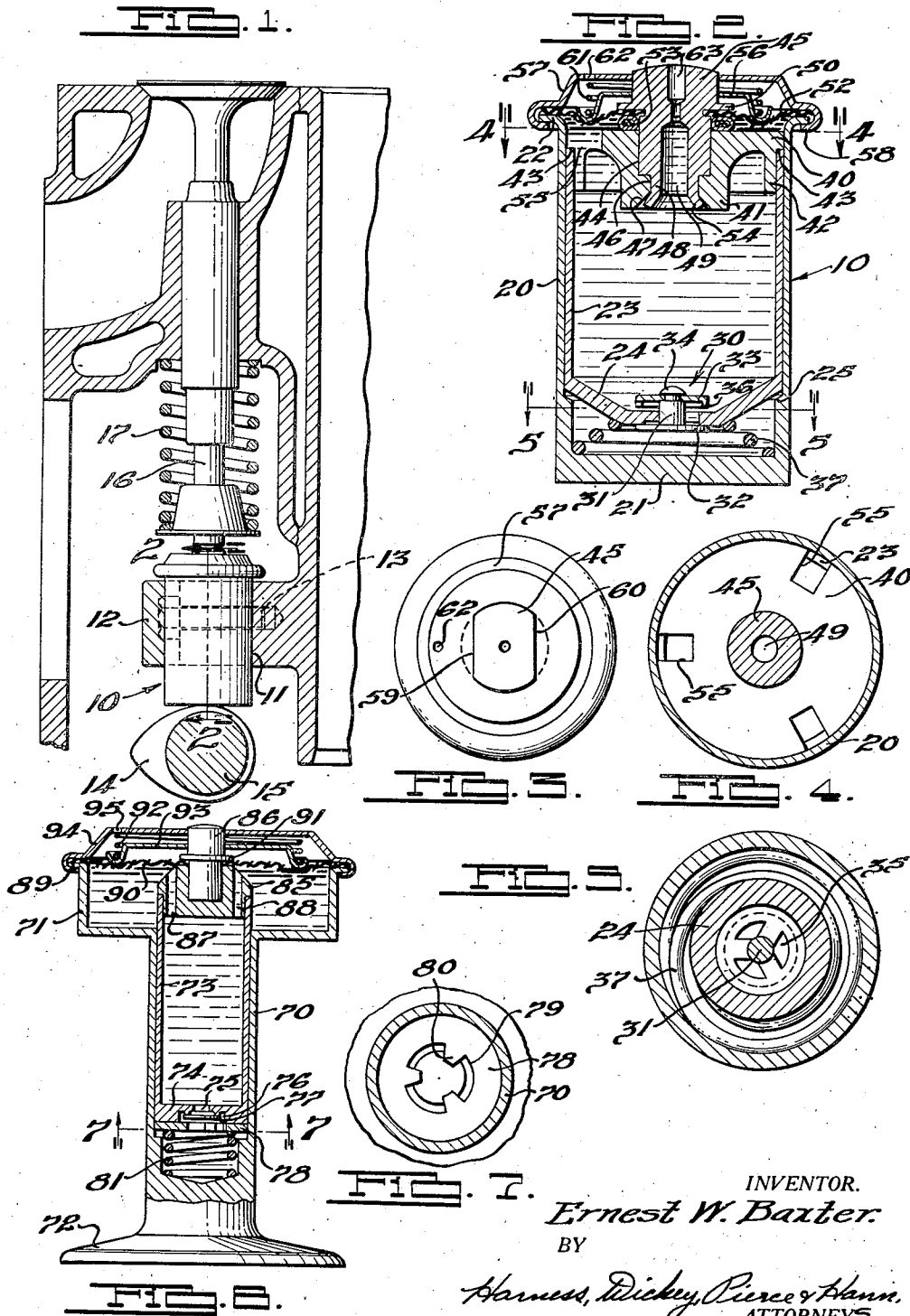
Jan. 16, 1940.

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2,187,008

HYDRAULIC VALVE LIFTER

Original Filed Feb. 10, 1936



UNITED STATES PATENT OFFICE

2,187,008

HYDRAULIC VALVE LIFTER

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Application February 10, 1936, Serial No. 63,188
Renewed June 9, 1939

10 Claims. (Cl. 123—90)

This invention relates to an automatic adjusting hydraulic tappet of the type used to transmit motion between moving machine parts, and particularly between the cam shaft and valve of an internal combustion engine.

In prior hydraulic tappets of the type mentioned, considerable difficulty has been encountered by reason of the fact that the oil supply, which is usually drawn from the crank case of the engine, contains foreign matter such as carbon and air or gas, which interfere with the operation of the tappet. Solid material tends to clog the passageways in the tappet and the air or gas renders the fluid compressible; whereas the satisfactory operation of hydraulic tappets requires that the fluid be relatively free from solids and substantially incompressible. It has been suggested to make the hydraulic tappet self-contained so far as the liquid supply is concerned, but in the suggested construction an air space is left above the liquid within the self-contained unit, with the result that the rapid reciprocations of the tappet tends to churn the liquid and air together, forming a mixture or emulsion which is compressible and hence unsatisfactory.

Accordingly, it is one of the objects of the present invention to provide a self-contained hydraulic tappet in which there is no air space whatsoever, the entire interior of the unit being completely filled with liquid.

Another object of the invention is to provide a self-contained tappet which is sealed by means of a flexible diaphragm, in combination with means for urging the diaphragm into contact with the liquid within the unit in order to prevent formation of gas pockets.

Another object of the invention is to provide an enlarged diaphragm chamber at the top of the tappet in order to permit the use of a larger diaphragm than the normal dimensions of the tappet unit would permit.

Another object of the invention is to provide means to prevent twisting of the diaphragm and consequent injury thereto.

Referring to the drawing, wherein like numerals refer to like parts in the several views:

Figure 1 shows a fragmentary vertical section through a portion of an internal combustion engine and illustrates the manner in which the hydraulic tappet is utilized;

Fig. 2 is an enlarged vertical section through the self-contained hydraulic tappet unit taken on the line 2—2 of Fig. 1;

Fig. 3 is a top plan view of the tappet;

Fig. 4 is a horizontal section taken on the line 4—4 of Fig. 2;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 2;

Fig. 6 illustrates a modified form of the self-contained hydraulic tappet;

Fig. 7 is a horizontal section taken on the line 7—7 of Fig. 6.

Referring to Fig. 1, the self-contained hydraulic tappet unit indicated generally at 10 is slidably journaled in a bearing 11 carried by the cylinder block of an internal combustion engine. The bearing may be of one piece construction but as shown is provided with a removable cap 12 held in place by means of stud bolts 13. The tappet unit is reciprocated in bearing 11 by means of a cam 14 on the engine cam shaft 15, and engages at its upper end the lower end of a valve rod 16. A spring 17 of conventional construction operates to urge the valve against its seat, and the hydraulic tappet unit 10 against cam 14 at all times.

As shown best in Fig. 2, the tappet unit comprises a cylindrical casing 20 having a relatively heavy bottom wall 21 adapted to engage and be operated upon by the cam 14. The upper end of the casing is open and is provided with an outwardly turned flange 22. Slidably mounted within and fitting the casing 20 is a hollow plunger 23 having an inverted frusto conical bottom wall 24, and a correspondingly shaped internal shoulder 25 on casing 20 is adapted to engage the bottom wall 24 of the plunger and limit its downward movement with respect to the casing. Centrally of the bottom wall 24 there is provided a check valve 30 adapted to control the flow of fluid from one side of the wall 24 to the other. This check valve includes a valve stem 31 slidably mounted in a suitable opening in the bottom wall 24, and a valve head 32 at the lower end of the stem. The upper end of the stem is reduced in diameter and the reduced end receives a retaining head 33 which seats against the shoulder formed at the juncture of the reduced end and the main body of the stem. After the retaining head 33 is placed in position, the protruding reduced end of the stem is riveted over, as at 34, to secure it in position. The valve head 32 is adapted when subject to an excess of fluid pressure from its under side to close ports 35 in the bottom wall 24 of the plunger, but the downwardly extending peripheral flange on the retaining head 33 is slotted at 36 to prevent head 33 from sealing the ports 35. The spacing between the valve heads 32 and 33 is such that only

one can be in engagement with the end wall 24 of the plunger 23 at one time.

A coil spring 37 is provided between the bottom wall 24 of the plunger and the bottom wall 21 of the casing for urging the plunger upwardly in the casing. This spring, however, is of insufficient strength to overcome the force of the valve spring 17 and hence will only effect upward movement of the plunger when for any reason a clearance exists between the tappet unit and the end of the valve rod 16.

The top of the plunger 23 is closed by means of a head 40 having a downwardly extending centrally located projection or boss 41 and an outwardly spaced and downwardly extending skirt 42 which fits within the upper and open end of the plunger 23. A shoulder 43 on the head 40 abuts upon the end of the plunger and is adapted to transmit the valve lifting forces. The central boss 41 is provided with a bore 44 adapted to receive a hardened steel valve rod contacting member or tappet 45. Communicating with the lower end of the bore 44 is a smaller bore 46, which in turn communicates with a downwardly and outwardly flaring opening 47. Member 45 seats against the shoulder formed at the juncture of bores 44 and 46 and is provided with a reduced portion 48 extending through bore 46. The reduced end portion of member 45 is drilled as at 49 to provide a relatively thin walled cylindrical portion at the lower end of the member.

The upper portion of the valve contacting member 45 is provided with an outwardly extending flange 50 beneath which the member is recessed to provide a groove within which is seated the inner edges of an annular flexible diaphragm 52. When the head 40, member 45, and diaphragm 52 are assembled a packing ring 53 is placed between the diaphragm and the head 40, and the diaphragm and packing ring are clamped between flange 50 and the top surface of head 40. Then the lower end of member 45 is spread or spun outwardly into the flared opening 46, as at 54 to lock the parts together. This provides a permanent leak proof connection between the diaphragm and the valve contacting member 45. The outer edges of the diaphragm 52 are adapted to extend over the horizontally extending flanges 22 of casing 20.

When the device is assembled, the casing 20 is partially filled with the operating liquid and the plunger 23 is then inserted and pressed down against the body of liquid in the bottom of casing 20 until the fluid begins to leak out between the plunger 23 and the interior of the casing at the top of the plunger. It will be noted that during the application of this pressure to the plunger, the valve head 32 will close ports 35 and hence the air in the upper marginal portions of the cavity below wall 24 will be forced upwardly between the walls of the plunger and the casing and out at the top. When the liquid begins to appear at this point, it indicates that all of the air within the space below wall 24 has been forced out. As soon as this is accomplished the interior of the plunger assembly is completely filled with liquid through one of the notches or openings 55 in head 40, the edge of the diaphragm 52 being lifted away from flange 22 for this purpose. When the liquid level reaches the top of flange 22 the diaphragm is laid directly upon the top surface of the liquid, and its margin is positioned upon flange 22. At this time a sheet metal spring receiving cup 56 is laid on the top of the diaphragm. This mem-

ber 56 is centered upon the diaphragm by a central opening having a loose fit with the upper portion of member 45. Thereafter cap 57 is placed in position and its marginal edge 58 spun into clamping engagement around the diaphragm and flange 22 to provide a leak proof connection between the diaphragm and flange at this point. The upper end of the valve rod contacting member 45 is generally circular in cross-section but is provided with a pair of opposed flat surfaces 59 and 60, and the cap 57 is provided with a similarly shaped opening through which the top portion of member 45 extends, as shown in Fig. 3. As the result of this arrangement the cap restrains member 45 and, therefore, the plunger head 40 against rotation relative to the casing 20, and thereby prevents twisting of the diaphragm. After the unit is assembled, as above, a spring 61 is threaded by a spiral motion into the cap through a suitable opening 62 therein until it assumes the position shown in the drawing wherein its lower end rests within the annular peripheral groove in the retaining cup 56. It may be noted that as the liquid is inserted through openings 55 and fills the unit it will pass upwardly into the opening 49 in the valve rod contacting member 45, thereby ejecting the air from this opening through the small drilled hole 63. After the assembly is completed, the hole 63 is plugged in any suitable manner to seal the unit against the entrance of air or leakage of liquid, and the unit is ready for installation in an internal combustion engine.

It will be noted that the spring 61 constantly urges the diaphragm 52 into engagement with the top surface of the liquid in the container and thus prevents the formation of gas pockets therein. Accordingly, the unit is not only completely self-contained, but is gas free, with the result that there is no danger of air or gas bubbles getting within the space below the wall 24 where it will interfere with the operation of the device. Any suitable liquid may be used within the unit so long as it has some lubricating qualities, will not attack metal, and will not freeze, vaporize, or disintegrate at the temperatures normally incurred in operation. Examples of such fluids are heavy lubricating oils, glycerine, ethylene glycol, diethylene glycol, triethylene glycol and propylene glycol. The diaphragm 52 is preferably formed of a balloon cloth impregnated with a substance which will seal the fabric against leakage and protect it from attack by the liquid used, if necessary. The sealing substance itself must be so chosen as to resist deterioration by reason of heat and contact with the liquid in the container, and hence if oil is used the fabric may be impregnated with artificial rubber which is resistant to attack from oil. If the other named liquids are used the sealing material may be either natural or artificial rubber.

The device operates as follows: In the normal position of the parts, shown in Figs. 1 and 2, plunger 23 is spaced upwardly by a slight distance from the shoulder 25 on the interior of casing 20 and the space beneath the bottom wall 24 of the plunger is completely filled with liquid. In this state of affairs the valve spring 17 acting through the valve rod, valve rod contacting member 45 and plunger 23 overcomes the force of spring 37 and places the liquid beneath the plunger under compression. Under these circumstances the pressure of the liquid beneath the plunger maintains valve head 32 in sealing engagement with the ports 35 of bottom wall 24, 75

thereby preventing any leakage of the liquid through the ports. As cam 14 is rotated during normal operation of the engine it lifts the hydraulic tappet unit by engagement with its under surface 21 and transmits the lifting force to the valve through the hydraulic pressure beneath the plunger. During opening and closing movements of the valve the spring 17 normally maintains the liquid beneath the plunger under compression and thereby maintains valve head 32 closed and the hydraulic tappet unit continues to operate as a solid tappet member. However, if for any reason a clearance should occur between the bottom of the valve rod 16 and the valve rod engaging surface of member 45 when the engine valve is seated, the force of valve spring 17 will no longer be transmitted to the plunger, with the result that spring 37 will move the plunger upwardly until the valve contacting member 45 again engages the valve rod, thereby taking up the clearance. During this movement, valve 30 in the bottom wall of the plunger will open, permitting the flow of liquid from the interior of the plunger into and fill the space below the wall 24, thus providing a liquid abutment for the plunger. The unit will operate as before having automatically adjusted itself to take up the clearance.

During normal operation of the unit, such clearances may occur by reason of contraction of the valve rod with lowering of its temperature, wear in the bottom of the valve rod, or by reason of leakage of the fluid from beneath the plunger upwardly between the walls of the plunger and the walls of the casing to the space above the head 40, or by leakage of the fluid past the valve head 32. It will be noted, however, that correction of these maladjustments, no matter how caused, is immediately and automatically made, and hence the valve unit will operate substantially continuously in perfect adjustment with respect to the valve rod. When the valve rod expands due to an increase in its temperature during operation of the engine, it will force the plunger downwardly in the cylinder, displacing liquid through the small space between the piston and the cylinder walls.

It should be noted that as the plunger moves upwardly to compensate for any maladjustment, it carries the inner margins of the diaphragm 52 upwardly, with respect to the outer margins thereof, but since the volume of fluid within the unit remains constant, the main body of the diaphragm must move downwardly to compensate for the upward movement of the inner edge. This is accomplished by means of the spring 58 which constantly urges the main body of the diaphragm into engagement with the body of fluid, and the diaphragm itself is made sufficiently loose to permit a bodily movement downwardly even though the inner margin of the diaphragm is moved upwardly.

In Fig. 6 is shown a modified form of the tappet in which the main barrel of the casing is of reduced diameter, preferably of the diameter of the solid valve tappets now in use. This tappet is adapted to be used in the same manner as that illustrated in Fig. 1, but it will be noted that it is necessary to have a split bearing such as that shown in Fig. 1 since the opposite ends of the casing are enlarged and, therefore, cannot be inserted into a closed bearing. In order to provide a sufficiently large diaphragm the upper end of the casing 70 is enlarged, as at 71, and the lower end of the casing is provided with

an enlarged cam engaging foot 72. The plunger 73 is provided with a bottom wall 74 having a circular port 75 therein. Port 75 is enlarged at the under side of the bottom wall 74 to provide a valve retaining recess 76 in which is mounted a disc valve 77. A retaining plate 78 having a central opening 79 and spaced inwardly extending fingers 80 are provided for retaining the valve disc 77 within the valve cavity 76. The diameter of the opening 79 is greater than that of the disc with the result that flow of liquid from the interior of the plunger 73 into the space below the bottom wall 74 of the plunger is unrestricted. Flow in the opposite direction, however, is prevented by the disc valve 77 which engages its seat and thereby closes port 75. A spring 81 is provided within a suitable recess in the lower portion of the casing 70 and bears against the plate 78, thus holding it in engagement with the bottom of the plunger and constantly urging the plunger upwardly in the manner described with respect to spring 37 in Fig. 2.

The upper end of plunger 73 is closed by means of a head 85 having mounted therein a valve rod engaging member 86. And the head is provided with a pair of vertically extending bores 87 and 88 providing a fluid communication between the interior of the plunger and the space within the enlarged diaphragm chamber 71. The top of the diaphragm chamber is flanged outwardly at 89 to provide a seat for the diaphragm 90, which is held in sealing relation with the head 85 by means of a flange 91 on the valve rod engaging member 86. A spring 92, spring retaining plate 93 and cap 94 are provided in the manner described with respect to the modification shown in Fig. 2, and the cap is provided with an opening 95 through which the spring may be inserted, as indicated above.

The lower portion of the casing 70 may be filled with fluid in the manner described with respect to the modification in Fig. 2 whereupon the interior of the plunger and the interior of the diaphragm chamber 71 may be completely filled with fluid and the diaphragm secured in place by means of the cap 94, in the manner described with respect to the preferred embodiment. It may be noted that in this modification it is unnecessary to provide an opening for the escape of air from within the plunger as was necessary in connection with the structure shown in Fig. 2.

In operation, the structure shown in Figs. 6 and 7 performs the same function in the same manner as does the structure shown in Figs. 1 to 5.

It will be observed that I have provided a self-contained hydraulic tappet which is air free and which, therefore, insures that the body of liquid through which the valve opening force is transmitted will be substantially incompressible. While only two forms of the invention are shown it is apparent that other modifications may be utilized within the spirit of the invention as set forth herein and within the scope of the appended claims.

I claim:

1. A self contained hydraulic valve lifter, comprising a sealed rigid casing having a flexible wall, a bodily movable means in said casing defining a pair of closed chambers in said casing, one way valve means for admitting fluid from one of said chambers to the other, a liquid completely filling all space within the confines of the casing not occupied by solid material, and means for main-

taining said flexible wall in contact with said liquid at all times.

2. A self contained hydraulic valve lifter, comprising a sealed rigid casing having a flexible wall, a bodily movable means in said casing defining a pair of closed chambers in said casing, one way valve means for admitting fluid from one of said chambers to the other, a liquid completely filling all space within the confines of the casing not occupied by solid material, said flexible wall having a portion connected to said bodily movable means for movement therewith, and means for maintaining said flexible wall in contact with said liquid at all times.

3. A self contained hydraulic valve lifter, comprising a rigid casing having open and closed ends, a plunger fitted to the walls of said casing and movable therein, a flexible diaphragm secured in sealing relation to the open end of said casing, a liquid completely filling all spaces within said casing not occupied by solid material, a check valve adapted to permit flow of fluid in one direction only from one side of said plunger to the other, said plunger and a portion of said diaphragm being movable together to effect adjustment of the length of the lifter, and means for maintaining said flexible diaphragm in contact with said liquid at all times.

4. A self contained hydraulic valve lifter comprising, a cylinder having an open end, a piston adapted to work in said cylinder, means adapted to provide a one way fluid by-pass from one end of said cylinder to the opposite end thereof, a flexible closure member secured in sealing relation over the open end of the cylinder, a substantially incompressible fluid completely filling all spaces within said cylinder and at both sides of said piston, and resilient means urging said closure member towards the other end of the cylinder.

5. A self contained hydraulic valve lifter comprising a cylinder having an open end, a piston adapted to work in said cylinder, means adapted to provide a one way fluid by-pass from one end of the cylinder to the opposite end, a substantially incompressible fluid in said cylinder, a flexible closure member connected in sealing relation with said piston and said open end of the cylinder, and means for preventing relative rotation between said piston and cylinder.

6. A self contained hydraulic valve lifter comprising a cylinder having an open end, a piston adapted to work in said cylinder, means adapted to provide a one way fluid by-pass from said open end of the cylinder to the opposite end, a substantially incompressible fluid in said cylinder, a flexible closure member connected in sealing relation with said piston and said open end of the cylinder, means fixed with respect to said piston and extending through said flexible closure mem-

ber, and a cover plate for said closure member having an opening to receive said last named means and being fixed to the open end of said cylinder, said plate opening and said last named means being formed to prevent relative rotation between the same without interfering with relative axial movement.

7. A self contained hydraulic valve lifter comprising a cylinder having an open end, a piston adapted to work in said cylinder, means adapted to provide a one way fluid by-pass from said open end of the cylinder to the opposite end, a substantially incompressible fluid in said cylinder, and a flexible closure member connected in sealing relation with said open end of the cylinder, said open end of the cylinder and said flexible closure member being of greater diameter than the piston and the remainder of said cylinder and the central portion of said flexible closure member being connected to said piston.

8. A self contained hydraulic valve lifter comprising a cylinder having an enlarged open end, a piston adapted to work in said cylinder remotely from said enlarged end portion, means adapted to provide a one-way fluid by-pass from one end of said cylinder to the opposite end thereof, a flexible closure member secured in sealing relation over said open end of the cylinder, a substantially incompressible fluid completely filling all spaces within said cylinder and at both sides of said piston, and resilient means urging said flexible closure member towards said opposite end of the cylinder, said piston being connected to the central portion of said diaphragm.

9. A self contained hydraulic tappet, comprising a sealed rigid casing having an opening therein, a plunger movable in said casing, a substantially incompressible fluid completely filling said casing, means including a flexible wall closing the opening in said casing for maintaining said fluid under pressure at all times, and by-pass means for conducting fluid from one side of said plunger to the other in one direction only, said flexible wall having a portion movable with said plunger.

10. A self contained hydraulic valve lifter comprising a rigid casing having an opening, means closing and sealing said opening, said means including a movable member and being so constructed and arranged as to maintain the internal volume of said casing constant during movement of said member, a movable plunger defining a pair of closed chambers in said casing, said plunger being connected to said movable member, one way valve means for admitting fluid freely from one of said chambers to the other, and an incompressible fluid completely filling all open spaces within said chambers.

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