Oct. 18, 1960 M. V. DADD 2,956,557

HYDRAULIC TAPPETS

Filed Dec. 11, 1958 2 Sheets-Sheet 1

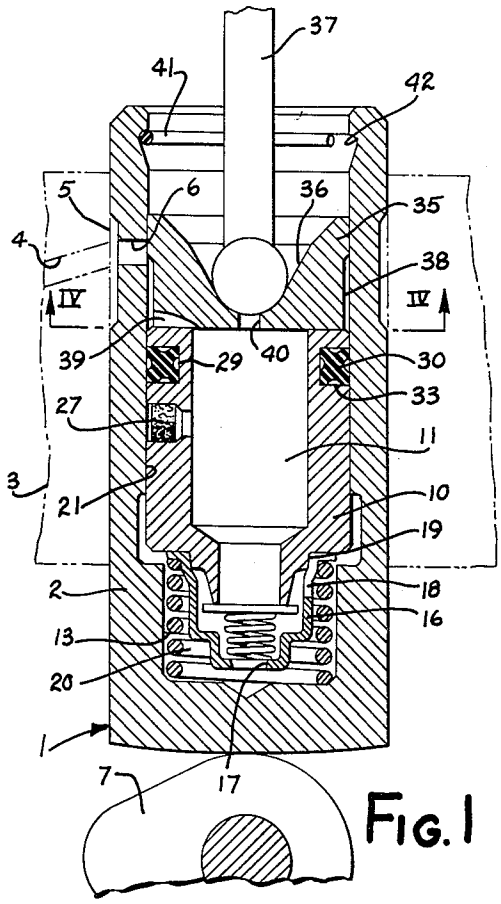


FIG. 1

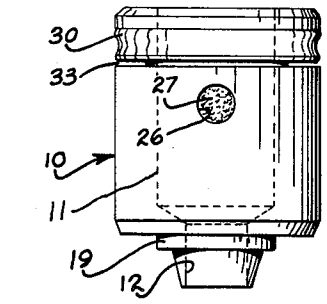


FIG. 2

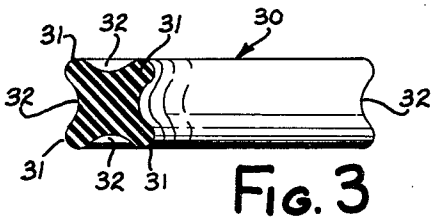


FIG. 3

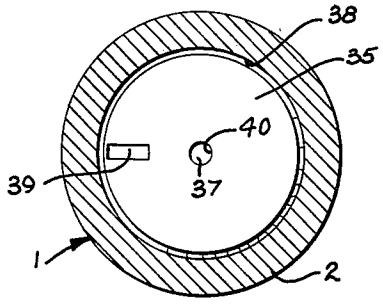


FIG. 4

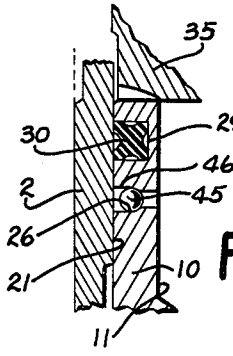


FIG. 8

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HYDRAULIC TAPPETS

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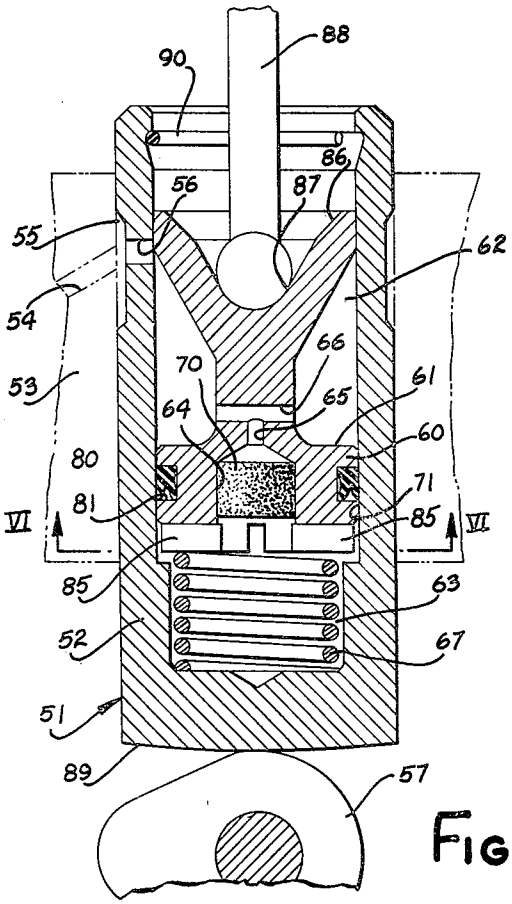


FIG. 5

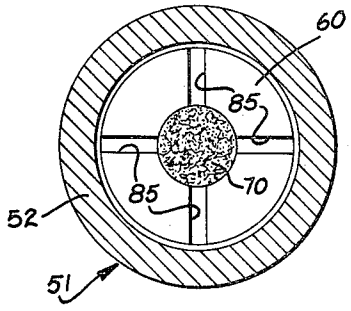


FIG. 6

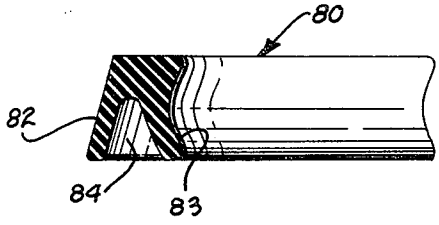


FIG. 7

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HYDRAULIC TAPPETS

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16 Claims. (Cl. 123—90)

This invention relates to tappets and more particularly to hydraulic tappets.

This application is a continuation-in-part of patent application Serial No. 710,450, filed January 22, 1958, and entitled Hydraulic Tappets.

Intake and exhaust valves of combustion engines are normally actuated and timed by cams acting through a valve train or actuating mechanism to open and close the valves at specific times in the combustion cycle. It is essential to the efficiency of an engine that the effective length of the valve train parts remain constant in order to repeatedly actuate the engine valves in this precise timing pattern. This is complicated by an unavoidable and appreciable change in the effective length of the valve train due to expansion and contraction of its parts.

During the initial period of operation of a cold engine, due to the temperature rise, an expansion of the various parts of the valve train takes place. At other times a temperature drop will cause contraction of the valve train parts. Thus, it is necessary to provide a means within the valve operating mechanism for compensating for the change in its effective length. Such means is preferably a self-compensating unit which automatically adjusts itself to decrease the length of the valve actuating train or mechanism as engine temperatures rise and which will increase such length when the engine has cooled. A self-compensating unit is also desirable if noise and wear between the different parts of the valve actuating mechanism is to be eliminated.

Hydraulic tappets have been used in engines for many years as a type of self-compensating unit.

Hydraulic tappets operate on the principle of transmitting the energy of the valve actuating cam through hydraulic fluid trapped in a chamber behind a plunger. During each operation of the cam, as the length of the valve actuating mechanism varies due to temperature changes, small quantities of hydraulic fluid are permitted to enter or escape from the pressure chamber and thus effect an adjustment in the position of the plunger and consequenlty an adjustment of the total length of the valve train.

In conventional hydraulic tappets the escape of hydraulic fluid from the pressure chamber is between the plunger and the walls of the tappet body or housing. Such escape, or "leakdown" as it is referred to, is controlled solely by the fit of the plunger within the tappet body or housing. Effective operation of a hydraulic tappet requires that the leakdown be precisely controlled and thus the fit between the plunger and the tappet body must be held to very close clearances. These clearances are normally limited to 0.0002–0.00023 of an inch. Such close clearances require selective fitting of the plunger to the tappet body and is an expensive operation. Even though considerable care is taken in making the selective fit a certain percentage of the assembled tappets have a leakdown which is either too fast or too slow and as a result the tappet will not operate satisfactorily.

It is here proposed to provide a means or device to

control the escape of hydraulic fluid from the pressure chamber. The control means proposed is not dependent upon a selective fit between the plunger and the tappet body. Much larger clearances are permissible between the plunger and the tappet body than heretofore have been considered acceptable. Aside from the elimination of precise machining operations and the requirement for selective fitting of tappet parts, the proposed control means is itself simple in construction, assembly, and operation.

It is proposed to make use of a porous plug mounted within a passage formed through the side wall of the plunger member between the pressure and reservoir chambers. The porosity of the plug is such that it will pass hydraulic fluid therethrough in response to fluid pressures built up within the pressure chamber. The porous member serves as a one-way check valve permitting the flow of fluid from the pressure chamber to the reservoir but preventing a reverse flow of hydraulic fluid therethrough.

In making use of the proposed type of porous valve or control a larger clearance fit is allowable between the plunger and tappet body members. Because of the larger clearance it is found desirable to provide a fluid pressure seal about the upper end of the plunger member. Such a seal may itself be formed to operate as a one-way check valve to allow the flow of fluid from the reservoir chamber to the pressure chamber while preventing a reverse flow thereof. The fluid seal used may also include features whereby the seal is urged into tighter fluid pressure sealing engagement between the plunger and tappet body member during the high fluid pressure conditions built up within the pressure chamber.

The use of a porous plug member and a one-way fluid sealing ring also suggests a different form of plunger member; such as one having the reservoir chamber provided circumferentially about the plunger member.

Numerous other modifications, variations and adaptations of the principles taught by this invention will come to mind upon a further reading of this application by those skilled in the art.

One such modification, or variation, includes the use of a ball check valve in place of the porous plug member. The ball check valve is mounted within the side wall of the tappet plunger and permits the restricted flow of fluid from the pressure chamber to the reservoir.

In the drawings:

Fig. 1 is a cross sectional view of a substantially conventional hydraulic tappet modified to include certain features of this invention.

Fig. 2 is a side elevational view of the plunger member in the tappet of Fig. 1, shown removed from the tappet body member.

Fig. 3 is an enlarged view of a part of the annular sealing ring shown in Fig. 1.

Fig. 4 is a cross sectional view through the hydraulic tappet shown by Fig. 1, taken in the plane of line IV—IV thereon, and looking in the direction of the arrows.

Fig. 5 is a cross sectional view of a new and different type hydraulic tappet including several features of this invention.

Fig. 6 is a cross sectional view of the tappet shown by Fig. 5 as seen in the plane of line VI—VI and looking in the direction of the arrows thereon.

Fig. 7 is an enlarged view of a part of the one-way sealing ring shown in the tappet disclosed by Fig. 5.

Fig. 8 is a partial cross sectional view through a tappet to show another form of this invention.

In executing the objects and purposes of this invention certain parts and features of conventionally known hydraulic tappets may be used. A hollow tappet body that is closed at one end is used. A plunger member is slidably disposed within the tappet body and forms a pres-

sure chamber with the blind end thereof. A rod seat member is either received within the tappet body above the plunger, or the upper end of the plunger may be formed to provide a rod seat portion. A reservoir chamber is formed within the tappet body between the ends of the plunger member. The reservoir chamber may be formed either within or externally around the plunger member. Passage means are formed through the plunger member between the reservoir and pressure chambers. One of these passages is closed by a check valve principally responsive to fluid pressure within the reservoir and the other of the passages is closed by a porous plug responsive to fluid pressure within the pressure chamber. Because of the larger clearance dimension permitted between the plunger member and the inner wall of the tappet body member the pressure chamber space may be considered as inclusive of the space between the plunger and tappet body members. The upper end of such annular space is closed by a suitable fluid pressure sealing ring. The proposed tappets operate to adjust the axial disposition of the plunger member within the tappet body by admitting hydraulic fluid into, or venting such fluid from, the pressure chamber.

Referring specifically to the drawings, one form of the proposed invention is shown by Figs. 1–4 to include a hydraulic tappet **1** having a tappet body **2** reciprocally seated within a housing **3**, such as would be provided by an engine block. The housing **3** has an oil supply passageway **4** communicating with a wide circumferential groove **5** formed externally about the tappet body **2**. The height of the groove **5** assures communication between the groove and the passage **4** as the tappet body reciprocates within the housing. An aperture **6** communicating with the groove **5** provides access for hydraulic fluid to the interior of the tappet body.

The tappet body **2** is closed at its lower end and is open at its upper end. The lower end is engaged by a timing cam **7**.

A plunger **10** is slidably disposed within the tappet body **2**. The plunger **10** is hollow and forms a hydraulic fluid reservoir **11**. A passage **12** is formed through the lower end of the plunger to provide a means of communication between the reservoir **11** and a pressure chamber **13**. The pressure chamber **13** is formed between the end of the plunger **10** and the blind end of the tappet body **2**. A stop check valve **14** is biased by a spring **15** into closed position against the end of the plunger **10** and over the passage **12**.

The lower end of the check valve spring **15** bears against a retainer cap **16**. The retainer cap **16** is engaged to the end of the plunger **10** about a wall **19** formed on the lower end thereof. An aperture **17** in the terminal end of the retainer, and apertures **18** provided in the sides thereof, permit the flow of hydraulic fluid therethrough. The plunger **10** is biased away from the closed end of the tappet body **2** by a plunger return spring **20**.

The fit of the plunger **10** within the tappet body **2** is such that the pressure chamber **13** is to be considered to extend between the plunger and tappet body members and to be inclusive of such annular space **21**. In a tappet constructed according to this invention, the clearance between the plunger and the inside surface of the tappet body may be as much as .005 or .006 of an inch as compared to the 0.0002–0.00023 of an inch clearance permissible in conventional tappet constructions. Although this clearance is not sufficient to allow unrestricted flow of the hydraulic fluid between the plunger and tappet body walls, it is sufficient to permit a substantially more uniform fluid pressure condition to exist within the pressure chamber and about the plunger.

A passageway **26** is formed through the side wall of the plunger **10** between the ends thereof. The outer end of the passage **26** is enlarged to receive a porous plug **27** therein. The porous plug is thus disposed between the pressure chamber space **21**, which is provided about the plunger, and the reservoir chamber **11**. Any of a number of different porous materials may be used to form this plug provided the material is resistant to any adverse effects from the hydraulic fluid used and its porosity is such that it will pass the hydraulic fluid therethrough in the manner hereinafter described. As an example of such a material a plug of sintered bronze may be employed.

An annular groove **29** is formed in the external peripheral face of the plunger member **10** near the upper end thereof. A sealing ring **30** is received within the annular groove **29**. The sealing ring **30** is of a resilient material such as neoprene suitable for use in the presence of hydraulic fluids and related liquid hydrocarbons. As seen in Fig. 3, the sealing ring is preferably a Quad-ring which has an X-shape in cross section. This provides spaced, annular, resilient lip or leg portions **31** with an annular groove or concave pocket portion **32** between each of the adjacent legs and within each external face of the ring member. The internal diameter of the resilient ring is less than the external diameter of the plunger at the base of the groove **29**, assuring a tight fit of the ring member within the groove. The width of the ring member is slightly greater than the depth of the groove **29** causing the outer peripheral legs **31** thereof to make fluid sealing engagement with the inner peripheral walls of the tappet body member **2**. It will be noted that the sealing ring **30**, as received within the groove **29**, provides a space **33** between the ring and the lower side wall of the groove **29**.

A push rod seat member **35** is slidably disposed within the tappet housing above the plunger **10**. The upper end of the push rod seat **35** is formed to provide a sliding and liquid restraining seal with the inner walls of the tappet body **2**. A generally spherical depression **36** is formed within the upper surface of the push rod seat for the reception of the end of a push rod **37**, which forms part of the valve train linkage. The end of the push rod seat **35** which engages the plunger **10** is of reduced cross section, as compared with the upper end thereof, creating an annular space **38** which is continuously in communication with the access **6** through the tappet body and with the groove **5** and oil supply passage **4** (Figs. 1 and 4). A radially disposed slot **39** in the lower end of the push rod seat provides a means of communication for hydraulic fluid to the reservoir **11**. The passage **40** extending through the push rod seat, in the spherical seat, is closed by the push rod **37** and serves no purpose other than as a manufacturing aid in forming the spherical seat **36**.

The members just described as being within the tappet body **2** are prevented from disassembly therefrom by a snap ring **41** received in a suitable groove **42** provided in the inner wall of the tappet body **2** adjacent its open end.

Variation

Fig. 8 shows a minor modification or variation in the structure just described; namely the use of ball check valve **45** in place of the porous plug **27**.

The plunger **10** is substantially as has been described. Accordingly, the same numbers have been used to designate similar parts. The passageway **26** is formed as before; with the outer end thereof, which is in communication with the annular clearance space **21**, enlarged. The shoulder **46** between the enlarged end and the inner end of passageway **26** is formed to provide a valve seat for the check valve **45**. The check valve ball **45** has restricted freedom of movement within the enlarged end of passageway **26** permitting it to back off from the valve seat **46** to provide in the order of between .004" and .020" clearance therebetween.

Modification

Figs. 5–7 show a modification of the hydraulic tappet design of Figs. 1–4. The hydraulic tappet **51** includes

a tappet body 52 reciprocally seated within a housing 53 such as would be provided in an engine block. The housing 53 has an oil supply passageway 54 communicating with a wide, external, and circumferential groove 55 formed about the tappet body 52. The width of the groove 55 assures communication between the groove and the passage 54 as the tappet body reciprocates within the housing. An aperture 56, formed through the tappet body 52 and communicating with the groove 55, provides an access for hydraulic fluid to the interior of the tappet body.

The tappet body 52 is closed at its lower end and is open at its upper end. The lower end 89 is engaged by a timing cam 57.

A plunger member 60 is slidably disposed within the tappet body 52. The plunger member 60 is formed to include a peripheral recess 61 between its ends which serves as a reservoir chamber 62 when closed by the internal side walls of the tappet body 52. The lower end of the plunger 60 forms a pressure chamber 63 with the closed end of the tappet body member 52. An enlarged passage 64 is formed centrally within the lower end of the plunger 60. This passage communicates by means of other passages 65 and 66 with the reservoir chamber 62 and thereby provides communication between the reservoir and pressure chambers. A porous plug 70 is disposed within the enlarged passage 64 and prevents communication between the pressure and reservoir chambers except under certain pressure conditions existing within the pressure chamber.

The lower end of the plunger member 60 is engaged by a plunger return spring 67. The plunger return spring 67 is disposed within the pressure chamber 63 and is engaged with the closed end of the tappet body in order to exert force on the plunger member.

The pressure chamber 63 is to be considered to be inclusive of the annular space 71 between the inner walls of the tappet body 52 and the outer periphery of the lower end of the plunger member 60. This is in accord with the teachings of this invention that the clearance between the plunger and the inside surface of the tappet body may be as much as .005 or .006 of an inch as compared to the much more limited clearances permissible in conventional tappet constructions. Again, it is pointed out that, this clearance is not to be considered as sufficient to allow unrestricted flow of hydraulic fluids, of viscosity ranges normally encountered in engine designs, between the plunger and tappet body walls. However, it is to be considered sufficient to permit a substantially uniform fluid pressure condition to exist within the pressure chamber and about the lower end of the plunger.

A sealing ring 80 is provided about the lower end of the plunger 60 to prevent communication between the pressure chamber space 71, provided between the peripheral walls of the tappet body and plunger member, and the reservoir chamber 62.

An annular groove 81 is formed in the external side wall of the plunger member 60, adjacent its lower end, and is adapted to receive the sealing ring 80 herein. The sealing ring 80 is an annular member of resilient material, such as neoprene, suitable for use in the presence of hydraulic fluids and related liquid hydrocarbons. The ring 80 has a R-shape in cross section, as best shown by reference to Fig. 7. This provides depending and divergent annular leg or lip portions 82 and 83. The outer peripheral one of these leg portions 82, is disposed in yielding engagement with the inner wall of the tappet body member. The divergent legs 82 and 83 form an annular fluid pocket or channel 84 therebetween which is on the side of the sealing ring next adjacent the pressure chamber 63.

The outer flange or lip 82 is held in fluid pressure sealing engagement with the tappet body member 52 when the pocket portion 84 is filled with hydraulic fluid under a pressure greater than that within the reservoir 62. The

presence of this pocket provides a large working area for the fluid pressure to act against the sealing lips 82 and 83. A particularly effective seal is thus formed.

When the fluid pressure in the reservoir 62 is greater than that within the pressure chamber 63 the outer peripheral leg or lip portion 82 will be flexed or collapsed inwardly compressing the pocket 84 and allowing hydraulic fluid to pass from the reservoir 62 into the pressure chamber 63.

The radially disposed slots 85 (Figs. 5 and 6) formed within the lower end of the plunger member 60 permit continuous communication between the annular space 71, about the lower end of the plunger member, and the pressure chamber space 63 between the end of the plunger and the blind end of the tappet body member. Such communication serves both to assure an equalization of the pressure conditions in the pressure chamber spaces and provides passage means for the bleeding of air from the pressure chamber spaces to the porous plug 70.

In the modification shown, the upper end of the plunger member 60 is formed to provide a push rod receiving and seating portion 86 and a spherical recess 87 is formed therein to receive the push rod 88.

The members just described as being disposed within the tappet body 52 are prevented from disassembly therefrom by a snap ring 90 seated in a suitable groove 71 provided in the inner wall of the tappet body adjacent its open end.

Operation

The cam actuating mechanism and valve train linkage has not been shown with either of the illustrated embodiments of this invention since such mechanism and linkage is of conventional design and its relation to parts shown is considered to be adequately known and understood.

The tappet 1 illustrated by Figs. 1–4 operates in the following manner. Hydraulic fluid is allowed to flow from the reservoir 11 into the pressure chamber 13, through the one-way check valve 14, as necessary to replenish fluid in the pressure chamber and maintain a pressure condition therein which is not substantially less than the pressure condition in the reservoir chamber. The plunger return spring 20 serves to bias the plunger 10 in engagement with the push rod seat member 35, and the push rod seat member, in turn, in engagement with the push rod 37.

During normal engine operations, that is when the engine's temperature is substantially constant, the cam member 7 acts against the lower end of the tappet body 2 to raise the engine valve push rod 37 against the resisting force of the engine valve spring. The lifting force of the cam 7 is transmitted directly through the tappet to the push rod due to the incompressible nature of the hydraulic fluid in the pressure chamber spaces 13 and 21 and the fact that the fluid is trapped or locked up in the pressure chambers due to the sealing ring 30. The sealing ring 30 serves to prevent any escape of hydraulic fluid from the annular pressure chamber space 21 between the plunger and tappet body wall.

During the rise of the tappet, to lift the engine valve against the resisting force of the engine valve spring, a higher fluid pressure force is required to be built up in the pressure chamber 13 to overcome the increasing resistance of the engine valve spring. This pressure build up assures an equality of fluid pressure within the pressure chamber spaces 13 and 21.

The porosity of the porous plug 27 is such as will allow a controlled amount of oil flow from the pressure chamber to the reservoir. Upon a return of the tappet to the base circle of the cam 7 and a relief of the external pressures thereon, by the cam and the engine valve spring acting through the push rod 37, a lower pressure condition may exist within the pressure chamber 13 than exists in the reservoir chamber 11. In such event, the higher pressure condition in the reservoir 11 will tend to

unseat the check valve 14 and allow hydraulic fluid to flow from the reservoir into the pressure chamber spaces to replenish the lost fluid.

During the high pressure condition built up within the pressure chamber, hydraulic fluid enters the space 33 and the annular groove 32 under the sealing ring 30. This fluid acts within the fluid pocket 32 next adjacent the pressure chamber space 21 to compress the sealing ring axially and to expand the outer peripheral lips or flanges 31 into tighter fluid pressure sealing engagement with the tappet body member. This prevents any escape of hydraulic fluid from around the plunger member.

During the warm up period of a cold engine, having the proposed type tappet therein, where the valve train parts are expanding, it is necessary for the plunger member 10 to be adjusted axially within the tappet body 2.

During the engine warm up period, the tappet must progressively reduce its effective length to compensate for the expansion of the valve train parts. It will be appreciated that the expansion which occurs in the valve train parts during each rise and wall of the tappet is in very small increments, in the order of 0.0004 of an inch. Thus, very little hydraulic fluid is actually required to be vented from the pressure chamber and into the reservoir chamber each cycle to permit the necessary axial adjustment of the plunger member.

On a return of the tappet to the base circle of the cam 7 the expansion of the valve train parts requires that the push rod seat 35 be returned to a lower axial position in the tappet body 2 than it previously occupied. If adequate fluid has been bled from the pressure chamber spaces during the rise and fall of the tappet such lowered disposition is easily obtained. The push rod seat being in a lowered position merely reduces the volumetric space of the pressure chambers.

With the ball check valve 45 of Fig. 8 used in place of the porous plug 27, the operation is as follows:

During the operation of the motor, the cam shaft rotates at high speeds and as a result cam 7 opens and closes the engine valve at these speeds. Accordingly the tappet is also raised and lowered at these speeds.

Generally the ball check valve 45 is held closed during the lifting of the tappet and is open when the tappet is on the base circle of the cam. However, the speed of lifting and lowering of the tappet and the inertia of the ball is such that there is a lag in the closing of the ball upon initiation of the lifting of the tappet.

As the tappet body begins to rise previous and preparatory to lifting the engine valve through the various valve train parts, the pressure chamber space 13 begins to reduce in volume due to the push rod 37 tending to force the plunger 10 to remain stationary. The fluid in the pressure chamber begins to return to the reservoir past the check valve 45 to allow the reduction, but in doing so the viscosity of the fluid flowing past the ball check valve causes it to become seated on valve seat 46. The fluid in the pressure chamber areas 13 and 31 is then trapped in the pressure chamber space and pressure builds up in the pressure areas in accordance with the engine valve spring load. The pressure keeps the ball check valve 45 against the seat 46 throughout the engine valve actuating event.

The fluid lost from the pressure chamber space 13 preparatory to opening the engine valve as described above is sufficient to allow for any increases in valve train length during the engine valve operating cycle.

Upon return of the tappet to the base circle of the cam the pressure in the pressure chamber areas 13 and 21 reduces allowing the ball check valve 45 to fall away from its seat 46.

Upon a return of the tappet cylinder body 2 to the base circle of the timing cam 7, the poppet check valve 14 will open or not depending upon the fluid pressure differential within the pressure chamber and reservoir spaces 13 and 11. If the valve train parts are expanding the reduced volumetric space within the pressure chamber 13 may result in a high enough pressure condition to offset the fluid loss through the check valve 45. Otherwise the poppet check valve 14 will open when and as necessary to compensate for such fluid loss.

The ball check valve 45 has an advantage over the porous plug control 27 in that it is less subject to becoming clogged by impurities in the fluids passing therethrough.

In the modification tappet 51 shown by Figs. 5–7 the operation of the tappet is as follows:

The plunger return spring 67 serves to keep the plunger member 60, including the push rod seat portion 86 formed at the upper end thereof, in engagement with the push rod 88. The sealing ring 80 provides a one-way check valve between the reservoir chamber 62 and the pressure chamber 63. The porous plug 70 serves to prevent the flow of hydraulic fluid from the pressure chamber 63 to the reservoir 62 except under certain pressure conditions within the pressure chamber.

As the cam member 57 acts against the end 89 of the tappet body 52 to raise the tappet, this force is transmitted directly through the tappet to the push rod 88 due to the incompressible nature of the hydraulic fluid within the pressure chamber 63, and the fact that it is trapped or locked up in the pressure chamber due to the one-way check valve sealing ring 80 and the porous plug member 70.

During the rise of the tappet, to lift the engine valve against the resisting force of the engine valve spring, a higher fluid pressure condition is built up in the pressure chamber 63 to overcome the increasing resistance of the engine valve spring. This pressure build up assures an equality of fluid pressure within the pressure chamber and the annular space 71 about the plunger. Consequently, the annular pocket 84 formed within the sealing ring face next adjacent the pressure chamber spaces 63 and 71 is filled with hydraulic fluid. The high fluid pressure holds the outer peripheral flange 82 of the sealing ring in fluid pressure sealing engagement with the inner wall of the tappet body member 52 and prevents the escape of hydraulic fluid past the check valve and into the reservoir chamber 62.

The porosity of the porous plug member 70 is such as permits hydraulic fluid to pass therethrough and into the reservoir chamber 62, during the lifting of the engine valve. Upon a return of the tappet to the base circle of the cam 57, and the tappet being relieved of the external pressures thereon, the pressure condition within the reservoir chamber 62 may be greater and sufficient to fold the outer peripheral lip 82 of the sealing ring 80 within the pocket portion 84 thereof and permit hydraulic fluid to pass from the reservoir chamber into the pressure chamber. This action is further assisted by the effort of the plunger return spring 67 to move the plunger member 60 upwardly and thereby increase the volumetric space within the pressure chamber spaces.

When an engine is warming up and the valve train parts are expanding, the requirement of an adjustment of the plunger member axially within the tappet body is more apparent.

When an engine is started cold, the length of the valve train parts is substantially shorter, due to contraction, than after the engine has been running for a while. During the engine warm up period, the tappet must progressively reduce its effective length of compensate for the expansion of the valve train parts as has been previously pointed out. Again it is mentioned that the expansion which occurs in the valve train parts during each rise and fall of the tappet is in very small increments, in the order of 0.0004 of an inch. Thus very little hydraulic fluid is actually required to be vented from the pressure chamber and into the reservoir chamber to permit the plunger to move to a lower axial position within the tappet body and thereby reduce the overall effective length of the tappet member.

If the valve train parts have expanded, during the rise of the tappet member **51**, the fluid pressure in the pressure chamber **63** may be increased to overcome the increased resistance of the engine valve spring to further compression. This increase in pressure may cause more hydraulic fluid to be passed through the porous plug **70**.

On a return of the tappet to the base circle of the actuating cam **7**, the push rod **88** seeks to return the plunger **60** to a lower relative position within the tappet body due to the expansion of the valve train parts. If sufficient fluid has been previously bled from the pressure chamber spaces, the plunger will be disposed at a lower relative position in the tappet body. Consequently less or no opening of the check valve **80** may be required to replenish fluid lost from the pressure chamber spaces.

The reservoir responsive check valve sealing ring **80** will open only when the fluid pressure condition in the pressure chamber spaces **63** and **71** falls below that in the fluid reservoir **62**. This condition may or may not exist during each cycle of the tappet depending upon the quantity of hydraulic fluid which escapes through the porous member **70**.

In conclusion, while there has been described a preferred embodiment of this invention and a modification thereof, it will be understood and appreciated that other modifications and improvements may be made. Such of these modifications and improvements as incorporate the principles of this invention are to be considered as included in the hereinafter appended claims, unless these claims, by their language, expressly state otherwise.

I claim:

1. In a hydraulic tappet comprising a hollow tappet body member closed at one end, a plunger member slidably disposed within said hollow tappet body, said plunger forming a pressure chamber with the closed end of said tappet body, a reservoir chamber provided within said tappet body and separate from said pressure chamber, and check valve means disposed between said reservoir and pressure chambers for maintaining certain fluid pressure conditions within said pressure chamber; means allowing for the axial adjustment of said plunger within said tappet body by the venting of fluid from said pressure chamber and comprising: having said pressure chamber formed to be inclusive of the space between the adjacent peripheral walls of said tappet body and plunger members, and a porous member disposed between and separating said pressure and reservoir chambers, said porous member being responsive to fluid pressures greater than those within said reservoir and less than the fluid pressure condition within said pressure chamber due to the requirement of axial adjustment of said plunger, for passing fluid therethrough to said reservoir.

2. A hydraulic tappet comprising: a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body, a reservoir chamber provided within said tappet body on one end of said plunger and a pressure chamber provided therein on the other end of said plunger, and check valve means separating said pressure and reservoir chambers, the one from the other, one of said check valve means comprising a porous member responsive only to fluid pressure conditions within said pressure chamber for permitting hydraulic fluid to escape therethrough.

3. Means allowing for the relative axial adjustment of a plunger member within a hydraulic tappet member having separate pressure and reservoir chambers provided therein, and comprising; a reservoir pressure responsive check valve disposed between said chambers for venting said reservoir to said pressure chamber, and a porous member disposed between said chambers for venting said pressure chamber to said reservoir by allowing fluid to pass therethrough under fluid pressures built up in said pressure chamber under the requirement for axial adjustment externally imposed upon said hydraulic tappet member.

4. A hydraulic tappet, comprising: a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body member and forming a pressure chamber with the closed end thereof, a reservoir chamber formed within said tappet body by said plunger member, and one-way check valve means provided between said pressure and reservoir chambers for the control of the flow of hydraulic fluid therebetween, one of said check valves comprising a porous plug having opposite faces thereof exposed within said pressure chamber and said reservoir chamber, said porous valve being responsive to fluid pressure conditions greater than those in said reservoir and less than those developed in said pressure chamber for venting said pressure chamber to said reservoir.

5. The hydraulic tappet of claim 4, including; an annular groove formed about said plunger member next adjacent the inner wall of said tappet body, a resilient sealing ring received within said groove, said ring including an annular peripheral lip engaged with said tappet body wall and an annular fluid receiving pocket formed within the face thereof next adjacent said pressure chamber, said resilient ring being axially compressed upon the receipt of hydraulic fluid under pressure within said pocket and expanding said peripheral lip into tighter fluid pressure sealing engagement with said tappet body wall.

6. A hydraulic tappet comprising; a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body and forming a fluid pressure chamber with the closed end thereof, a fluid reservoir chamber formed peripherally about said plunger between the outer peripheral wall thereof and the inner peripheral wall of said hollow tappet body member, and one-way check valve means disposed between and separating said reservoir and pressure chambers, one part of said check valve means being adapted to vent said reservoir chamber to said pressure chamber under certain fluid pressure conditions in said chambers, and another part of said check valve means being adapted to vent said pressure chamber to said reservoir chamber under different fluid pressure conditions in said chambers.

7. A hydraulic tappet comprising; a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body and forming a fluid pressure chamber with the closed end thereof, a fluid reservoir chamber formed peripherally about said plunger between the outer peripheral wall thereof and the inner peripheral wall of said hollow tappet body member, and one-way check valve means disposed between and separating said reservoir and pressure chambers, one part of said check valve means being adapted to vent said reservoir chamber to said pressure chamber under certain fluid pressure conditions in said chambers and provided between the slidably engaged peripheral portions of said plunger and tappet body members, and another part of said check valve means being adapted to vent said pressure chamber to said reservoir chamber under different fluid pressure conditions in said chambers.

8. A hydraulic tappet comprising; a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body and forming a fluid pressure chamber with the closed end thereof, a fluid reservoir chamber formed peripherally about said plunger between the outer peripheral wall thereof and the inner peripheral wall of said hollow tappet body member, and one-way check valve means disposed between and separating said reservoir and pressure chambers, one part of said check valve means being adapted to vent said reservoir chamber to said pressure chamber under certain fluid pressure conditions in said chambers and provided between the slidably engaged peripheral portions of said plunger and tappet body members, and another part of said check valve means being adapted to vent

said pressure chamber to said reservoir chamber under different fluid pressure conditions in said chambers and being disposed centrally within said tappet body member and in communication with said peripheral reservoir chamber via passageways formed through said plunger member.

9. A hydraulic tappet comprising; a hollow tappet body closed at one end, a plunger member slidably disposed within said tappet body and forming a pressure chamber with the closed end thereof, said plunger member being formed at the open end of said tappet body to provide an engine valve lifter rod seat, a reservoir chamber formed about said plunger member between the ends thereof and closed by the inner wall of said tappet body member, and separate check valve means disposed between and separating said reservoir and pressure chambers, said valve means being separately responsive to different fluid pressure conditions within said chambers for venting said chambers one to the other and vice versa as necessary for the axial adjustment of said plunger within said hollow tappet body.

10. The hydraulic tappet of claim 9 including a passageway formed through said plunger member between said reservoir and pressure chambers and having one of said check valves disposed therein, said one check valve comprising a porous plug closing said passageway and being responsive to fluid pressures greater than exist within said reservoir and less than are built up in said pressure chamber for the uni-directional control of fluid flow therethrough.

11. A hydraulic tappet, comprising a blind end hollow tappet body having a plunger member slidably disposed within said tappet body and forming a pressure chamber with the blind end thereof, a plunger return spring disposed within said pressure chamber and engaged with the lower end of said plunger and the blind end of said tappet body, an engine valve lifter rod seat formed within the upper end of said plunger member, a fluid reservoir chamber formed within said plunger about the periphery thereof and between the ends thereof, said reservoir being closed by the inner wall of said tappet body member, a passage formed within the lower end of said plunger member and communicating between said pressure and reservoir chambers, a porous plug disposed within said passage and responsive to fluid pressure conditions greater than exist in said reservoir chamber and less than exist in said pressure chamber under certain operating conditions of said tappet, for passing fluid therethrough, and an annular check valve disposed between said reservoir and pressure chambers and peripherally about the lower end of said plunger member next adjacent the inner wall of said tappet body, said check valve yielding only to pass fluid from said reservoir to said pressure chamber as necessary to eliminate clearance between the valve train parts actuated by said tappet.

12. A hydraulic tappet comprising: a hollow tappet body member closed at one end, a hollow plunger member slidably disposed within said tappet body, a reservoir chamber provided within said tappet body on the outside of said plunger and a pressure chamber provided therein on the inside of said plunger, check valve means separating said pressure and reservoir chambers, one from the other, one part of said check valve means being disposed within and including a passage formed through the side wall of said plunger and communicating between said reservoir and pressure chambers.

13. A hydraulic tappet comprising: a hollow tappet body member closed at one end, a hollow plunger member slidably disposed within said tappet body, a reservoir chamber provided within said tappet body on the inside of said plunger and a pressure chamber provided therein on the outside of said plunger, check valve means separating said pressure and reservoir chambers, one from the other, one part of said check valve means being provided about said plunger and being responsive to reservoir chamber pressure conditions, another part of said check valve means being provided within and including a passage formed through said plunger member and being responsive to pressure conditions within said pressure chamber.

14. A hydraulic tappet comprising: a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body, a reservoir chamber provided within said tappet body on the inside of said plunger and a pressure chamber provided therein on the outside of said plunger, check valve means separating said pressure and reservoir chambers, one from the other, one part of said check valve means being provided about said plunger and being responsive to reservoir chamber pressure conditions, another part of said check valve means being provided within and including a passage formed through the lower end wall of said plunger member and being directly responsive to the pressure condition within said pressure chamber for controlling the one-way flow of fluid from said pressure chamber to said reservoir.

15. A hydraulic tappet comprising: a hollow tappet body member closed at one end, a plunger member slidably disposed within said tappet body, a reservoir chamber provided within said tappet body on one side of said plunger and a pressure chamber provided therein on the other side of said plunger, check valve members separating said pressure and reservoir chambers, one from the other, one of said check valve members including a shouldered passage formed through the side wall of said plunger and communicating between said reservoir and passage chambers, and a ball member disposed within said passage and seating on the shouldered portion thereof.

16. Means allowing for the relative axial adjustment of a plunger member within a hydraulic tappet member having separate pressure and reservoir chambers provided therein, and comprising; a reservoir pressure responsive check valve disposed between said chambers for venting said reservoir to said pressure chamber, and a ball check valve provided between said chambers and normally held closed by the pressure condition within said pressure chamber space, said ball check valve yielding during high fluid pressure conditions within said pressure chamber space to allow a restricted flow of fluid from said pressure chamber space to said reservoir.

References Cited in the file of this patent

UNITED STATES PATENTS

2,081,040	King	May 18, 1937
2,394,354	Barr	Feb. 5, 1946
2,420,929	Buffington	May 20, 1947
2,700,561	Svenson	Jan. 25, 1955
2,904,060	Bergmann	Aug. 27, 1957
2,830,566	Allen	Apr. 15, 1958