April 8, 1941. C. VOORHIES 2,237,854

COMPENSATING HYDRAULIC VALVE TAPPET FOR INTERNAL COMBUSTION ENGINES

Filed June 4, 1934 3 Sheets-Sheet 1

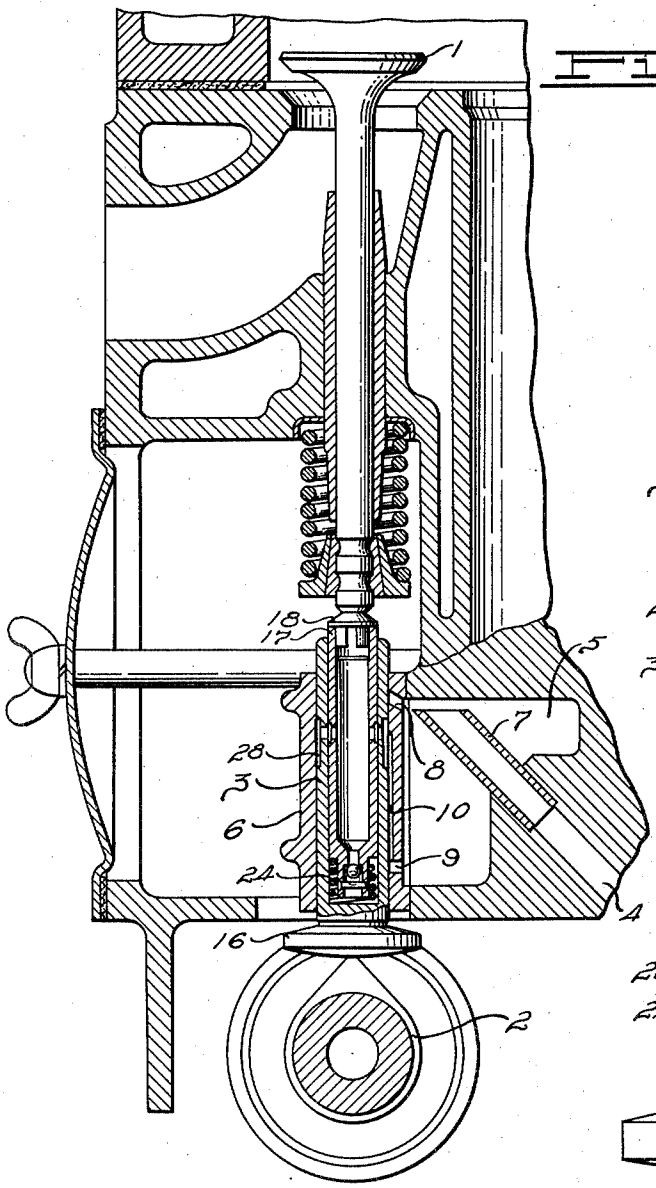


FIG. 1.

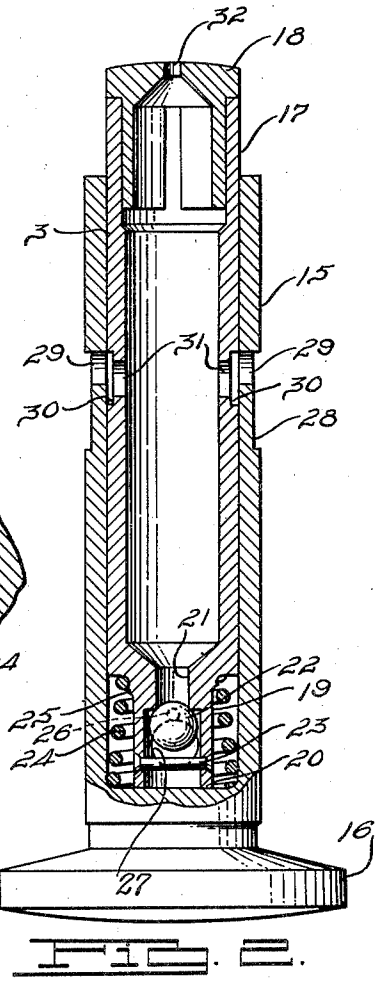


FIG. 2.

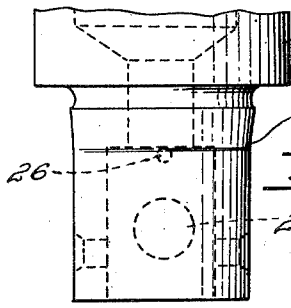


FIG. 3.

INVENTOR.
Carl Voorhies.
BY
Harness, Dickey, Pierce & Hann.
ATTORNEYS.

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Filed June 4, 1934 3 Sheets-Sheet 2

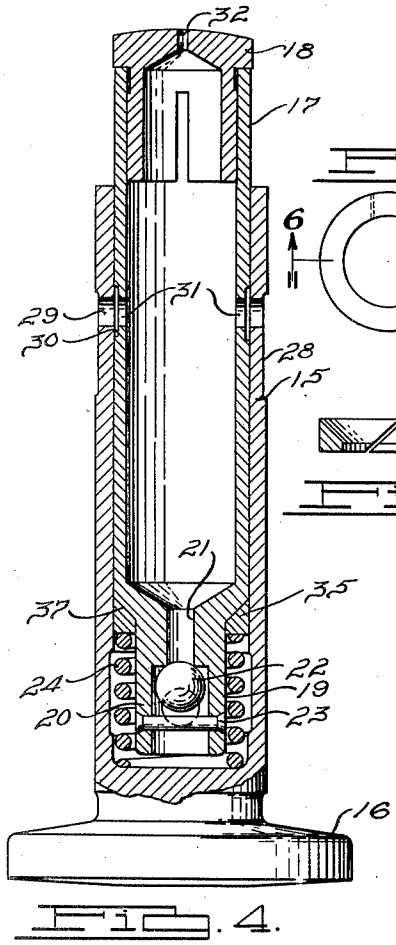


Fig. 4.

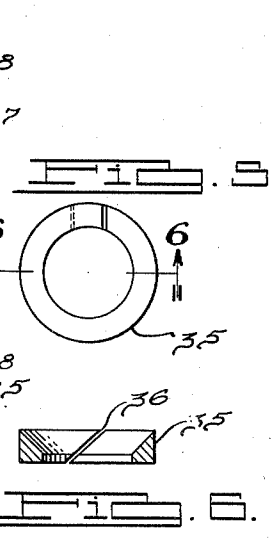


Fig. 5.

Fig. 6.

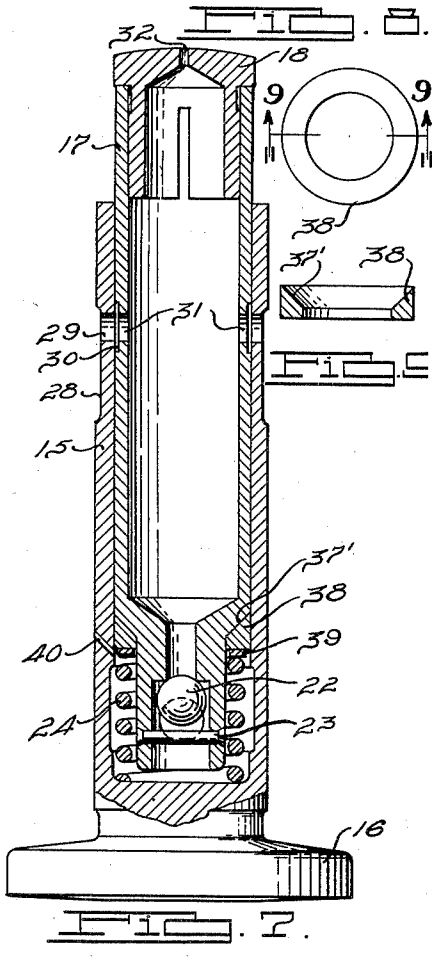


Fig. 7.

Fig. 8.

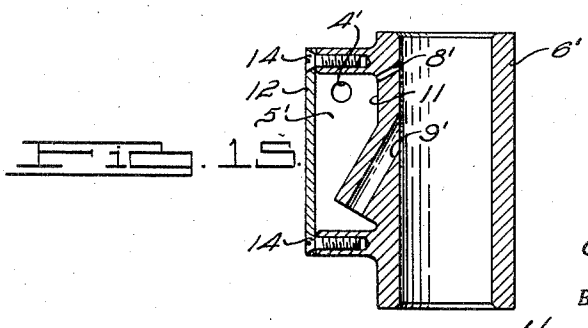


Fig. 15.

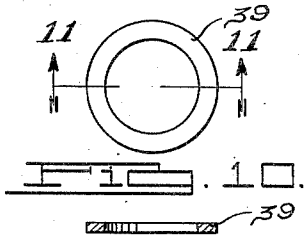


Fig. 10.

Fig. 11.

INVENTOR.
Carl Voorhies.
BY
Harness, Dickey, Pierce & Mann
ATTORNEYS.

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COMPENSATING HYDRAULIC VALVE TAPPET FOR INTERNAL COMBUSTION ENGINES

Filed June 4, 1934 3 Sheets-Sheet 3

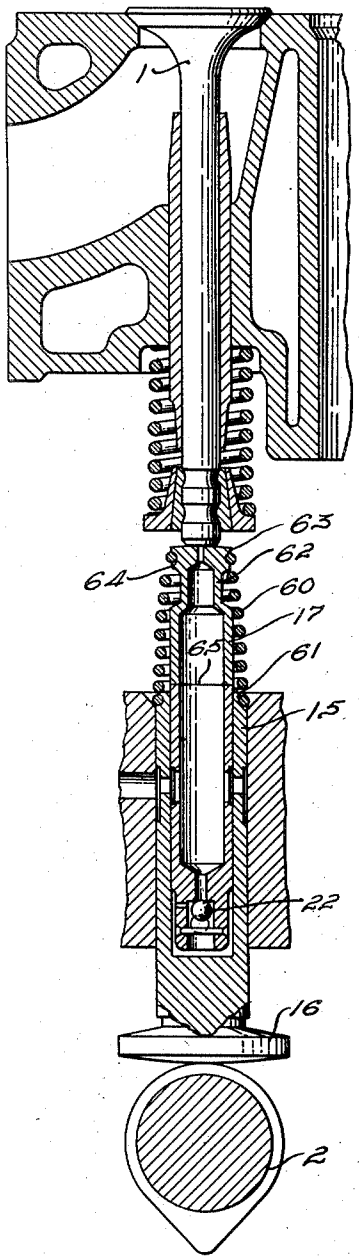


Fig. 12.

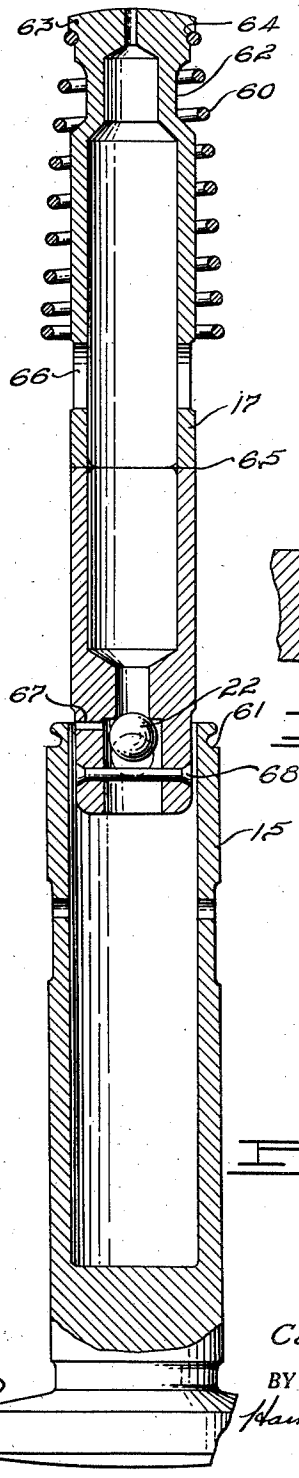


Fig. 13.

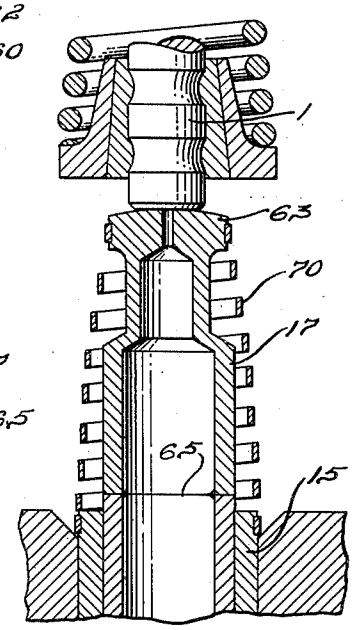


Fig. 14.

INVENTOR.
Carl Voorhies.
BY
Haines, Dickey, Pierce & Hann.
ATTORNEYS.

Patented Apr. 8, 1941

2,237,854

UNITED STATES PATENT OFFICE

2,237,854

COMPENSATING HYDRAULIC VALVE TAPPET FOR INTERNAL COMBUSTION ENGINES

Carl Voorhies, Detroit, Mich., assignor, by mesne assignments, to Eaton Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application June 4, 1934, Serial No. 728,813

19 Claims. (Cl. 123—90)

This invention relates to improved constructions in tappets and push rods for internal combustion engines which are hydraulically operated to compensate for expansion clearance between the valves and the tappets and push rods which transmit the thrust of the cams to the valves of internal combustion engines. The improvements may also be adapted to like devices for other uses than those specifically mentioned.

It is an object of my invention to provide a clearance compensating valve tappet or push rod, operated by means of a hydraulic medium, having a valve controlled plunger of novel construction, and having novel features of arrangement of the compensating parts and means for liberating air or gases from the liquid and for venting gases from the compression chambers and reservoirs for the hydraulic medium, and having a new arrangement of spring support for the reciprocating compensating member of the tappet, and a novel construction of spring.

It is another object of the invention to provide novel and efficient means for sealing the relatively movable parts of the tappet, to provide for retention of the hydraulic medium in the compression chamber.

Another object of the invention is to provide a tappet, plunger and spring arrangement in conjunction with liquid admission means so constructed that the liquid and spring causes the plunger to follow a valve operating member for only a limited distance but not beyond the point at which the admission of liquid to the valve is cut off and the full length of the spring attained.

Another object is to provide a novel adjustment of check valve travel for a hydraulic compensating valve tappet.

It is a further object to provide a novel construction of certain parts of the tappet for the purpose of facilitating the manufacture thereof and economizing therein.

These and other objects will become apparent from the following description of the invention when taken in conjunction with the accompanying drawings, in which—

Figure 1 is a view partly in section and partly in elevation of a fragment of an internal combustion engine showing the valve tappet and cam in operative relation relative to the engine and to one another.

Fig. 2 is a view partly in elevation and partly in section of one form of compensating tappet embodying my invention.

Fig. 3 is an enlarged, elevational and fragmentary view of the lower end of the plunger member of the tappet construction shown in Fig. 2.

Fig. 4 is a view partly in elevation and partly in section showing a novel sealing means combined with the plunger and cylinder of the tappet.

Fig. 5 is a plan view of the sealing gasket embodied in the construction shown in Fig. 4.

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 5.

Fig. 7 is a view partly in elevation and partly in section similar to Fig. 4 but showing a modified form of sealing means.

Fig. 8 is a plan view of the modified form of the sealing gasket shown in Fig. 7.

Fig. 9 is a cross-sectional view taken on the line 9—9 of Fig. 8.

Fig. 10 is a plan view of the washer used in connection with the sealing gasket shown in Fig. 7.

Fig. 11 is a cross-sectional view taken on the line 11—11 of Fig. 10.

Fig. 12 is a view partly in elevation and partly in section showing a part of an internal combustion engine with the valve, tappet and cam in their relative operating positions and showing a novel arrangement of spring support for the compensating plunger in the tappet, and a novel plunger construction.

Fig. 13 is an enlarged sectional view of another form of tappet with the parts partly separated to better illustrate the construction.

Fig. 14 is a fragmentary elevational view partly in section, disclosing a novel construction of spring support for the compensating plunger of the tappet.

Fig. 15 is a vertical section taken through the axis of the bore of a modified form of valve tappet guide which may be employed and embodies therein an oil settling chamber.

In the construction disclosed in Fig. 1, the valve 1 and cam 2 and their arrangement and construction are conventional. My improvements reside in the construction of the compensating tappet, designed generally by the numeral 3, and in the construction and arrangement of the means for supplying oil, which is the hydraulic medium customarily used, to the tappet 3, and in venting or eliminating the air or gases therefrom. The hydraulic medium in the form of oil is supplied to the tappet from the lubricating system of the engine and the oil is introduced through a passage 4 into a chamber or conduit 5 provided in the engine block adjacent the tappet guide 6, said tappet guide forming a cover or closure for

the pocket in the block. If desired the pocket could be formed in the valve guide and a separate cover provided therefor. A tube or pipe 7 is provided in the passage 4 and extends in a diagonal direction upwardly to a point adjacent the upper wall of the chamber 5, or the passage 4 may lead into the upper part of the pocket and the pipe omitted. The chamber 5 is provided with a gas or air outlet passage 8 extending from its upper end through and near the upper end of the tappet guide 6. The chamber 5 is also provided with another passage 9 leading from its lower portion into the bore of the tappet guide 6, and the tappet guide 6 is provided with a longitudinal groove 10 in its intermediate portion through which oil may pass from the passage 9 upwardly along the inner wall of the guide 6 to a point where it is admitted through suitable openings into the tappet itself, as will be hereinafter explained. As before stated, the oil is passed upwardly through the passage 4 and the tube 7, spills out of the upper end of the tube into the chamber or conduit 5. This provision of means for introducing the oil into the upper end of the chamber 5 and permitting it to spill therein has the effect of assisting in the separation of gases or air included in the oil at the point of the discharge of the oil from the tube 7. Aerated oil delivered at a point high in chamber 5 will remain in upper portion of the chamber until the air is released therefrom. The gases or air naturally remain in the upper part of the settling chamber 5 and will pass outwardly through the passage 8 into the tappet guide 6 and thence upwardly between the guide and the tappet to escape. Thus the oil in the bottom of the settling chamber 5, which is introduced through the passages 9 and 10 to the tappet, is substantially free of air or gas which air or gas makes the oil undesirably compressible if carried into the compression chamber of the tappet, i. e., the presence of air or gas in the oil which is used to support the reciprocable plunger of the tappet in its adjusted positions, is very undesirable for the reason that it enables the supporting hydraulic column beneath the plunger to be compressed to a degree which seriously interferes with and sometimes actually prevents the compensating function of the reciprocable plunger, and makes it impossible to accurately regulate the opening and turning of the valves.

Reference may now be had to Fig. 15 in which a modified form of tappet guide 6' is disclosed, which guide is provided with a pocket 11 serving in conjunction with a cover element 12 fastened, as for example by screws 14, to one face of the guide so as to cover the pocket 11 to provide a settling chamber 5'. In this form of the invention, the hydraulic medium, such as oil, is introduced through a passage 4' into the upper portion of the settling chamber from the lubricating system of the engine. The tappet guide 6' is provided with a passage 8' extending in an inclined direction from the upper portion of the settling chamber to the upper portion of the bore of the guide for allowing air or gas to escape from the settling chamber outwardly between the tappet guide and the tappet disposed therein. The tappet guide is also provided with a passage 9 extending in an inclined direction from the lower portion of the settling chamber to an intermediate portion of the bore of the guide and through which oil, free from air or gas, passes through a suitable opening into the interior of the tappet proper.

The tappet construction, as shown in Fig. 2, comprises a cylindrical tappet body 15 so formed as to fit in the guide sleeve 6 and provided with an enlarged cam contacting head 16. The cylindrical body 15 is provided with an internal cylindrical bore, as shown, extending substantially the full length of the body. Within this bore is disposed a plunger 17 preferably in the form of a hollow tube throughout its upper portion and provided with a plug insert 18 at its upper end which is adapted to close the upper end of the body and to contact and support the end of the valve stem, as shown in Fig. 1.

The lower end of the plunger 17 is provided with a projection 19 of reduced diameter. The lower end of this projection is provided with a cylindrical bore 20 which terminates short of the upper end of the reduced portion 19 and which is connected with the internal bore of the main body 17 by a smaller passage 21. The shoulder at lower end of this smaller passage 21 and the upper end of the bore 20 in projection 19 provides a seat for a valve 22. The ball valve is retained in the bore 20 by means of the cross pin 23 extending across the base 20 below the ball 22 and secured in the walls of the projection 19. A coil spring 24 is positioned around the projection 19 with one end bearing against the lower end of the main body of plunger 17 and its other end bearing against the bottom of the internal bore of the tappet body 15. The lower end of the spring 24 is preferably of larger diameter than the upper end and is press-fitted in the bottom of the bore of the tappet body 15 to prevent rotation. The upper end of the spring is positioned behind a ridge or raised portion 25 on the projection 19 which is so dimensioned as to retain the spring tightly against the shoulder formed by the larger portion of the plunger 17 and prevent relative rotation of the plunger and spring.

Thus by the tight fit of the spring in the bottom of the bore of the tappet body 15 and its close attachment to the plunger 17, the plunger is prevented from substantial rotation relative to the tappet body and allows the removal of the spring 24 with the plunger 17 when disassembling the plunger and tappet body. Spring 24 while holding the plunger from substantial rotation also causes slight oscillating motion of the plunger during axial movement of the latter with respect to the tappet body which assists in preventing mechanical sticking of the plunger and tappet body.

The projection 19 is provided with an air vent opening 26 adjacent the top of the bore 20. It is also provided with another opening 27 in the opposite side adjacent the center of the projection. This second opening is merely an access opening to aid in adjusting the ball valve 22 relative to the retaining cross pin 23. The vent opening 26 is positioned at the top of the bore 20 and provides an escape for air or gas included in the oil which is trapped in the bore 20 during the operation of the tappet. This allows any air or gas to escape into a larger compression chamber outside of the bore 20 and it is eventually eliminated by leaking out between the plunger 17 and the body 15. The plunger 17 and tappet body 15 are so dimensioned as to relative lengths that the lower end of the projection 19 on the plunger 17 may rest upon the bottom of the bore in the body 15 and the overall length of the tappet will be sufficient, in the event of failure of the oil supply to the compression chamber beneath the plunger, to enable the cam

to operate the valve sufficiently to keep the engine running.

The body 15 is provided with an annular groove or recessed portion 28 around its intermediate portion and with oppositely disposed passages 29 which lead from the upper portion of this recess to the interior of the tappet body. The plunger 17 is provided with an annular recess 30 in its intermediate portion and with passages 31 leading from the bottom of the recess 30 to the hollow interior of the plunger. Oil is introduced into the plunger through the recess 28, passage 29, recess 30 and passage 31, where it falls to the bottom of the plunger against the ball valve 22 and as the plunger is raised relative to the tappet body 15 and the pressure relieved beneath the ball 22, the oil will leak down past the ball into the lower part of the tappet body 15 and into the compression chambers there provided between the end of the plunger and the tappet body. It is desirable that the plunger 17 does not follow up a stuck valve 1 too far and to this end, the groove 30 may be of only sufficient width to allow for the desired adjustment of the tappet and shuts off the supply of oil when the plunger moves in excess of the amount necessary for adjustment. The spring 24 is compressed from free length only the amount required for adjustment thus causing the plunger to follow up a stuck valve only a limited distance.

An opening or passage 32 is provided in the plug 18 to permit the escape of air or gas from the interior of the plunger 17 and the end of the valve stem which rests upon the plug 18 and covers the opening 32 will prevent oil from splashing out but will permit slight continuous leakage of air and prevent the hollow plunger from becoming an airtrap.

In operation, when the engine is started, the lubricating system will force oil through the passage 4 and the tubes 7 into the chamber or conduit 5, from which it passes through the lower opening 9 into the tappet guide sleeve 6 and along the groove 10 to a point where it passes into the interior of the plunger 17 by way of the passages 29 and 31. The coil spring 24, bearing against the bottom of the tappet body and the lower end of the plunger 17, will raise the plunger 17 to take up any clearance that occurs between the stem of the valve 1 and the upper end of the plunger 17 and during this raising movement by which the clearance is taken up, the ball valve 22 will drop from its seat and permit oil to pass from the interior of the plunger body into the bottom of the tappet body 15 and fill the space between the end of the plunger and the end of the bore in the tappet body, thus providing a hydraulic column beneath the plunger and supporting it in close engagement with the end of the valve 1, and with its lower end raised slightly above the end of the bore in the tappet body.

During the operation of the engine some of the oil in the compression chamber in the lower part of the tappet will leak outwardly between the plunger and the tappet body and as this occurs the leakage will be replaced through the ball valve 22 by the oil in the upper portion of the plunger. The spring 24 acts constantly during the intervals when the valve 1 is on its seat to force the plunger 17 against the valve stem and to eliminate any clearance between the two, and any movement of the plunger 17 outwardly of the tappet body 15 will reduce the pressure in the chamber or space between the end of the plunger and the end of the bore in the tappet body and so permit the ball valve 22 to fall away from its seat by its own weight and admit sufficient oil into the compression chamber beneath the plunger to maintain the plunger in its adjusted position.

It has been found to be of utmost importance and essential to the successful operation of hydraulic compensating tappets to eliminate compressible air or gas from the oil or other hydraulic medium relied upon to support a tappet plunger against the valve stem. If such air or gas is not eliminated from the hydraulic column upon which the plunger is supported, it is impossible to properly adjust the timing and degree of opening of the valves due to the variance in compressibility of the hydraulic columns in the various tappets. Great pains have been taken to design and invent the construction described to eliminate air and gases from hydraulic medium under compression and among the features contributing materially and substantially to this result, in addition to those already described, are the construction of the plunger to permit the introduction of oil or other hydraulic medium into a reservoir in the interior of the plunger where it may settle and the air and gas separate therefrom and from which it is subsequently let, as needed, into the compression chamber beneath the plunger.

During operation, the hollow interior of the plunger 17 will be filled with oil substantially to the intake opening 31. This body of oil is not used immediately. Consequently any air or gas included therein has the opportunity to work to the upper surface and to escape through the vent openings 32, and the oil entering the compression chamber beneath the plunger is taken from the bottom of the reservoir in the plunger which will immediately be most free from air or gas. This feature is of further importance in that it provides a constant reservoir of oil which is immediately available for induction into the compression chamber beneath the plunger upon the starting of the engine so that the automatic adjustment may be immediately obtained upon starting even though the engine has not been running for a considerable time.

Referring to the modification shown in Figs. 4, 5 and 6, I have provided additional means for insuring a tight seal between the plunger 17 and the tappet body 15, which consists of a packing ring or gasket 35 of any suitable resilient packing material. This ring is resilient and when made of metal is split at 36 in order that the same may expand and contract radially in operation and the dimension of the split may be adjusted to control the leakage of oil from the compression chamber beneath the plunger. The gap provided at the split 36 is open at all times and allows air to be vented from the compression chamber below the ball valve and well in the lower end of the tappet body 15, the gap opening an increased amount as the cam lifts. The packing ring 35 has an outside diameter slightly less than the bore of the tappet body 15 and is supported against the inclined shoulder 37 on the plunger by the upper end of the coiled spring 24. The co-operation of the inclined upper surface of the packing ring 35 and the inclined shoulder 37 of the plunger results in a wedging action upon the compression stroke of the plunger which not only frictionally resists the downward movement of the plunger but also increases the efficiency of the seal. The width of the gap 36 in the ring controls the leak-down

rate while the angle 37 effects the desired wall pressure.

In the modification shown in Figs. 7, 8, 9, 10 and 11, I have provided a seal of slightly different kind than that shown in Figs. 4, 5 and 6. The packing ring 38 here shown is of an incompressible or compressible material. It is not split or divided and may be of lead, leather or of a suitable fabric or felt composition. It is retained in place by means of a metal washer 39 which bears against its underside and is in turn supported by the upper end of the coil spring 24. This type of packing ring tends to pack between the plunger and the tappet body and to become more dense with use and consequently provide a more effective seal. The angle 37' between the sealing ring 38 and the plunger may be varied to regulate the wall pressure of the ring and the leak-down rate on this type of lifter is made substantially constant by providing a small opening 40 through the wall of the tappet body just below the ring 38. This opening is masked by the tappet guide.

In Figs. 12 and 13, I have shown tappet organizations of essentially the same form as shown in Figs. 1 to 3 inclusive, with the exception of the spring member 60 which is positioned around the upper end of the tappet body 15 and around the upper end of the plunger 17. The construction of the plunger 17 is also different as will be explained.

The upper end of the tappet body 15 is provided with a groove 61 in which the lower coil of the spring 60 is snapped and the upper end of the plunger 17 is formed with a reduced neck portion 62 and a flanged end portion 63. This flanged end portion 63 is provided with a circumferential groove 64 in which the upper coil of the spring 60 is snapped. The upper and lower coils of the spring 60 are fitted tightly in the grooves 61 in the tappet body and 64 in the plunger end 63 to prevent substantial rotation of the plunger relative to the tappet body. This construction is of advantage in that the spring for maintaining the plunger in contact with the valve 1 is removed from the bottom of the bored tappet body and positioned outside of the compression chamber beneath the plunger at a place convenient for assembly, removal and repair, and in a position where it will not churn or agitate the oil in the compression chamber.

The closed upper end is integral with the bore and may be machined out only from one end, therefor each end is made as a separate part and the two are joined at their open ends by butt welding, as indicated at 65. This provides a cheap and substantial construction for the hollow plunger.

Referring more particularly to Fig. 13, it will be noted that the weld 65 is disposed below the passage 66 in the plunger 17. Passage 66 permits oil to pass into the bore of the plunger 17 urging the plunger and tappet body 15 apart, keeping the face of the lifter against the cam 2, and the upper end 63 against the valve stem. The ball-check valve forms a trap which permits oil to pass into the chamber below the end of the plunger, but will not allow its return. In order to prevent the trapping of air in such chamber, a fine drilled hole 67 is provided through the lower end of the plunger 17. A check ball pin 68 limits the travel of the ball-check valve keeping it in close proximity to the seat. The travel of the ball-check valve may be adjusted by bending the pin 68 with a shim of a predetermined thickness inserted between the ball and pin to obtain the clearance desired. The body 15 has a smaller coefficient of thermal expansion than that of the plunger 17 so as to close clearance between these elements when the oil is hot to compensate for changes in the viscosity of the oil during all ranges of operating temperatures.

In the modification shown in Fig. 14, the construction is the same as that described in Figs. 12 and 13 with the exception of the spring 60. In Fig. 14, I have provided a spring 70 of a different form and construction. The spring 70 is made of wire or steel of rectangular cross-section, as shown, in order that the spring will have small tendency to sway the plunger laterally. The rectangular cross-section of the spring enables its manufacture with less care than a spring of round cross-section, such as 60 shown in Figs. 13 and 14 since the spring 70 is relatively weak in a lateral direction and will not cock or cause misalignment of the plunger 17 within the tappet body. The spring 70 is mounted and attached to the tappet body 15 and the plunger 17 in the same manner as described and shown in Figs. 12 and 13.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. The combination with a hydraulic compensating valve tappet including a tappet guide, a tappet body reciprocably received in said guide and having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger in said bore, spring means for axially elongating said tappet body and plunger assembly, said hollow plunger providing a liquid reservoir, a liquid chamber between the closed end of said tappet body and the inner end of said plunger, an inwardly opening check valve for closing the inner end of said plunger, registrable ports in said tappet body and plunger, a source of liquid, a liquid reserve and gas separation chamber of substantial vertical depth arranged outside said valve tappet, means for conducting liquid from the bottom of said last named chamber to said ports for supplying liquid to the reservoir in said plunger, and a restricted opening in the upper portion of said reserve chamber for venting gas therefrom.

2. The combination with a hydraulic compensating valve tappet including a tappet guide, a tappet body reciprocably received in said guide and having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger in said bore, spring means for axially elongating said tappet body and plunger assembly, said hollow plunger providing a liquid reservoir, a liquid chamber between the closed end of said tappet body and the inner end of said plunger, an inwardly opening check valve for closing the inner end of said plunger, registrable ports in said tappet body and plunger, a source of liquid, a liquid reserve chamber of substantial vertical depth arranged outside said valve tappet, means for conducting liquid from said source to a point adjacent the top of said reserve chamber, means for conducting liquid from the bottom of said reserve chamber to said registrable ports for supplying liquid to the plunger reservoir, and restricted openings adjacent the tops of said plunger reservoir and of said reserve chamber for venting gas therefrom.

3. The combination with a hydraulic compen-

sating tappet including a tappet guide, a tappet body reciprocably received in said guide and having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger in said bore, spring means for axially elongating said tappet body and plunger assembly, said hollow plunger providing a liquid reservoir, a liquid chamber between the closed end of said tappet body and the inner end of said plunger, an inwardly opening check valve for closing the inner end of said plunger, registrable ports in said tappet body and plunger, of a source of liquid, a liquid reserve chamber of substantial vertical depth arranged outside said valve tappet, a conduit extending from said liquid source to a point adjacent the upper end of said reserve chamber, said conduit having an upwardly directed open end for spilling liquid from said source over the conduit end to free gas from said liquid, means for conducting liquid from the bottom of said reserve chamber to the interior of the reservoir in said plunger, and restricted openings adjacent the upper portion of said reserve chamber and plunger reservoir for venting gas therefrom.

4. A compensating tappet comprising a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore and having a substantially fluid tight fit therein, the outer end of said plunger being substantially closed and adapted to thrust against a valve operating member, the inner end of said plunger having a hollow reduced longitudinal projection and provided with an opening of smaller cross-sectional area than that of the hollow interior of said plunger, an inwardly opening check valve housed within said projection and adapted to control the flow of fluid through said opening, and spring means disposed about said projection and bearing against the bottom of said bore and the end of said plunger and tensioned to force said plunger outwardly, means for admitting oil to the interior of said hollow plunger at a point spaced substantially above said check valve in the lower end thereof thereby providing an oil reservoir in said plunger above and always available to said valve checked opening in the lower end of the plunger.

5. A hydraulic compensating tappet comprising a body member having a longitudinal cylindrical bore therein, a hollow reciprocable plunger in said bore, means for controlling leakage between said plunger and the bore of said body member, said plunger having a substantially closed upper end adapted to contact a valve stem, a reduced hollow projection formed on the lower end of said plunger and enclosed within said bore, said projection being provided with a valve seat, an inwardly opening check valve housed in said hollow projection, a cross pin fixed to said projection for supporting said valve a predetermined and slight distance from said valve seat and bendable to vary the distance between the valve seat and valve when the latter is supported by said pin.

6. A compensating tappet comprising a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore, means for controlling leakage between said plunger and the bore of said tappet body, the outer end of said plunger being substantially closed and adapted to thrust against a valve operating member, a reduced hollow projection formed on the lower end of said plunger and disposed within said bore, said projection being provided with a valve seat, an inwairdly opening check valve housed in said hollow projection, said projection being of sufficiently heavy construction and arranged to contact the closed end of said tappet body to lift said valve operating member when the plunger and tappet body are in axially closed relation.

7. A hydraulic compensating tappet comprising a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore, the outer end of said plunger being substantially closed and adapted to thrust against a valve operating member, the inner end of said plunger having a reduced longitudinal projection, an inwardly opening check valve housed within said projection, a radially expansible sealing ring reciprocably mounted on said projection, said plunger and ring being provided with engageable parts for expanding said sealing ring, and spring means disposed about said projection and bearing against the sealing ring and the closed end of said tappet body for causing radial expansion of said ring to provide a seal between the plunger and the bore of said tappet body.

8. A hydraulic compensating tappet comprising a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore, the outer end of said plunger being substantially closed and adapted to thrust against a valve operating member, the inner end of said plunger having a reduced longitudinal projection, an inwardly opening check valve housed within said projection, an angularly split sealing ring reciprocably mounted on said projection and provided with an inwardly beveled annular shoulder, said plunger being provided with an annular shoulder between said plunger body and said projection and adapted to contact the shoulder on said ring, spring means disposed about said projection and bearing against said sealing ring and the closed end of said tappet body for radially expanding said split ring to provide a seal between the lower end of said plunger and the bore of said tappet body.

9. A hydraulic compensating tappet comprising a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore, the outer end of said plunger being substantially closed and adapted to thrust against a valve operating member, the inner end of said plunger having a reduced longitudinal projection, an inwardly opening check valve housed within said projection, a radially expansible sealing ring reciprocably mounted on said projection and consisting of a displaceable material, said plunger and ring being provided with engageable parts for expanding said sealing ring, and spring means disposed about said projection and bearing against the sealing ring and the closed end of said tappet body for causing radial expansion of said ring to provide a seal between the plunger and the bore of said tappet body.

10. In a hydraulic compensating tappet including a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore and comprising upper and lower sections, each section being hollow and having a reduced end portion partially closing the hollow bore therein, the remaining ends of said sections being joined together to provide a unitary plunger.

11. In a hydraulic compensating tappet in-

cluding a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore and providing a liquid reservoir, a reduced longitudinal projection formed on the inner end of said plunger and provided with a cylindrical bore, an inwardly opening check valve in said last named bore for permitting flow of liquid from said reservoir to the space between the inner end of said plunger and the closed end of said tappet body, and a coil spring of diminishing diameter from one end to the other arranged with the smaller diametered end frictionally engaging the projection on said plunger and the larger diametered end frictionally engaging the bore of said tappet body at its closed end.

12. In a hydraulic compensating tappet including a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore and providing a liquid reservoir, a reduced longitudinal projection formed on the inner end of said plunger and provided with a cylindrical bore, an inwardly opening check valve in said last named bore for permitting flow of liquid from said reservoir to the space between the inner end of said plunger and the closed end of said tappet body, a coil spring of diminishing diameter from one end to the other arranged with the smaller diametered end frictionally engaging the extension periphery of the projection on said plunger and the larger diametered end frictionally engaging the bore of said tappet body at its closed end, and a shoulder on said projection over which a portion of said spring is disposed to cause the spring to remain secured to the plunger upon disassembly of the plunger and tappet body.

13. In a hydraulic compensating tappet including a tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger reciprocable in said bore and providing a liquid reservoir, a reduced longitudinal projection formed on the inner end of said plunger and provided with a cylindrical bore, having a reduced section providing a valve seat, an inwardly opening valve engageable with said valve seat to check the flow of liquid from the space between the inner end of said plunger and the closed end of said tappet body to the reservoir in said plunger, and a restricted opening through the wall of said projection and inwardly of said valve seat for venting gas from the cylindrical bore of the projection.

14. The combination with a guide member having a guide bore and an oil passage communicating with said bore, of a self-adjusting hydraulic tappet comprising a valve shoe having a plunger bore open at one end only, a plunger slidably mounted in said plunger bore, said shoe being reciprocably mounted in said guide bore, said shoe having an annular oil receiving reservoir arranged to register with said oil passage at predetermined positions of said shoe with respect to said guide bore, said reservoir opening into said plunger bore, said plunger having an oil chamber in communication with the opening of said reservoir into said plunger bore and a passageway opening into said oil chamber and into the space between the end of said plunger and the closed end of said plunger bore, said passageway having a counterbore at the end of said plunger to provide a valve seat, a check valve in said counterbore, means for retaining said valve in close proximity to said valve seat, a spring metal member interposed between the end of said plunger and the bottom of said plunger bore, and means for permitting the escape of air from said oil chamber.

15. The combination with a guide member having a guide bore and an oil passage communicating with said bore, of a self-adjusting hydraulic tappet comprising a valve shoe having a splunger bore open at one end only, a plunger slidably mounted in said plunger bore, said shoe being reciprocably mounted in said guide bore, said shoe having removable means for preventing complete separation of said plunger and shoe and having an annular oil receiving reservoir arranged to register with said oil passage at predetermined positions of said shoe with respect to said guide bore, said reservoir opening into said plunger bore, said plunger having an oil chamber in communication with the opening of said reservoir into said plunger bore and a passageway opening into said oil chamber and into the space between the end of said plunger and the closed end of said plunger bore, said passageway having a counterbore at the end of said plunger to provide a valve seat, a check valve in said counterbore, means for retaining said valve in close proximity to said valve seat, and means for permitting the escape of air from said oil chamber.

16. The combination with a guide member having a guide bore and an oil passage communicating with said bore, of a self-adjusting hydraulic tappet comprising a tappet body having a plunger bore open at one end only, a plunger slidably mounted in said plunger bore, said body being reciprocably mounted in said guide bore, said body having an annular oil receiving reservoir arranged to register with said oil passage at predetermined positions of said body with respect to said guide bore, said reservoir opening into said plunger bore, said plunger having an oil chamber in communication with the opening of said reservoir into said plunger bore and a passageway opening into said oil chamber and into the space between the end of said plunger and the closed end of said plunger bore, said passageway having a counterbore at the end of said plunger to provide a valve seat, a check valve in said counterbore, means for retaining said valve in close proximity to said valve seat, a spring normally tending to move said plunger relative to said body, said spring having one end thereof detachably connected to said body and its opposite end detachably connected to said plunger, and means permitting the escape of air from said oil chamber.

17. A hydraulic valve tappet assembly comprising: a cylindrical body having a longitudinal cavity extending thereinto from one end thereof, a cylindrical plunger projecting into said cavity, and spring means coacting between said plunger and body for urging said plunger outwardly with respect to said body during normal operation, said spring means having a normally free length such that said body and plunger will be placed in proper operative relation in use by only a slight axial compression of said spring, one end of said spring being detachably connected with the upper end of said body and having its opposite end detachably connected with the upper end of said plunger, whereby said spring means will retain said body and plunger together against inadvertent disassembly prior to installation and, during use, when the thrust pressure on said plunger is relieved, the outward movement of

said plunger relative to said body will be limited to the slight expansion of said spring.

18. A hydraulic valve tappet assembly comprising: a cylindrical body having a longitudinal bore extending thereinto from one end thereof, a cylindrical plunger projecting into said bore, said plunger fitting in said body with such clearance as to permit a given desired rate of liquid leakage therebetween when in use, and spring means coacting between said plunger and body for urging said plunger outwardly with respect to said body during normal operation, said spring means having a normally free length such that said body and plunger will be placed in proper operative relation in use by only a slight axial compression of said spring, the opposite ends of said spring being detachably connected to said body and plunger, respectively, whereby said spring means will retain said body and plunger together against inadvertent disassembly prior to installation and, during use, when the thrust pressure on said plunger is relieved, the outward movement of said plunger relative to said body will be limited to the slight expansion of said spring.

19. A hydraulic valve tappet comprising: a body having a longitudinal cavity closed at one end and open at the other, a plunger reciprocably mounted in said cavity, the outer end of said plunger being adapted to transmit thrust from a valve operating member to a valve stem, a liquid chamber between the closed end of said body and the inner end of said plunger, means for admitting liquid into said chamber upon movement of said plunger outwardly of said body including a check valve controlling the flow of liquid into said chamber, and spring means coacting between said plunger and body independently of said check valve for urging said plunger outwardly with respect to said body during normal operation, said spring means having a normally free length such that said body and plunger will be placed in proper operative relation in use by only a slight axial compression of said spring, the opposite ends of said spring being detachably secured to said body and plunger, respectively, whereby said spring means will retain said body and plunger together against inadvertent disassembly prior to installation and, during use, when the thrust pressure on said plunger is relieved, the outward movement of said plunger relative to said body will be limited to the slight expansion of said spring.

CARL VOORHIES.