

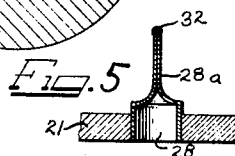
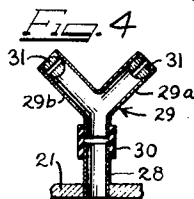
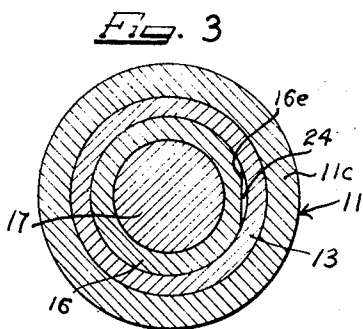
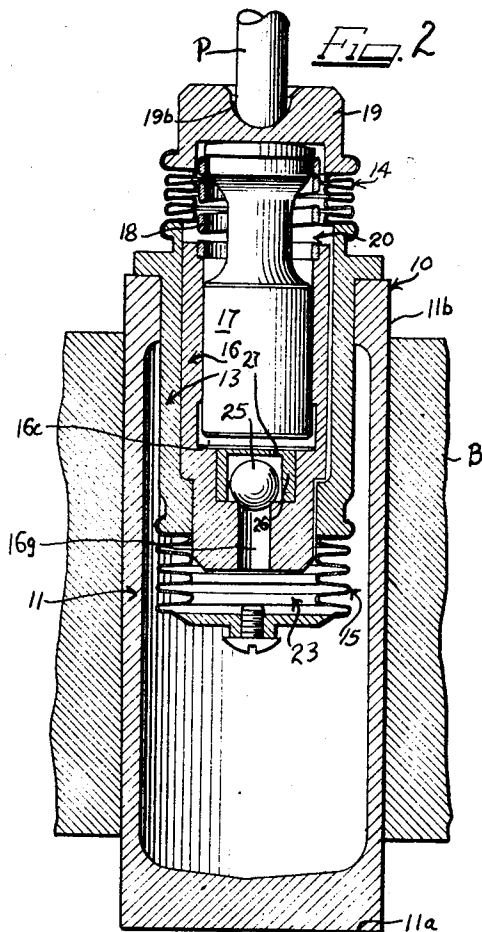
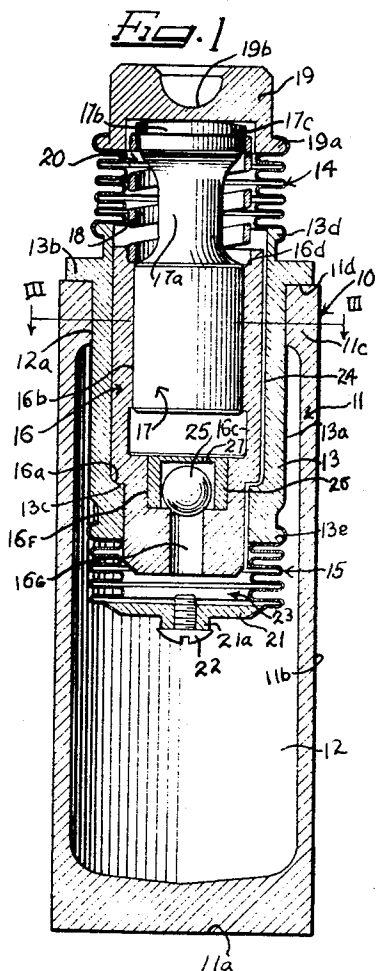
May 22, 1951

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2,553,756

SELF-CONTAINED AUTOMATIC VALVE TAPPET

Filed Dec. 6, 1946



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UNITED STATES PATENT OFFICE

2,553,756

SELF-CONTAINED AUTOMATIC VALVE
TAPPET

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Application December 6, 1946, Serial No. 714,491

10 Claims. (Cl. 123—90)

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This invention relates to self-contained automatic adjusters for taking up clearance in a linkage assembly without producing an unwanted extension of the assembly.

Specifically, the invention deals with a self-contained hydraulic valve tappet of the piston and cylinder type which is equipped with a separate shell around the cylinder and has expansible bellows anchored on the ends thereof.

The valve tappets of this invention are complete in themselves and need no communication with reservoirs for hydraulic operating fluid or the like.

According to the invention, opposed interconnected fluid-filled expansible and contractible chambers feed a piston chamber in a cylinder with working fluid and receive working fluid from the piston chamber. The piston is bottomed on fluid trapped in the chamber during the valve-opening cycle. A check valve on the cylinder traps the fluid in the piston chamber. Some leakage occurs from the piston chamber into one of the expansible chambers during the valve-opening cycle, and a very slight clearance condition is thereby obtained in the valve linkage during the valve-opening cycle. This clearance may be increased or decreased by wear, expansion, or contraction, but is immediately reclaimed after the valve-closing cycle, wherein working fluid from the expansible and contractible chambers is again admitted into the piston chamber through the check valve for acting on the piston to cause it to assume a no-clearance position.

A feature of the invention resides in the use of expansible and contractible chamber-defining members secured on opposite ends of a cylinder containing shell for housing the working fluid of a piston-actuated tappet without ever subjecting these chambers to force-transmitting loads. Since these chambers are conveniently defined by metal bellows, the bellows metal is soldered or brazed to the shell without distorting or affecting metallurgical properties, such as hardness, of the cylinder or the piston.

Another feature of the invention resides in the formation of a passage connecting the bellows chambers by merely creating a localized gap between the shell and cylinder. This gap is conveniently produced by grinding or machining a flat band area along the length of the outer face of the cylinder.

Still another feature of the invention resides in the provision of a check valve on the cylinder instead of on the piston of a self-contained piston and cylinder type tappet to thereby elim-

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inate heretofore required valve-closing springs.

A further feature of the invention resides in the provision of a tappet assembly that can be easily completely filled with working fluid to purge out heretofore-encountered air bubbles which, being compressible, cause malfunctioning of the tappet. The elimination of air from the tappet renders it useful in any position.

An object of the invention is to provide a self-contained piston and cylinder type automatic extensible and contractible device for controlling clearance conditions in a linkage assembly, which device has a separate bellows-carrying shell surrounding the cylinder thereof.

A further object of the invention is to provide a self-contained automatic hydraulic valve tappet having expansible and contractible working fluid chambers which are never subjected to force-transmitting loads and are connected with each other through a gap between two nested members.

A still further object of the invention is to provide a self-contained cylinder and piston type automatic valve tappet with opposed interconnected liquid-filled spring bellows for feeding working fluid through a cylinder-mounted check valve to a piston chamber and for receiving working fluid leaking from the piston chamber thereby causing the piston to contract the tappet when loaded during a valve-operating cycle, and to extend when unloaded during a valve operating cycle.

Another object of the invention is to provide a self-contained hydraulic valve tappet with a piston acted on by liquid trapped with a springless valve during the valve-opening cycle and receiving additional liquid thereagainst after the valve-closing cycle for replenishing oil leaking past the piston during the valve-opening cycle, with an amount just sufficient to cause extension of the tappet to a no-clearance condition in the valve linkage.

Another object of the invention is to provide a piston and cylinder type bellows-equipped valve tappet with a floating piston free from anchoring connections with a bellows.

A further object of the invention is to provide a self-contained hydraulic valve tappet with opposed liquid-filled intercommunicating bellows chambers on the ends of a separate shell, a piston chamber connected to one of said bellows chambers through a check valve-controlled passage, and a piston slidable freely in the chamber to allow leak-down of fluid from the piston chamber into the other bellows chamber.

Other and further objects of this invention will be apparent to those skilled in the art from the following detailed description of the annexed sheet of drawings which show a preferred embodiment of the invention.

On the drawings:

Figure 1 is an enlarged axial cross-sectional view, with parts in elevation, of a self-contained hydraulic valve tappet according to this invention in its free expanded condition.

Figure 2 is a view similar to Figure 1, but illustrating the tappet in its working condition in a valve train.

Figure 3 is a transverse cross sectional view taken along the line III—III of Figure 1.

Figure 4 is a fragmentary cross-sectional view of an alternate end cap arrangement illustrating a filling of the tappet with fluid.

Figure 5 is a view similar to Figure 4, but showing the filling tube in sealed condition.

As shown on the drawings:

In Figures 1 and 2 the reference numeral 10 designates generally a self-contained automatic valve tappet according to this invention. The tappet 10 includes a hollow tappet body 11 providing a chamber 12. The body 11 has a closed bottom 11a, a cylindrical side wall 11b, a thickened rim top portion 11c, and a top shoulder 11d. The thickened portion 11c provides a reduced-diameter bore 12a giving access to the chamber 12. A shell 13 is partially disposed in the chamber 12 and has a cylindrical side wall 13a snugly fitting the bore 12a together with an out-turned flange 13b bottomed on the shoulder 11d. The shell 13 is hollow with open ends, and has an internal shoulder 13c intermediate said open ends. A first rim bead 13d is provided at the upper end of the shell above the flange 13b and has anchored thereon one end of a first spring-metal bellows 14. The other end of the shell has a second rim bead 13e having anchored thereon one end of a second spring-metal bellows 15. To insure leak-proof joints between the shell and bellows, the bellows are soldered, brazed, or welded to the ends of the shell. The bellows 14 is outside of the body 11, while the bellows 15 is disposed entirely within the chamber 12 of the body 11, but in freely spaced relation from any of the walls of the body.

A cylinder 16 is seated in the shell 13 and has a shoulder 16a bottomed on the shoulder 13c of the shell. The cylinder 16 has a cylindrical bore 16b extending from the open top thereof to a slightly enlarged chamber 16c. A piston 17 is slidable in the bore 16b and has its end face projecting into the chamber 16c. The piston 17 has an integral rod portion 17a projecting above the cylinder 16, and terminating in a head 17b having a rounded top surface 17c. The top end face of the cylinder 16 has a groove 16d therein receiving the bottom end coil of a spring 18. This spring 18 has the other end coil thereof bottomed on a shoulder provided under the head 17b of the piston, so that the spring is effective to urge the piston outwardly of the cylinder 16. An end cap 19 overlies the piston head 17b and is adapted to rock on the surface 17c thereof. This cap 19 has a bead rim 19a around the bottom thereof receiving the top end of the bellows 17 in sealed engagement therewith. The cap 19 has a fragmental spherical recess 19b in its top face adapted to receive the rounded lower end of a push rod P (Figure 2) in a valve train.

The bellows 14 thus encloses a chamber 20 between a top end cap 19 and the upper end of the

shell 13. This chamber 20 receives the piston rod 17a and the spring 18 therein.

The bellows 15 in the chamber 12 of the body 11 is closed by an end cap 21 having an internally threaded boss portion 21a receiving a threaded closure plug 22. The bellows 15 thus encloses a chamber 23 on the lower end of the shell 13 within the chamber 12 of the body 11. This chamber 23 is in communication with and receives a part of the cylinder 16.

The bellows chambers 20 and 23 are joined by a passageway 24. This passageway 24 is formed between the shell 13 and cylinder 16 by a flat band area 16e on the outer cylindrical wall of the cylinder 16 as best shown in Figure 3.

The bottom of the piston chamber 16c in the cylinder 16 has a well 16f in the central portion thereof. This well is joined, by a reduced-diameter passageway 16g through the end of the cylinder, with the interior of the bellows chamber 23. A metal ball 25 is disposed in the well 16f and seats on the top end of the passageway 16g to close this passageway. An inverted cup member 26 is seated in the well 16f around the ball 25 and has a top wall, substantially flush with the bottom of the piston chamber 16c, equipped with a small orifice 27 to connect the piston chamber 16c with the interior of the cup around the ball 25. As shown, the ball is free to rise and fall in the cup onto and off of its seat at the top of the passageway 16g.

In its free unloaded condition, the tappet 10 assumes the extended position of Figure 1 because the spring 18 urges the piston upwardly to raise it substantially out of the piston chamber 16c. This piston chamber 16c, the bellows chambers 20 and 23, the passageways 24 and 16g, and the interior of the cup 26 are all filled with hydraulic liquid, such as oil of uniform viscosity even at widely variant temperatures, and extension of the spring 18 with its attendant movement of the piston 17 merely results in free flow of the liquid within the assembly.

The assembly is filled with liquid through the boss 21a of the cap 21, and is purged of all gas bubbles by placing the boss uppermost during the filling operation. The plug 22 seals the liquid within the assembly. If desired, as shown in Figure 4, the boss 21a and plug 22 can be replaced with a small tube 28 brazed into or integral with the cap 21 and projecting therefrom out of the chamber 23. A Y fitting 29 is coupled to the tube by a hose 30 and has valves 31 in the branches 29a and 29b thereof. One branch 29a is connected to a vacuum pump (not shown). The other branch 29b is connected to a source of oil (not shown) or other fluid for the tappet. The valve in branch 29a is opened and the other valve 31 is closed. The pump is then operated to evacuate the tappet, and, when the air in the tappet is exhausted, the opened valve 31 is closed and the other valve 31 opened, whereupon the oil is drawn into the tappet to completely fill all chambers thereof without admitting any air. The tube 28 then has the projecting end thereof pinched closed as at 28a (Fig. 5) and a drop of solder 32 is applied to the tip of the pinched end to seal the tappet.

When the tappet 10 is mounted for operation in the valve train of an internal combustion engine, for example, as shown in Figure 2, the body 11 has its cylindrical side wall 11b slidably mounted in the engine block B and has its closed bottom 11a acted on by the engine cam C. The recess 19b of the top cap 19 receives the

valve push rod P. With the engine valve (not shown) in closed position, the valve spring (not shown) exerts some downward pressure on the push rod P which is transmitted through the cap 19 to slightly compress the spring 18 thereby forcing the piston 17 partly into the piston chamber 16c, preferably about half way between the top and bottom of the piston chamber. Thus, the tappet assumes a somewhat contracted position when mounted in a valve train even when the valve is completely closed and the tappet is not transmitting force for opening the valve. This contracted position is readily assumed from the free expanded position of Figure 1 by flow of liquid from the chamber 20 through the passageway 24 into the chamber 23 whereupon the chamber 20 partially collapses and the chamber 23 expands. Liquid that was trapped in the piston chamber 16c can leak from this chamber alongside of the piston 17 into the chamber 20 at a relatively slow rate since the piston 17 has a rather free sliding fit in the cylinder bore 16b. Back flow of liquid from the chamber 16c through the passageway 16g into the chamber 23 is prevented by the ball 25 which acts as a check valve in seating on the mouth of the passageway 16g.

When the cam C rotates in the direction shown by the arrow, the cam lobe C' thereon raises the valve body 11 and this lifting movement is transmitted to the shell 13 which, in turn, transmits it to the cylinder 16. Liquid trapped in the piston chamber 16c by the ball 25 bottoms the piston 17 and causes it to rise with the cylinder 16. The piston 17 thrusts against the cap 19 thereby raising the push rod P. During this lifting operation of the valve-opening cycle, some liquid will leak along the piston 17 out of the chamber 16c thereby permitting the piston to move further into the chamber 16c and creating a clearance in the valve linkage. This clearance is controlled by the degree of leak-down permitted around the piston and, of course, the degree of leak-down is controlled by the relative sizes of the piston and cylinder bore. For example only, and not by way of limitation, if the total movement of the piston 17 from its free position at the top of the piston chamber 16c shown in Figure 1 to a completely collapsed position where it is bottomed on the cup 26 is one-eighth of an inch, the tappet, when installed in an engine, has the piston positioned as shown in Figure 2 midway between the top and bottom of the piston chamber 16c. From this midposition, the piston can move one-sixteenth of an inch in either direction thereby being capable of adjusting the effective length of the tappet in either direction a distance of one-sixteenth of an inch. If the leak-down during the entire valve-opening cycle of operation caused by movement of the tappet with the lobe C' of the cam from the point of initial contact with the lobe to the point where the round part of the cam acts on the tappet is .002 inch, there exists a clearance in the linkage of .002 inch as the cam lobe rotates past the tappet. At this point there are three conditions which might exist.

First, if the effective length of the valve linkage has remained constant during the lift-cycle around the cam lobe, the piston 17 is immediately biased outwardly .002 inch by the spring 18 and/or bellows 14 and 15, and the flow of working fluid from the spaced chambers 23 to 16c takes place and the fluid is trapped in piston chamber 16c by the check ball 25. Therefore, the

next lift-cycle begins at substantially zero clearance in the valve.

Secondly, if, in addition to the leak-down of .002 inch, the effective length of the valve linkage has decreased, for example .001 inch, there will be a clearance of .003 inch in the linkage as the lift-cycle is completed. In that case, the piston 17 is biased outwardly .003 inch and the working fluid will fill the piston chamber 16c so that the next lift-cycle will again begin with substantially zero clearance.

Thirdly, if in addition to the leak-down of .002 inch, the valve linkage has increased in length, for example .001 inch, a .001 inch clearance would result at the completion of the lift-cycle and the piston 17 would only be biased outwardly for this distance and a corresponding amount of fluid would be trapped in the piston chamber 16c so that the lift-cycle would begin again with substantially zero clearance.

During overspeeding of an engine, or as a result of faulty cam design, it occasionally happens that the tappet will lose contact with the cam face for short periods of time. This is known as cam jumping, and, during the interval of time in which the jump takes place, the tappet is free to extend itself. If this unwanted extension per lift-cycle is greater than the leak-down per lift-cycle, the valve will eventually be held off of its seat between lift cycles and thereby result in malfunctioning of the engine. The tappet of this invention, on the other hand, minimizes unwanted extension during cam jumping periods by providing the restricted fluid flow orifice 27, and also by restricting the passage 16g so that the rate of fluid flow is choked. This choking of the working fluid slows down extension of the tappet sufficiently so that substantially no extension will result in those very short periods of time when the tappet leaves the cam. By properly calibrating the size of the orifice 27 and the flow capacity of the passageway 16g, the unwanted extension of the tappet can be substantially eliminated.

The shell 13 may become heated when the bellows 14 and 15 are welded thereon, but this heat does not affect the separate cylinder 16 which is preferably heat-treated for hardness properties. The cylinder 16 can fit rather freely in the shell 13, and may be free to turn therein without blocking the passage 24. Likewise, the piston 17 floats in the cylinder 16, since it is not anchored to a bellows and only thrusts against the cap 19. This movable relationship of shell, cylinder, and piston, together with parts carried thereby, minimizes galling or scuffing action on closely mated parts and eliminates torsion strains on the bellows.

Because the ball check valve coacts with the cylinder and not the piston, it can be springless and operate efficiently due to fluid pressure differentials alone.

From the above descriptions it will be understood that this invention provides a self-contained automatic hydraulic tappet having bellows chambers at opposite ends of a shell surrounding a separate piston-containing cylinder. The addition of the piston to the self-contained bellows arrangement for carrying all lifting forces greatly increases the wear life of the tappet and minimizes danger of rupturing of any fluid-containing passages.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the prin-

ciples of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. An extensible and contractible device comprising a shell, an open-ended cylinder in the shell, a check valve in one end of the cylinder controlling flow into the cylinder, a piston rotatable and slidable in the other end of the cylinder, fluid-filled interconnected expansible and contractible chamber-defining members secured to opposite ends of the shell and communicating with opposite ends of the cylinder, a cap secured to one chamber-defining member and acted on by said piston, means biasing the piston outwardly of the cylinder against said cap, said piston being freely slidable in said cylinder to accommodate restricted flow of fluid around the piston whenever the cap loads the piston and fluid in the cylinder is loaded by the piston and being free to creep with respect to said cylinder in a rotational direction, and means connecting the expansible and contractible chambers for transfer of fluid therebetween whereby fluid leaking around the loaded piston is fed to one of said chambers and then transferred to the other of said chambers for flow through the check valve into the cylinder to bottom the piston as soon as it is unloaded and biased outward by the spring.

2. A self-contained hydraulic valve tappet comprising a shell, an open-ended cylinder rotatably seated in said shell, a valve-driving piston rotatable and slidable in said cylinder, means for lifting said shell and cylinder to load the piston, resiliently expansible fluid-filled chamber-defining means anchored on the ends of the shell and respectively closing the open ends of the cylinder, a check valve accommodating fluid flow from one expansible means to the piston and stopping reverse flow of fluid to trap fluid between the cylinder and piston for driving the valve, said piston being freely fitted in said member to accommodate leakage of fluid therearound when said means for lifting loads the piston thereby creating a clearance in the valve linkage during the valve-lifting cycle and being free to creep with respect to said cylinder in a rotational direction, and a gap between the shell and cylinder defining a conduit for transferring the fluid from one expansible chamber-defining means to the other irrespective of the angular position of said cylinder relative to said shell for feeding through said check valve to the piston as soon as said means for lifting releases the load on the piston.

3. A clearance-eliminating device comprising a hollow open-ended sheath, a cylinder seated in said sheath, a spring metal bellows welded to the ends of said sheath and defining expansible and contractible chambers communicating with said cylinder and having end walls spaced outwardly from the cylinder and sheath, a piston slidable in said cylinder and extending into one of said chambers for thrusting against the end wall thereof, a check valve interposed in said cylinder between the other of said chambers and the piston, means interconnecting said chambers for fluid flow, means biasing said piston outwardly of said cylinder against said end wall, said piston being freely slidable in said member and accommodating leakage of fluid therearound and being free to creep with respect to said cylinder in a rotational direction, said cylinder and chambers

being filled with liquid, and an actuating housing surrounding an end portion of said sheath and connected thereto to impart axial forces to said cylinder relative to said piston whereby liquid in the cylinder is trapped by said check valve during the axial force application to act on said piston for transferring the axial force to said end wall while some fluid leaks around the piston and is transferred back to the check valve for reintroduction into the member upon cessation of the axial force.

4. A self-contained hydraulic valve tappet comprising a hollow open-ended shell, spring metal bellows at the ends of said shell defining expansible and contractible chambers, one of said bellows being closed by an end cap having a recess adapted to receive a push rod, the other of said bellows being closed by an end cap having a fluid charging nipple thereon, a hollow cylinder disposed in said shell and mounted therein for creeping movement with respect thereto in a rotational direction a check valve interposed between the interior of said cylinder and said other of said bellows, a piston freely rotatable and slidable in the cylinder on the discharge side of the check valve, a spring interposed between the cylinder and piston biasing the piston against the end cap for receiving the push rod, and means defining a flow path between the chambers housed by the bellows, said piston being freely slidable in said cylinder and accommodating a leakage of fluid around the piston during the valve-lift cycle whereupon said fluid is transferred back to the cylinder and trapped beneath the piston by said check valve as soon as the lift-cycle is completed.

5. A self-contained hydraulic valve tappet which comprises a hollow body, a shell projecting into the body and bottomed thereon, a hollow cylinder seated in the shell and rotatable therein, first and second fluid-filled bellows each having one end thereof affixed to the shell and defining chambers communicating with the interior of the cylinder, caps closing the outer ends of the bellows, a piston slidable and rotatable in the cylinder and arranged to have one end thereof thrust against one of said caps and the other end thereof terminate in said cylinder, a check valve controlling fluid flow between said other end of the piston and the adjacent bellows, and a restricted passageway connecting the interiors of both bellows whereby fluid trapped between the check valve and the piston will transmit valve-lifting force through the piston to the end cap actuated thereby while some trapped fluid leaks into the bellows to be fed on the valve-closing cycle in required amounts to the cylinder for maintaining zero clearance.

6. In a self-contained hydraulic valve tappet of the opposed bellows, cylinder and piston type, the improvement of a separate sheath surrounding the cylinder and sealingly anchoring the inner ends of the bellows, said cylinder and said piston being mounted in said sheath free from said bellows, for creeping rotational movement with respect thereto, whereby said cylinder and piston may rotate relative to said sheath and relative to each other, whereby said cylinder may rotate relative to said sheath and the piston.

7. In a self-contained hydraulic valve tappet having a cylinder, a piston slidable and rotatable therein and a bellows defining an expansible fluid chamber communicating with the cylinder, the improvements of a shell around the cylinder, a sealing connection from one end of said shell to one end of the bellows, an end cap, and a sealing

connection between said end cap and the other end of the bellows, a spring biasing the piston against said end cap and said piston and cylinder being free from said bellows, whereby both said piston and cylinder may shift rotationally.

8. In a self-contained hydraulic valve tappet having a reciprocably movable body, a shell mounted in said body for movement therewith, a cylinder in said shell, a piston within said cylinder, spring means urging said piston in an extended position with respect to said cylinder, an end cap adapted to be engaged by the upper end of said piston, a restricted fluid passageway from the lower end of said cylinder to said piston, a check valve therein, said piston being mounted in said cylinder with a predetermined clearance, to form a restricted passageway along the walls of said cylinder from the lower to the upper end thereof, a fluid passageway between said cylinder and shell allowing fluid to pass from one end of said cylinder to the other, the improvements comprising separate bellows closing and forming expansible chambers at opposite ends of said shell and communicating with opposite ends of said cylinders, sealing connections between said bellows and opposite ends of said shell and a sealing connection between one of said bellows and said end cap, said bellows being so constructed and arranged as to be entirely free from said piston and cylinder and to permit rotational creeping movement of said cylinder with respect to said shell and rotational creeping movement of said piston with respect to said cylinder.

9. In a self-contained hydraulic valve tappet having a reciprocably movable body, a shell mounted in said body for movement therewith and for rotational creeping movement with respect thereto, a cylinder in said shell, a piston within said cylinder and a chamber within said cylinder into which the lower end of said piston moves, spring means urging said piston in an extended position with respect to said chamber, a restricted fluid passageway into said chamber and a valve in said passageway holding fluid under pressure therein, said piston being mounted in said cylinder with a predetermined amount of clearance to form a restricted passageway allowing a predetermined volume of fluid to leak thereby, a fluid passageway between said shell and cylinder communicating from one end thereof to the other, expansible bellows extending from opposite ends of said shell, sealing connections between said bellows and shell, a closure plate sealed to the lower of said bellows and

forming an expansible chamber at the lower end of said cylinder, and the closure member for the upper of said bellows comprising an end cap member sealed thereto, free from and adapted to be abutted by the outer end of said piston.

10. In a self-contained hydraulic valve tappet having a reciprocably movable body, a shell mounted in said body for movement therewith and for rotational creeping movement with respect thereto, a cylinder in said shell, a piston within said cylinder and a chamber within said cylinder into which the lower end of said piston moves, spring means urging said piston in an extended position with respect to said chamber, a restricted fluid passageway into said chamber and a valve in said passageway holding fluid under pressure therein, said piston being mounted in said cylinder with a predetermined amount of clearance to form a restricted passageway along the walls of said cylinder allowing a predetermined volume of fluid to leak thereby, a fluid passageway between said shell and cylinder communicating from one end thereof to the other, expansible bellows extending from opposite ends of said shell, sealing connections between said bellows and shell, a closure plate sealed to the lower of said bellows and with said bellows forming an expansible chamber extending from the lower end of said cylinder, and the closure member for the upper of said bellows comprising an end cap member sealed thereto and free from and adapted to be abutted by the outer end of said piston, said end cap member affording a means for actuating a push rod of the valve opening mechanism and being so constructed and arranged as to be engaged with said piston and permit creeping movement of said piston with respect to said cylinder and end cap in a rotational direction.

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