June 14, 1960 G. T. RANDOL 2,940,433

HYDRAULIC VALVE TAPPET

Filed Dec. 1, 1958 2 Sheets-Sheet 1

Fig. 1.

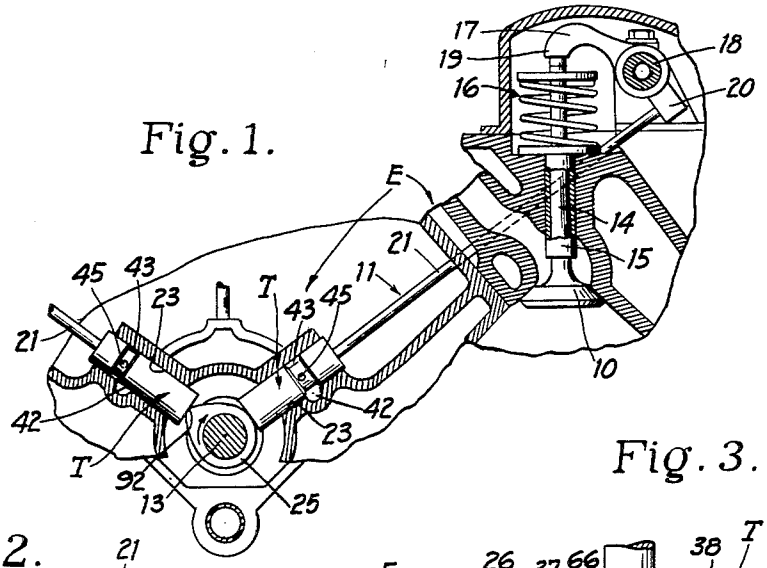
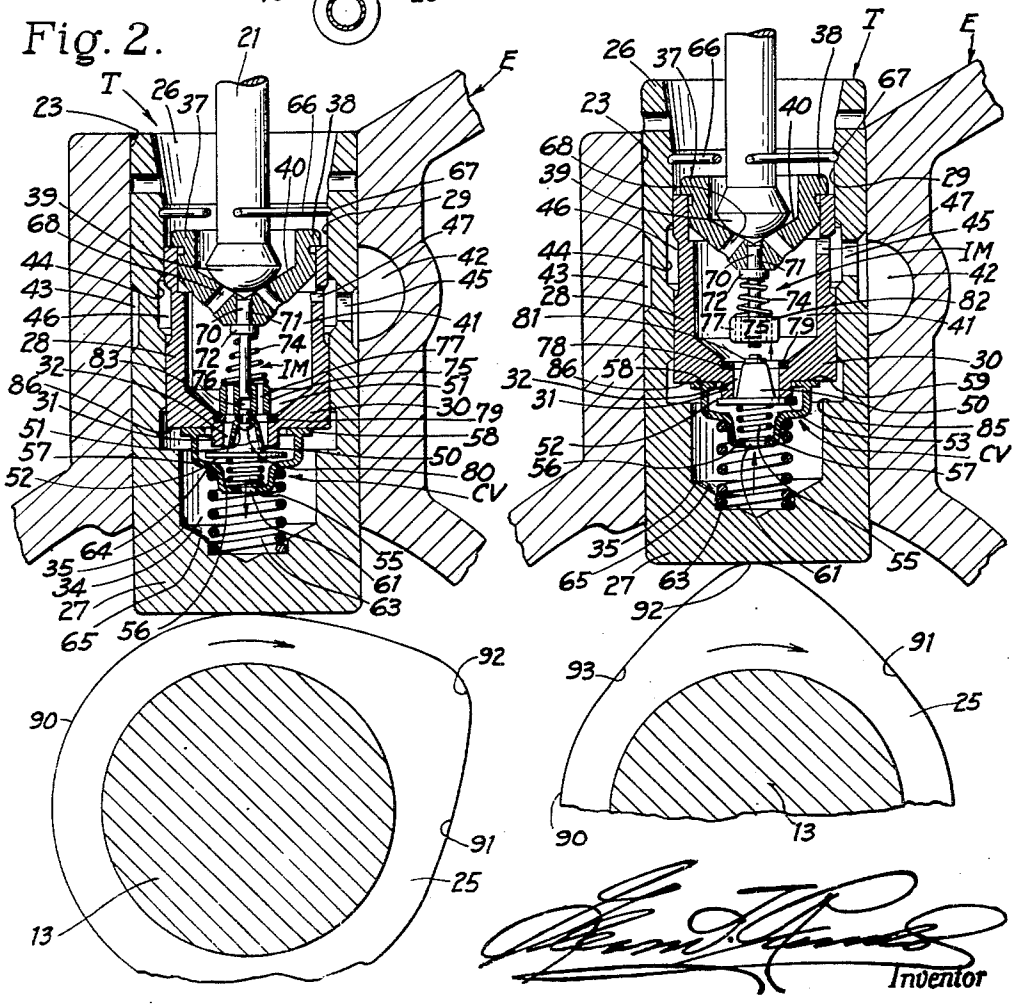


Fig. 3.

Fig. 2.



Inventor

June 14, 1960 G. T. RANDOL 2,940,433

HYDRAULIC VALVE TAPPET

Filed Dec. 1, 1958 2 Sheets-Sheet 2

Fig. 4.

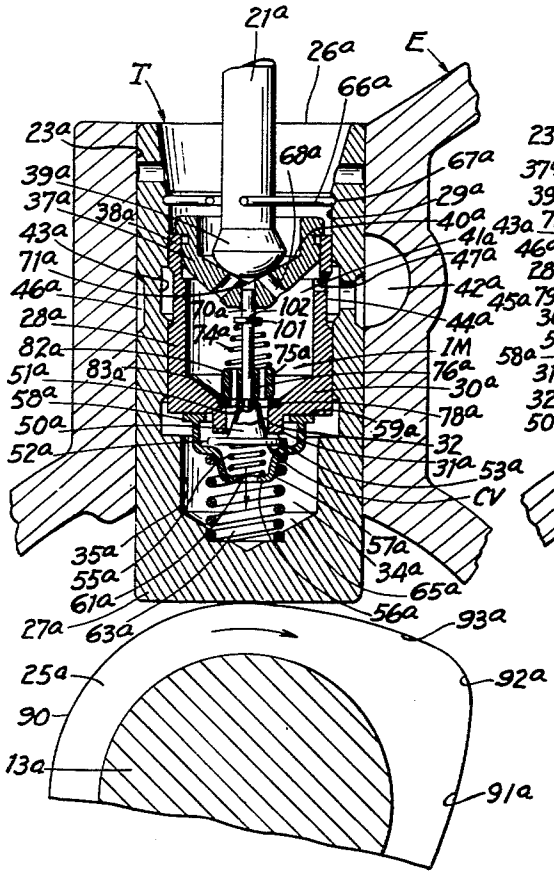


Fig. 5.

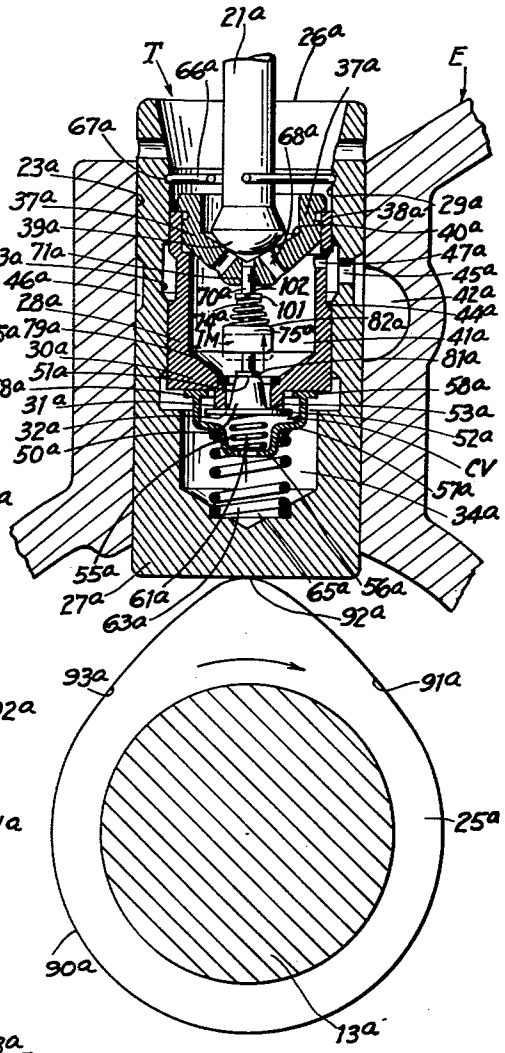
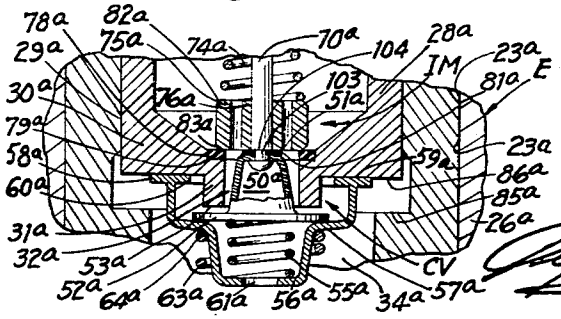


Fig. 4A.



Inventor

United States Patent Office 2,940,433 Patented June 14, 1960

2,940,433

HYDRAULIC VALVE TAPPET

Glenn T. Randol, P.O. Box 53, 2nd and Paul Sts., Mountain Lake Park, Md.

Filed Dec. 1, 1958, Ser. No. 777,327

15 Claims. (Cl. 123—90)

My invention relates to valve tappets or lifters adapted to automatically maintain substantially zero clearance in the valve drive train of an internal-combustion engine, and more particularly, the invention is concerned with improvements related to and associated with the valve tappet construction disclosed in my U.S. Patent No. 2,695,013 issued November 23, 1954.

The improvements above referred to comprise: a check-valve of novel construction in the shape of a hollow frustum of a cone to provide added rigidity against distortion under the high pressures to which it is subjected, and therefore affords improved sealing characteristics under all operating pressures; a non-metallic abutment element carried atop the conical-shaped check-valve normally in circular alignment with a ring-type non-metallic element embedded in a suitable recess which encircles a passageway through the lower closed end of the plunger reservoir, to silence the impact of the inertia hammer or weight to move the check-valve to open said passageway to accommodate relative adjustment between the principal body members of the tappet; and a central stem on which the inertia weight slides is fixed on the plunger cap separate from the check-valve enabling the inertia weight to slide relatively to the stem into and out of engagement with the upper face of the abutment atop the check-valve under influence of a conically-shaped expansion spring encircling said stem above the weight with said spring reacting between said weight and portion of said stem adjacent its attachment to said plunger cap.

In a modified construction, the central stem is fixed at one end to the check-valve and a portion of the other end is slidably supported in a centrally disposed bore in the plunger cap whereby the inertia weight is capable of sliding relatively to and in unison with the stem and engages the check-valve to move simultaneously therewith to open it. Accordingly, the action of the aforesaid encircling conical spring is also modified so that it moves with the stem and relatively thereto in response to like movements of the inertia weight in controlling the check-valve.

A more specific object of my invention is to provide a commercial design of the structure shown in my patent above referred to, so that the novel concepts disclosed may be marketed as original equipment or through after-market channels as a replacement product.

Objects and advantages not specifically set forth hereinbefore will be noted in the course of the detailed description of the invention to follow with reference to the accompanying two sheets of drawings, wherein the preferred embodiment and a slightly modified embodiment are illustrated:

Figure 1 is a fragmentary longitudinal sectional view, partly in elevation, of an internal-combustion engine and its valve drive gear or linkage, the view demonstrating the disposition of the present self-adjusting tappet assembly between the engine camshaft and the lower end of the push-rod included in said linkage;

Figure 2 is an enlarged longitudinal sectional view through the tappet assembly of Figure 1, with the camshaft disposed substantially 90° to the plane of this longitudinal section;

Figure 3 is a view similar to Figure 2, exhibiting the changed status of certain parts of the tappet assembly in response to another position of the camshaft to effect opening of the corresponding engine valve; and

Figures 4, 4A and 5 are longitudinal sectional views of a modified embodiment of the invention showing operational sequences similar to Figures 2 and 3, said Figure 4A being a fragmentary view of Figure 4 on an enlarged scale for clarity of detail.

Referring now to the drawings, and particularly to Figures 1, 2 and 3, my invention is shown incorporated in a conventional internal-combustion engine designated as a whole by the letter E which has a plurality of poppet-type valves one of which is shown at **10**. A valve drive gear or train, indicated generally at **11**, is provided for each valve of the engine, and is conventional in all respects except for the valve tappet mechanism of the present invention, which is embodied therein. The valve drive train **11** extends between the valve **10** and the camshaft **13** of the engine. The valve **10** may be of any known construction and that selected for illustration includes a stem portion **14**, guided in a collar **15**, and having normally preloaded spring means **16** associated therewith normally tending to close the valve. A rocker arm **17** pivotally mounted intermediate its ends on a suitable rock shaft **18** is adapted to bear at one end **19** thereof against the free upper end of stem **14** when rotated in a counterclockwise direction as viewed in Figure 1, to open valve **10** against the force of spring means **16**. The other end **20** of the rocker arm **17** has a hemispherical recess (not shown) in its under surface to accommodate the outer complemental end of a push-rod **21**, the other end of which bears against a dished fitting disposed in the upper hollow end of a valve tappet generally designated T constructed in accordance with the present invention and which will now be described in detail.

The valve tappet T, which is of cylindrical construction, is illustrated as slidably mounted in a bore **23** radially disposed, in respect to the axis of the camshaft **13** in the block of the engine E so that the inner end of the tappet T bears on the surface of the cam **25** allotted thereto.

Referring now to Figure 2 for a more complete understanding of the structure and functioning of the valve tappet T, it will be seen that each of these comprises: a first principal element disclosed as an outer body or shell **26** having a working fit in its bore **23** in the block of the engine, and having a closed bottom end **27** engaging the surface of the cam as seen in this figure. A second principal element of the tappet is disclosed as a telescopically-related plunger **28** of cup-like form, the outer cylindrical surface thereof sliding with a substantially oil-tight fit within a complemental longitudinal counterbore **29** in the shell part **26**. The plunger **28** is closed at the bottom by a wall **30** having a centrally disposed downwardly projecting spout **31** provided with a passageway or port **32** therethrough. A compartment or high pressure chamber **34** is seen to be confined between the walls of a longitudinal bore **35** which terminates the inner end of said counterbore and the inner end wall **30** of the plunger **28**, which chamber when appropriately filled with oil and closed by a movable member or check-valve designated CV over the port **32** functions as a solid medium to cause lift of the valve train by the cam acting on the bottom wall of the shell **26**. The upper end of the plunger **28** supports with a snap-fit a push-rod thimble or cup **37** fitting within its bore and having a circular flange **38** overlying the upper end of the cylindrical wall of the plunger. The dished

upper surface of the cup provides accommodation for the rounded lower end 39 of the push-rod 21. For functional cooperative relationship, the part engaging the rod end 39 is a conical taper as shown at 40. This provides for a line contact between the rounded end of the push-rod and the upper face of the cup 37 which serves more or less to seal against the outflow of oil in an upward direction.

There is thus provided a more or less oil-tight reservoir 41 beneath the thimble 37 and above the bottom wall 30 of the plunger 28. This is constantly supplied with an excess quantity of oil from the pressure lubricating system of the engine E, the pump of the system providing oil through a suitable conduit to the channel 42 in the wall of the bore 23 in the engine block (see Figures 1 and 2). This channel is in continuous communication with a circumferential groove 43 in the outer surface of the wall of the tappet shell 26 which in turn connects to an inner circular channel 44 via a radial bore or port 45. The cylindrical outer surface of the plunger 28 is circumferentially grooved at 46 to provide a passageway for oil which communicates through a bore or port 47 with the reservoir 41 in the plunger.

The previously mentioned movable check-valve CV serves to close the port 32 and comprises: a conical cylindrical hollow portion 50 closed at its upper end by a wall 51, and open at its bottom end which terminates in a circular outturned valve face or flange 52 disposed at right angles to the axis of the tappet body T. The principal conical portion of the check-valve is disposed within port 32 in circular alignment therewith, said portion being of smaller mean diameter than said bore accommodates passage of oil therebetween when said flange 52 is out of engagement with its complemental seat 53, the latter terminating the lower end of the aforesaid spout 31 integral with the plunger 28. The check-valve is influenced at all times by the biasing action of a light normally preloaded helical spring 55 reacting between the valve flange 52 and the bottom wall 56 of a spring cage 57. The normal pretensioned status of the spring 55 is preferably of such magnitude as to enable the check-valve flange to disengage from the seat 53 thereby opening said port 32 (see Figure 2) under influence of the overriding action of novel spring-loaded inertia mechanism generally designated IM operably associated therewith which will be described fully in the course of the description to follow, said overriding action becoming effective despite differential pressures acting on opposite sides of the check-valve CV to hold it closed. The said spring cage is in the nature of an inverted cylindrical cup having its open upper end formed as a circular flange 58 to provide a base seating at 59 against the flat bottom of the tappet plunger 28 surrounding the spout 31. The inner diameter of the upper or flanged portion of the spring cage provides a free clearance for the flanged seat of the check-valve CV while the lower reduced diameter portion provides a seat to stabilize the valve spring 55 in centralized relation with respect to the check-valve. Thus this cage serves as a valve retainer and spring abutment and is provided with a large central aperture 61 to accommodate the free flow of oil around the check-valve and through the port 32 in its movement between the reservoir 41 and the high pressure chamber 34 during relative adjustment of the two principal body parts 26, 28 of the tappet T as will appear.

The plunger 28 is constantly biased outwardly with respect to shell 26 tending to enlarge the chamber 34, by an expansion helical-type spring 63 the upper end of which bears on the shoulder 64 at the juncture of the two diameters of the spring cage, and the lower end of which preferably fits into a pocket or bore 65 in the bottom wall 27 of the outer body part 26. This bore and the smaller diameter portion of the spring cage 55 serve to centralize spring 63.

To prevent separation of the two body parts 26, 28 of the tappet T before incorporation in an engine, a suitable split snap ring 66 fits into an appropriate internal groove 67 adjacent the open end of the bore in the tappet shell 26 and serves to prevent displacement of the plunger 28 from the tappet body 26 by the spring 63 before the tappet is installed.

A plurality of angular passageways 68 are provided through the tapered wall of the plunger cup 37 to prevent possible compression effects between the push-rod end 39 and confronting tapered surface of the cup, as a consequence of the reciprocable movement of the cup from which a stem or rod 70 is supported in the reservoir 41 by pressfitting its upper end into a central bore 71 through the apex of the plunger cup 37, the lower end of said stem being slightly spaced from the upper end of the check-valve CV to accommodate movement of the latter to open and close the port 32. A circular collar 72 integral with the stem is spaced from the upper end of said stem to limit the depth to which the stem is inserted in the bore 71, and the underside of said collar serves as an abutment for the upper end of a conical expansion spring 74 which encircles said stem. The lower larger end of this spring reacts on the upper face of an inertia member or weight 75 having a central bore 76 for slidably receiving the end portion of the rod 70 below the collar 72 whereby said inertia weight is capable of sliding loosely on said rod. A plurality of longitudinal bores 77 are provided through the inertia weight in spaced parallel relation to the axis thereof to facilitate movement of said weight through the mass of oil surrounding it. The aforesaid parts comprise the previously mentioned inertia mechanism IM.

The upper end of the valve port 32 terminates in a counterbore 78 which provides an L-shaped wall recess in which is embedded a non-metallic washer 79 against which the inertia weight normally rests when tappet motion ceases. Attached to the outer surface of the end wall 51, as by a special type rivet 80 or otherwise, of the check-valve CV is a non-metallic (hard rubber or the like) disc 81, the upper surface of which is normally in the same plane with the undersurface of the inertia sleeve and washer 79 when the check-valve is open as illustrated in Figure 2. Accordingly, when the inertia member moves downwardly to open the check-valve, the impact is silently received first by the disc 81 and then by the washer 79 whereby silent operation is obtained rather than a metallic "click" as would be the case were the impact of the inertia member metal-to-metal.

The upper and lower edges of the inertia weight are chamfered as at 82, 83 respectively to facilitate its high speed movement through the oil contained in the reservoir 41. Obviously, the inertia weight may move relatively to the rod 70 from its own inertia and the rapid upward movement of the valve tappet, causing compression of the spring 74. When the forces are in the opposite direction, the weight 75 is moved downwardly toward the check-valve CV with increased speed over that resulting from inertia alone, the additional energy being supplied by the expanding action of the inertial spring 74. When the weight 75 strikes the upper face of the disc 81 on the check-valve CV, it drives the latter away from its seat 53 on the end of the spout 31 best demonstrated in Figure 2, thus releasing the modulated pressure in the chamber 34 beneath it for an important purpose to be later described.

In the event of failure of the check-valve CV to trap the liquid in chamber 34, provision is made to prevent inoperativeness of the tappet T by incorporating complemental internal circular shoulders in confronting normally spaced relation at 85, 86 on the tappet body elements 26, 28 respectively, whereby these shoulders become engaged during the lift portion of the tappet cycle to open the engine valve notwithstanding the check-valve

CV is open thus disabling the function of the chamber 34 as a solid medium.

Operation of the valve tappet mechanism T of the first embodiment of the invention is as follows:

With the engine valve 10 in closed position as shown in Figures 1 and 2, the various elements of the mechanism T assume relative positions as illustrated in these figures. Here the spring 63 between the tappet body 26 and plunger 28 expands the tappet in length between the push-rod 21 and the base circle 90 of the cam 25 on the camshaft 13 so that the lower bottom end 27 of the tappet body 26 bears thereon with substantially the force exerted by spring 63. The entire assembly T is charged with oil from the pressure lubricating system of the engine, as previously explained, such that any air initially trapped in chamber 34 is slowly vented through leakage between the plunger and bore of the tappet body and replaced by oil during operation. The strength of spring 55 is preferably less than spring 74 plus the static weight of the inertia element 75 which enables the check-valve CV to assume an open position as best demonstrated in Figure 2 when tappet motion ceases. Thus, the check-valve is held lightly away from its seat 53 by such differential forces acting on opposite sides of the check-valve, so that the volume of oil in the chamber 34 may decrease or increase by flow through the open port 32 connected to the reservoir 41. This change in volume of oil in chamber 34 results from shortening or lengthening of the relative disposition of the tappet body and plunger to compensate for backlash, if present, in the valve drive gear, whereupon closure of the check-valve by the inertial effect on the weight 75 in response to the lift portion of the tappet cycle traps the adjusted volume of oil in chamber 34 to act as a solid body on the valve drive train to open the selected engine valve 10 as is understood.

As cam 25 rotates in a clockwise direction as viewed in the figures, the opening ramp 91 thereon which merges with the base circle with the lift, operatively engages the underface of the bottom wall 27 of the tappet body 26 and begins to lift the same either with a quick lift, if the cam contour is designed for the conventional type of hydraulic valve tappet, or with a slower more gentle lift if the cam is especially designed for the tappet of the present invention. Under these circumstances movement of the tappet being resisted by the engine valve spring means 16 through the push-rod 21, tends to apply pressure on the solid mass of oil in the chamber 34 between the tappet body 26 and plunger assembly 28 which imparts a pressure or hydraulic impact to the underside of the check-valve CV which is normally minutely spaced from its seat 53 in open condition upon closure of the engine valve, and forces the check-valve CV to tightly close, best demonstrated in Figure 3, thereby imprisoning the oil within the chamber 34 in a sufficiently solid acting mass to cause the parts of the tappet T to move in unison and thus lift the engine valve 10 from its seat as though a solid tappet were in place. The engine valve train clearance having been substantially zero at the position indicated by Figure 2 because of the action of the expanding spring 63 between the two tappet body elements, the action in operating the valve drive train is that of a mechanical lifter with substantially zero-lash present.

When the cam opening ramp first engages the underface of the tappet, all parts associated therewith are given a rapid upward thrust including the inertial weight 75 to tightly seat the check-valve CV without flexing it due to the frustoconical design thereof. Being unrestrained in its movement except by the light conical spring 74, the inertial member 75 moves more rapidly than the other parts of the tappet assembly under the initial impetus and thus compresses the spring 74 so that the inertial member moves, for example, up to the position illustrated in Figure 3 wherein its lower face is seen to be spaced well away from the upper closed end 51 of the check-valve CV. This condition obtains at least until the cam 25 reaches its position of maximum lift as illustrated in Figure 3 and during this movement the inertial member is compressing the spring 74 and the spring 55 is assisting the pressurized fluid in chamber 34 to hold the check-valve tightly sealed on its seat 53 against any tendency, such as might come from vibration or the like, to unseat it, thus insuring operation for this part of the tappet cycle with substantially zero backlash and absolutely quite operation of the engine valve train.

As the cam 25 progresses from maximum lift point 92 demonstrated in Figure 3 to the released or engine valve closing ramp 93 position, the tappet T is lowered and with it the engine valve 10 is closed by action of spring means 16 best demonstrated in Figure 2. Under these circumstances the downward movement of the tappet leaves the inertia hammer 75 in the Figure 3 position momentarily thus imparting lift to the inertia member until the tappet body 26 rides off of ramp 93 onto the base circle 90. Here, conditions reverse themselves, the downward movement of the tappet T ceases, the inertia of the member 75 no longer is sufficient to overcome the expanding action of the spring 74 and the weight of the member, both under influence of gravity and the pressure of spring 74, moves the inertia member 75 rapidly downwardly into impact with the closed end 51 of the check-valve CV and thus drives it from its seat as shown in Figure 2, despite the still considerable pressure which may be behind it, thereby establishing fluid communication between the chamber 34 and oil reservoir 41 whereby an appropriate movement of oil in the required direction take place. The springs 55, 74 are so weighted that at periods of tappet rest the latter spring plus the weight of the inertia hammer 75 substantially counterbalance the former whereby the check-valve CV is delicately held open. It is thus seen that rating the spring 55 to overcome the static weight of the inertia hammer 75 and reaction from the spring 74 that the check-valve CV may be caused to assume a lightly closed condition with the tappet T at rest, or by rating the spring 74 plus the weight of the inertia hammer 75 to overcome spring 55, the check-valve may be established in a full open poistion of Figure 2. Accordingly by varying the weight of the inertia hammer 75 and the weight of springs 55, 74 different adjusted positions of the check-valve CV with respect to its seat 53 may be had according to the timing and sensitivity of operation desired as may be dictated by the particular engine in which my invention is to be incorporated.

It is important to observe here that the variations discussed in the paragraph next above regarding the strength of spring 55 produce corresponding changes in the axial position of the inertia mechanism IM following impact to open the check-valve CV, while the tappet T is riding the base circle 90 of the engine-driven cam 25. For example, if the predetermined status of this spring is less than the combined static weight of the inertia hammer 75 and expanding action of the spring 74, then the check-valve after being opened to the position of Figure 2 by the downward throw of the hammer 75 accelerated by the spring 74, would remain in this position while the tappet T is at rest riding the base circle of the engine-driven cam 25, but were the pretensioned strength increased sufficiently to support the static weight of said hammer and expanding action of the spring 74, then the check-valve CV would recover from the position of Figure 2 induced by the impact of the hammer 75, to a position closer to the seat 53 or lightly engaged therewith in readiness for another lifting action by the cam 25 to open the selected engine valve 10. Thus, the sensitivity and timing of operation of the check-valve may be varied from wide open to closed positions by varying the relative pretensioned strengths of springs 55, 74 in relation to the weight of the inertia hammer 75, during the base circle cam contact with the tappet body 26. In this

manner, a greater or less portion of the initial portion of the opening cam ramp **93** is employed to initiate the lift portion of the tappet cycle, and therefore, the closer the check-valve flange **52** is to its seat **53** the less leakby occurs at inauguration of the opening phase of the tappet cycle with consequent minimum reintroduction of backlash into the valve drive gear.

If there has been over compensation to reduce the clearance to less than zero (excess pressure on the base circle of the cam **25**) then a certain amount of oil may transfer back to the reservoir **41**, or if as a result of temperature changes or wear in the valve drive train, there has been an accumulated backlash, this is immediately taken up under action of the spring **63** forcing the tappet T to elongate and again reduce the clearance to substantially zero. The slightly tendency of the check-valve CV to open under influence of its own inertia is very materially augmented by the action of the hammer blow of the inertia member **75** moving under the impetus of its spring and thus complete opening of the check-valve is assured under all circumstances so that full compensation may be made for clearance adjustment during each tappet cycle.

The check-valve CV is held open under the conditions shown in Figure 2 during a substantial degree of the arc during which the tappet body **26** is riding on the base circle **90**, but the momentum exerted on the hammer **75** is lost prior to approaching the opening ramp **91** so that the check-valve CV is substantially unloaded in readiness for the spring **55** and ensuing hydraulic impact when the tappet lifts on this ramp to open the engine valve **10**.

It is thus appreciated that the functioning of the first embodiment (Figures 1–3) of my invention produces maximum efficiency of the hydraulic valve tappet T under all circumstances and that substantially zero-lash is achieved in the valve drive gear during the whole time that the engine valve is opening and closing. After the engine valve **10** closing and when the tappet check-valve CV is open as shown in Figure 2 there is some slight relief of pressure on the heel or base circle **90** of the cam **25** so that minimum wear results on the contacting parts. With the tappet check-valve CV opening and closing once per cycle of the tappet, careful modulation and adjustment of the whole valve train is achieved that many times, so that the backlash or clearance in the whole train is maintained as near zero as feasible and desirable, all with the addition of only a few simple and low-priced parts to what has been considered as the normal or commercial type of hydraulic valve tappet.

Modified inertial mechanism and operation

This second embodiment of my invention is illustrated in Figures 4, 4A and 5, and in which corresponding parts are designated by like reference numerals distinguished, however, by the addition of the letter *a* to each.

This modification differs essentially from the first disclosure in the interaction of the rod **70**, the check-valve CV and the inertial hammer **75** including the latter's spring **74**.

The upper end of the rod **70***a* is slidably disposed in the bore **71***a*, and spaced from the apex of the plunger cup **37***a* is preferably an abutment ring **101** carried on the rod. The lower end of the rod **70***a* is provided with a reduced diameter portion **102** to produce a shoulder at **103** for the ring **101** to bear against. This reduced portion projects through a hole in the non-metallic disc **81***a* and the upper end wall **51***a* of the check-valve CV to rigidly secure these parts together as by peening over the end of the reduced diameter portion to form a head on the underneath side of the end wall **51***a*. Thus the special type rivet **80** is eliminated.

Operably disposed between the upper face of the inertial weight **75***a* and the abutment ring **101** is the conical expansion spring **74***a* to add accelerating movement to the downward throw of the inertia hammer **75***a*.

In operation, inertial effect on the hammer **75***a* is supplemented by the inertial effect on the stem **70***a* carried by the check-valve CV to close said valve, and the spring **74***a* not only moves with the rod **70***a* but is compressed relatively thereto by the inertial action on the hammer **75***a* during its upward throw. Accordingly, the upward throw or movement of the inertial hammer **75***a* is effective through the spring **74***a* to supplement the action of the check-valve spring **55***a* to close the valve as shown in Figure 5, such closure of the check-valve CV is aided by the inertial effect on the rod **70***a*.

The downward throw of the inertial weight **75***a* is given added acceleration by the compressed spring **74***a* to drive the valve flange **52***a* from its complemental seat **53***a* to open the check-valve CV at the end of the closing portion of the tappet cycle as shown in Figure 4 to enable the volume of oil in chamber **34***a* to vary in accordance with the adjusted length of the tappet T to remove substantially all backlash from the valve drive gear as is understood.

It is thus seen that in the present modification of my invention the rod **70***a* moves with the check-valve CV while in the first disclosure shown in Figures 1–3 inclusive, the stem **70***a* is separate from the check-valve CV and attached only to the plunger cup **37***a* for movement therewith. Also it should be observed that the inertial spring **74***a* in this embodiment moves with the rod **70***a* and relatively thereto under influence of the inertial hammer **75***a* while in the first embodiment, this spring moves with the plunger cap **37***a* and relatively only to said rod under influence of the inertial hammer.

This modification is operationally similar to the first embodiment in respect to the timing and sensitivity of operation of the check-valve CV which may be varied by changing the relative weights of the springs **55***a*, **74***a* and the weight of the inertial hammer **75***a*. For example, Figure 4 demonstrates the static weights of the stem **71***a*, inertial hammer **75***a* and spring **74***a* to be greater than the expansive force of the check-valve spring **55***a* with the tappet substantially at rest thus establishing the check-valve in full open position, but if the force of the spring **55***a* were increased sufficiently to support the static weights of the above three parts, then upon impact of the inertial hammer **75***a* with the check-valve disc **81***a* and then the embedded abutment washer **79***a*, the action of spring **55***a* as the tappet rides the base circle **90***a* of the cam **25***a* would be to recover the inertia mechanism IM until the valve flange **52***a* lightly engages its complemental seat **53***a* in readiness for the hydraulic impact to tightly close the check-valve and thus convert the tappet T into a solid body to open the selected engine valve **10**. Accordingly, this modification, with the tappet riding the base circle **90***a* would establish the inertial hammer **75***a* in engagement with the abutment washer **79***a* and the check-valve fully open as demonstrated by Figure 4, or under the circumstances of the check-valve spring **55***a* being weighted to support the static weight of the inertia mechanism IM, the latter would recover the position of its hammer **75***a* being spaced above the abutment washer **79***a* and the check-valve lightly seated in closed position, such spacing of the hammer being determined by the movement of the check-valve from wide open position to fully closed position in response to the downward impact of the hammer to open the check-valve and the recovery thereof along with the inertia mechanism IM to an intermediate position wherein the check-valve engages its seat **53***a*. Thus by rating the spring **55***a* sufficiently heavy, it would be capable of restoring the check-valve to lightly closed condition after a wide open position induced by the downward impact of the inertia mechanism IM as the tappet mechanism T rides the base circle **90***a* of the cam **25***a* and prior to inauguration of the lift portion of the tappet cycle.

It will be noted that the two principal elements of

the tappet T operate to eliminate any backlash in the valve drive train, and both function during the time that the tappet is riding the base circle of the engine-driven cam. The first of these is the expansion spring 63 tending to separate these two elements or actually elongate the tappet, and the second is the pressure on the oil from the engine lubricating system endeavoring to enter the chamber 34 after the check-valve CV is driven from its seat 53 by the impact of the inertial weight 75.

The present invention is particularly adapted as a replacement item for all valve tappet mechanisms whether mechanical or hydraulic. While it is preferred that the cam design be conventional, as shown on the drawing, it is clear that the present invention will operate efficiently with the particular cam design presently used for commercial hydraulic valve tappets where the opening ramp imparts a rapid rise to the tappet in order to provide the hydraulic impact on the check-valve CV to insure closure thereof substantially at the instant of initial tappet lift to prevent reintroduction of backlash in the valve drive gear during the opening cycle of the tappet T.

In the terminology used in the foregoing description and in the appended claims, the identifying expressions and/or terms employed are intended to convey meanings which include the range of reasonable equivalents in the patent sense. For example, the expressions "member," "body," "plunger," "shell" are intended to include any liquid filled casing and/or chamber having a pressure-responsive movable assembly therein, whether such assembly includes spring action, or some other force serving the same purpose. The terms "top," "bottom," "upward," "downward" and other directional words or characters are intended to have only relative connotation for convenience in describing the structure as illustrated, and are not intended to be interpreted as establishing any definite position of the tappet T or requiring any particular orientation with respect to associated structure external to the present disclosure.

It will be apparent that various changes, modifications rearrangements and substitutions may be made in the particular apparatus illustrated and described herein without departing from the scope or fair meaning of the subjoined claims.

Having thus described my invention, I claim:

1. A hydraulic valve tappet having a pair of relatively movable telescopically-related body members defining a liquid chamber therebetween, a source of liquid, a normally preloaded compression spring for biasing said body members apart and accommodating their movement relatively toward each other, a valve port in one of said body members normally open to establish liquid communication between said source and said chamber, the improvement which comprises: a movable check-valve having a hollow conical wall portion terminating at one end in an outturned annular flanged face and the opposite end being closed by an end wall; a valve seat encircling said valve port for engagement by said flanged face to close said valve port in response to pressure buildup in said chamber; a normally preloaded compression spring for biasing said check-valve face toward seated relation with respect to said valve seat to close said valve port in cooperation with said pressure buildup; a depending stem rigid with said ported body member and disposed coaxially with respect to said body members; and inertia means including a movable element having spring action in one direction slidably disposed on said stem and effective on the closed end of said check-valve to open the same by displacing its flanged face out of engagement with said valve seat during the relaxed portion of the tappet cycle whereby relative adjustment between said body members is accommodated.

2. A hydraulic valve tappet according to claim 1 plus means for limiting displacement of the two body members under influence of the first-mentioned spring prior to installation in operating disposition.

3. A hydraulic valve tappet according to claim 1 in which the said stem is rigidly attached to said check-valve for movement therewith and is slidable in a hole centrally disposed in the ported body member.

4. A hydraulic valve tappet having a pair of relatively movable telescopically-related body members defining a liquid chamber therebetween, a source of liquid, a normally preloaded compression spring for biasing said body members apart and accommodating their movement relatively toward each other, a valve port in one of said body members normally open to establish liquid communication between said source of liquid and said chamber, the improvement which comprises: a movable check-valve having a hollow conical wall portion disposed in said valve port and terminating at its lower end in an outturned annular flanged face and the upper end being closed by an end wall; a valve seat encircling said valve port for engagement by said flanged face to close said valve port in response to pressure buildup in said chamber; a normally preloaded compression spring for biasing said check-valve face toward seated relation with respect to said valve seat to close said valve port in cooperation with said pressure buildup; inertia means comprising a weight slidably longitudinally of the tappet relatively to the ported body member; and an elongated depending cylindrical rod rigid with one of the body members for slidably guiding the weight to strike the closed end of the check-valve to open the same against its biasing spring when tappet motion stops during the closing portion of the tappet cycle.

5. A hydraulic valve tappet according to claim 4 including spring means positioned in encircling relation with respect to said guiding stem above said weight to be compressed by said weight during upward movement of the tappet cycle.

6. A hydraulic valve tappet according to claim 5 in which said spring means is operably disposed between an abutment rigid with the ported body member and the said weight.

7. A hydraulic valve tappet according to claim 6 plus a non-metallic washer embedded in a counterbore terminating the upper end of said valve port for silencing the impact of the downward movement of the weight in opening the check-valve.

8. A hydraulic valve tappet according to claim 7 plus a circular non-metallic disc carried on the outer surface of the end wall of the check-valve, the upper face of said disc being in circular alignment with the upper face of said embedded washer aforesaid when the weight is at the limit of its downward throw to place the check-valve in open disposition.

9. A hydraulic valve tappet according to claim 8 in which said spring means comprise a conical spiral spring encircling said guiding stem on which the weight is slidable.

10. A hydraulic valve tappet including a cup-like outer body member for cam-actuated reciprocation in an engine block, a cup-like inner plunger member reciprocably disposed in said body portion to define a liquid chamber therebetween, a normally preloaded expansion spring operably disposed in said chamber tending to enlarge it, a push-rod cup carried atop of said plunger to provide a liquid reservoir therein connectible to a source of liquid, a port in the bottom of said plunger normally open to connect the chamber and reservoir, the improvement which comprises: a check-valve of hollow frustoconical configuration having an upper closed end and a lower open flanged end located in said port for cooperating with the latter to close it; a spring cage carried on the underneath side of the bottom of said plunger; a normally preloaded expansion spring operably disposed in said cage for biasing said check-valve to close said port; and an inertia weight effective to bear on the upper closed

end of said check-valve urging it toward open condition with respect to said port; and means in said reservoir guiding said weight for reciprocation on the axis of movement of the tappet.

11. In a hydraulic compensating valve tappet for internal-combustion engines including a cam-actuated tappet body having a longitudinal cylindrical bore closed at one end and open at the other, a hollow plunger assembly reciprocable in said bore and providing a liquid reservoir, a source of liquid, spring means including a normally preloaded compression spring for axially elongating said tappet body and plunger assembly relatively to each other, a liquid chamber provided between the closed end of said tappet body and the inner end of said plunger assembly, a valve port in the inner end of said plunger assembly, said port terminating in a valve seat, and adapted when open to interconnect said liquid reservoir and chamber, the improvement which comprises: an inwardly opening check-valve of hollow frusto-conical configuration having an upper closed end and a lower terminating flange engageable with said valve seat to close said valve port; spring means including a normally preloaded expansion spring for biasing said check-valve flange into engagement with said valve seat to close said valve port; and inertia means operably associated with said check-valve for supplementing the biasing action of said last-named spring means to maintain said valve port closed during the lift portion of the tappet cycle in response to tappet body movement to open a selected engine valve.

12. A hydraulic valve tappet according to claim 11 in which the inertia means include a movable element responsive to tappet motion, and spring means including an expansion spring operatively energized during the lift portion of the tappet cycle for accelerating the downward movement of said movable element into impact with the closed end of said check-valve to open the valve port substantially at the arrested point of tappet motion.

13. A hydraulic valve tappet according to claim 12 in which the inertia means include means for silencing and limiting the effectiveness of the movable element on the check-valve in an opening direction.

14. A hydraulic valve tappet according to claim 12 in which the second-named spring means are effective to substantially counterbalance the third-named spring means and static weight of said movable element at substantially closed position of said check-valve to normally close the said valve port when the tappet body is at rest.

15. A hydraulic valve tappet according to claim 12 in which the second-named spring means are incapable of overcoming the third-named spring means and static weight of said movable element whereby said check-valve normally opens the valve port when the tappet body is at rest.

References Cited in the file of this patent

UNITED STATES PATENTS

2,695,013	Randol	Nov. 23, 1954
2,745,391	Winkler	May 15, 1956