Jan. 27, 1959 E. L. DAYTON 2,870,756

HYDRAULIC VALVE TAPPET

Filed July 13, 1956

FIG. 1.

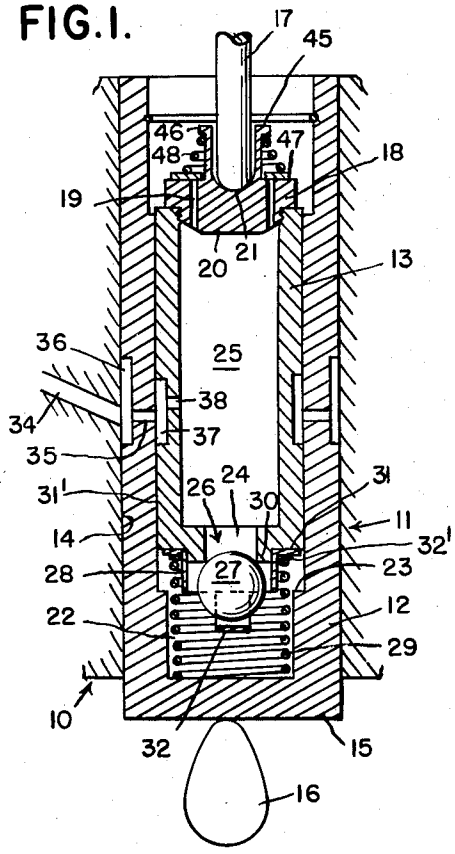


FIG. 2.

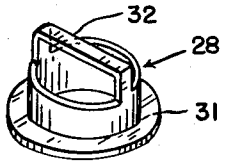


FIG. 3.

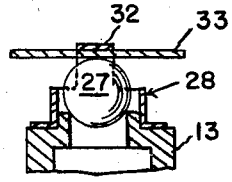
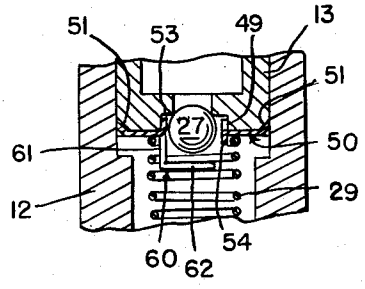


FIG. 4.



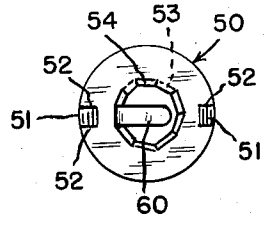


FIG. 5.

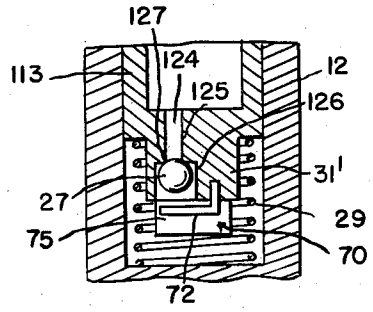


FIG. 6.

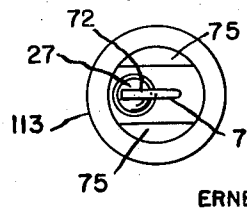


FIG. 7.

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HYDRAULIC VALVE TAPPET

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20 Claims. (Cl. 123—90)

This invention relates to an improved hydraulic valve tappet assembly of the type suitable for use in connection with internal combustion engines.

Hydraulic tappet assemblies, as used in internal combustion engines, are usually supplied with oil from the lubricating system of the engine and function to take up clearance between the valve push rods and tappets automatically as soon as such clearance exists. The specific structure of hydraulic valve tappets varies considerably but, in general, comprises a cylinder and a tubular plunger or piston slidably supported in the cylinder. When installed, the bottom of the cylinder is usually engaged by a cam on the camshaft of the engine and the top of the piston is closed by a plug which ordinarily engages the valve operating push rod.

Also, an adjusting chamber is normally provided in the cylinder below the piston and the bottom of the piston has a valve controlled port communicating with the adjusting chamber. Hydraulic fluid, such as oil, is admitted to the adjusting chamber through the valve controlled port and the clearance between the piston and push rod is taken up by the column of oil below the piston. The port in the piston is controlled by a ball valve member which operates as a check valve and is held in place adjacent the port by a suitable retainer. It is important to the satisfactory operation of the tappet assembly to limit the clearance between the ball valve member and the valve seat surrounding the port to precise tolerances. Moreover, it is extremely desirable to form the retainer so that it is readily adjustable to obtain the desired limit of clearance between the ball valve member and its seat. Accordingly, one object of this invention is to provide a retainer which is readily adjustable.

Another object of the invention is to provide a retainer for the valve member which includes an adjustable valve retaining bar which extends across the side of the valve member opposite the valve seat, the retainer being formed to provide sufficient clearance to permit the lateral insertion of a feeler gauge between the bar and the valve member during adjustment of the bar and when the valve member is seated against the seat.

Still another object of the invention is to provide a retainer for the valve member as described in the preceding paragraph in which the retainer is formed to provide clearance at the side of the bar opposite the valve member to enable striking the aforesaid side of the bar a blow to effect the necessary adjustment of the bar.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a longitudinal sectional view through a hydraulic valve tappet embodying the invention.

Figure 2 is a perspective view of the check valve retainer shown in Figure 1.

Figure 3 is a fragmentary sectional view showing the method employed in adjusting the check valve.

Figure 4 is a fragmentary sectional view showing a modification.

Figure 5 is a plan view of the valve retainer shown in Figure 4.

Figure 6 is similar to Figure 4 and shows still another modification.

Figure 7 is a bottom view of the piston shown in Figure 4.

Referring now more particularly to the drawings and especially to Figures 1–3, the numeral **10** indicates a part of an internal combustion engine and the numeral **11** designates a hydraulic valve tappet assembly embodying the invention. The tappet assembly comprises a cylinder **12** and a piston **13** supported within the cylinder for longitudinal sliding movement. The cylinder **12** is, in turn, slidably mounted in a bore **14** formed in the part **10** of the engine and the bottom of the cylinder is closed by a wall **15**. The bottom surface of the wall **15** forms a bearing for engagement with a cam **16** forming a part of the usual engine camshaft (not shown). The top of the cylinder **12** is open for receiving a push rod **17** which is operatively connected to one valve of the engine in a manner forming no part of this invention and, hence, not shown herein.

The piston **13** is tubular in cross section and the top of the piston is closed by a cap **18** which is securely fixed to the piston. In the present instance, the cap **18** has a restricted vent **19** therethrough and has a reduced part **20** which is externally threaded for threaded engagement with the internal threads formed in the upper end of the piston. The top of the cap has a hemispherical recess **21** for pivotally engaging a corresponding hemispherical portion at the lower end of the push rod **17**. The arrangement is such that the hydraulic tappet assembly provides a connection between the cam **16** and push rod **17** for operating the push rod in response to rotation of the cam.

The internal diameter of the cylinder **12** is reduced at the bottom to provide an adjusting chamber or oil reservoir **22** and also to provide an internal annular shoulder **23** for engaging the bottom of the piston in the leak-down or collapsed position of the piston within the cylinder. As illustrated in Figure 1, the piston **13** is shown in its extended position.

As shown in Figure 1, the bottom of the piston has a port **24** which establishes communication between the adjusting chamber **22** and the space or chamber **25** within the piston. The transfer of oil through the port **24** is controlled by a ball check valve **26** at the bottom of piston **13**. The check valve **26** comprises a ball member **27**, a retainer **28** and a coil spring **29**.

The ball member **27** is of a diameter to engage an annual seat **30** surrounding the port **24** at the bottom of the piston and the retainer **28** holds the ball in a manner to enable movement of the ball to its open position. The retainer **28** is of one-piece construction and is in the form of a cylindrical tubular sheet metal member extending around the ball in coaxial relationship to the piston **13**. The upper end of the tubular retainer **28** is turned radially outwardly to provide a flange **31** engageable with the underside of the piston **13**. The upper end of the tubular retainer closely receives the tubular extension **31'** at the lower end of the piston which surrounds the port **24**. A washer **32'** surrounds the tubular retainer and is engaged and pressed against flange **31** by the upper end of the spring **29** which has its lower end seated on the bottom wall **15** of the cylinder. The coil spring **29** is held under compression between the washer **32'** and wall **15** and is of sufficient strength to hold the retainer **28** in place on the piston **13** throughout the movement of the latter between its collapsed and extended positions. The coil spring **29** also tends to maintain the piston **13** in its extended posi-

tion relative to the cylinder during normal operation of the tappet but is not of sufficient strength to prevent movement of the cylinder 13 to its collapsed or leak-down position in which the lower end thereof engages the shoulder 23, when operation of the engine is discontinued. When the cylinder 12 rotates (as it often does because of an off center engagement with cam 16), and rotates the spring 29 and washer 32', the retainer 28 will not rotate because of the stronger frictional contact between the piston and washer than between the flange 31 and washer. This stronger frictional contact results from the fact that the area of contact between washer 32' and flange 31 is substantially less than that between flange 31 and the piston, coefficients of friction for the parts being about the same. Thus there is no wear on either the piston or flange 31 where they contact and hence no disturbance of the adjustment of the retainer.

The ball member 27 is held in assembled relation with the retainer 28 by a cross bar 32 integrally connecting opposite sides of the tubular retainer below the ball 27. As seen in the drawings, the major portion of the bar 32 is disposed at right angles to the axis of the cylindrical wall of the retainer and is spaced below the lower margin thereof, such lower margin being disposed entirely in a plane at right angles to the longitudinal axis of the retainer. The opposite ends of the bar are turned upwardly extending parallel to the retainer axis and integrally connect into the tubular portion of the retainer at diametrically opposite sides thereof. The bar 32 is as narrow as consistent with good stamping practice and, in any case, does not restrict the flow of oil through the retainer. The free flow of oil through the retainer 28 is important because it assists in filling the space below the piston 13 in the leak-down position of the tappet and also exposes a greater area of the ball 27 to the oil in said space to assure instantaneous closing of the ball against its seat.

The axial spacing between the bar 32 and seat 30 is accurately predetermined with the respect to the diameter of the ball member 27. In practice, the bar 32 is located to afford a predetermined maximum clearance between the seat 30 and ball 27 in the open position of the latter. With a retainer constructed in accordance with the foregoing, proper positioning of the bar 32 may be accomplished readily by inserting a feeler gauge 33 between the ball 27 and bar 32, and thereafter adjusting the bar 32 until the ball 27 is firmly engaged with the seat 30. It will be appreciated that since substantially the entire length of the bar 32 is below the tubular portion of the retainer 28, sufficient lateral clearance is afforded to permit the lateral insertion of the feeler gauge. After the feeler gauge is inserted, the adjustment may be accomplished by striking the lower side of the bar 32 a blow and the bar, which is deformable, will be deformed under the impact of the blow to the desired position of adjustment. It might be pointed out that the retainer is formed of a material having very little resilience so that this adjustment of the bar may be accomplished as described. Thus, the adjustment of the retainer is accomplished quickly and easily. Since no wear takes place between the retainer flange 31 and the piston, the adjustment will remain indefinitely. The feeler gauge may be readily inserted. This is because the relatively narrow width of the bar leaves practically 180° of arc at either side of the bar through which the feeler gauge may be inserted.

The retainer may be inexpensively manufactured and readily adjusted. This is in sharp contrast to conventional tappets which are not adjustable and in which the parts are precision made at great expense to obtain the exact tolerances.

Oil from the lubricating system of the engine is supplied to the hydraulic tappet assembly 11 by a passage 34 in the engine part 10 and a port 35 extending through the adjacent wall of cylinder 12 intermediate the ends of the latter. The intake side of the port 35 opens into an annular groove 36 formed in the outer surface of the

cylinder wall and the discharge side opens into an annular groove 37 formed in the outer surface of the piston. The annular groove 36 is of sufficient width to register with the supply passage 34 through the stroke of the cylinder within the bore 14. In the normal operation of the hydraulic tappet assembly, the groove 37 communicates with the chamber 25 in the piston 13 through a port 38 formed in the adjacent wall of the piston and the width of the groove 37 is sufficient to register with the port 38 throughout the full stroke of the piston relative to the cylinder.

The hydraulic tappet assembly is shown in its normal operating position in Figure 1 wherein it will be noted that the bottom of the piston is spaced above the shoulder 23, and a column of oil is provided between the lower end of the piston and the bottom wall 15 of the cylinder. This column of oil takes up the clearance between the push rod 17 and engine valve mechanism affording quiet operation of the latter. The port 38 meters fluid into the chamber 25 in the piston, and the oil thus admitted to the chamber 25 is maintained in the latter until the pressure below piston 13 drops sufficiently to enable movement of the ball member 27 away from its seat whereupon oil from the chamber 25 flows through port 24 into the cylinder below the piston. Owing to the fact that the bar 32 is very narrow, generous passages are provided at opposite sides of the bar with the result that ample oil is available in the retainer to replenish the space below the piston in the open position of the ball member 27, and with the added result that the ball member 27 is more readily responsive to an increase of pressure in the space below the piston. In other words, the ball member 27 will close practically instantaneously upon an increase in pressure in chamber 22. Hence, there is no apparent lost motion of the parts and objectionable clearance in the engine valve operating mechanism is avoided.

The reduction of lost motion is also assisted by fixing the cap 18 securely to the top of the piston in a manner such that displacement of the cap by lubricant under pressure in chamber 25 is prevented. It will be apparent that if lost motion is present in the valve operating mechanism and the cap 18 is not securely fixed to the piston, the pressure in the chamber 25 may simply lift the cap to take up the clearance in the valve operating mechanism without being exerted against the ball member 27 with sufficient force to unseat it. By securely fastening the cap 18 to the piston, the full effect of the oil pressure within chamber 25 is applied to the valve member 27 to open the same for replenishing chamber 22 and in such manner taking up the clearance in the valve operating mechanism.

The cap 18 has an integral extension in the form of a sleeve 45 loosely surrounding the push rod. The sleeve has an annular enlargement or flange 46 at the upper end, and a washer 47 loosely encircles the sleeve and overlies the vents 19. These vents are normally closed by the washer which is pressed down against the cap 18 by a compression coil spring 48 also encircling the sleeve. The upper end of the spring bears against the flange 46 and the lower end bears against the washer. Normally the vents are closed by the washer during the action described in the preceding paragraph. However, the spring has a force predetermined to allow the washer to raise or open when the pressure in the piston chamber exceeds a certain maximum amount, this pressure acting on the washer through the vents 19. Thus the washer is a relief valve to relieve excessive pressure on the piston chamber through vents 19.

Figure 4 illustrates a modified construction in which parts corresponding to those shown in Figures 1–3 are identified by the same reference numerals. The Figure 4 construction differs from that previously described primarily in the construction of the retainer herein designated by the reference numeral 50. The port 24 also

has a lower portion 49 of enlarged diameter. The retainer 50 is generally in the form of a one-piece flat ring having tabs 51 cut at diametrically opposite sides, formed by the generally radial slits 52. These tabs fit into tapered recesses at diametrically opposite sides of the piston to prevent the retainer from rotating when pressed up against the bottom of the piston. The recesses are of about the same circumferential extent or width as the tabs so that the tabs are closely confined by opposite sides of the recesses to prevent rotation. The central opening in the retainer has radial slits defining a plurality of fingers, alternate fingers 53 being turned axially upwardly into the enlarged portion 49 of port 24 to center the retainer, and the remaining fingers 54 being turned axially downwardly into the upper end of spring 29 to center the spring. The lower end of spring 29 is, of course, compressed against the bottom of the cylinder and presses the retainer tightly against the piston.

The ball member 27 is held in assembled relation with the retainer 50 and prevented from dropping through the opening in the retainer by a bar 60 which is integrally connected to the inner margin of the opening through the retainer. The bar 60 has a portion 61 which extends parallel to the axis of the retainer and a terminal portion 62 which extends at right angles to the axis. The bar is sufficiently narrow so that it does not restrict the flow of oil through the retainer. The axial spacing between the bar 60 and the seat 30 is accurately predetermined with respect to the diameter of the ball 27. In practice, the predetermined maximum clearance between the seat 30 and the ball 27 is provided by adjusting the deformable practically non-resilient bar 60 in a manner similar to the adjustment of the bar 32 in the first embodiment. That is, a feeler gauge, such as the gauge 33, is inserted between the ball and the portion 62 of bar 60 when the ball is seated against seat 30, and the portion 62 may be struck a blow to deform it against the feeler gauge. One advantage of this retainer construction over that first described is that the bar 60 is connected to the annular portion of the retainer at one end only, thereby increasing the angular positions from which the feeler gauge may be laterally inserted between the ball and the bar to effect an adjustment.

Figure 6 shows still another modification in which parts similar to those described in connection with the first two embodiments are identified by the same characters of reference. In this construction, the piston 113 differs from the piston 13 in that the port 124 has an upper portion 125 of reduced diameter and a lower portion 126 of enlarged diameter separated by an annular shoulder 127. The ball 27 seats against the annular corner between the shoulder 127 and the portion of the port of reduced diameter.

The retainer 70 is in the form of an L-shaped member of a material having little resilience, one leg of which extends up into a hole in the tubular extension 31' and is securely held in place therein. The other leg 72 extends transversely of the cylinder across the lower end of the piston and is provided to retain the ball 27 in place within the enlarged diameter portion of port 124. The predetermined maximum spacing between the ball 27 and its seat is determined by adjusting the transverse leg 72 of the retainer. The leg 72 is adjusted by deforming the same and this is accomplished in the same way as described in connection with the previous embodiments. That is, a feeler gauge, such as gauge 33, is inserted between the leg 72 and the ball and then a blow is struck against the leg 72 to bend or deform it tightly against the feeler gauge. Since the retainer 70 is secured at only one end, the feeler gauge may be inserted very easily from almost any angle. The extension 31' has diametrically opposite depending parts 75, only one of which appears, these parts being disposed on opposite sides of the port and retainer and extending beneath the

retainer for engagement with the bottom of the cylinder in the leak-down position of the device.

What I claim as my invention is:

1. A hydraulic valve tappet assembly comprising a cylinder having one end closed and having a chamber at the closed end thereof, a piston slidably supported in said cylinder and having a chamber therein a port in the end of said piston adjacent the closed end of said cylinder providing communication between said chambers, a seat surrounding said port, a valve member supported in a position to engage said seat, a retainer for said valve member carried by said piston and having an adjustable bar positioned to engage the side of said valve member opposite said seat, said retainer being formed to provide sufficient lateral clearance to permit the lateral insertion of a feeler gauge between said valve member and bar during adjustment of said bar when said valve member is seated against said seat.

2. A hydraulic valve tappet assembly as defined in claim 1, in which said bar is deformable and is adjusted by deforming the same.

3. A hydraulic valve tappet assembly as defined in claim 2, in which said retainer is formed to provide clearance at the side thereof opposite said valve member to permit deforming said bar by striking a blow against the aforesaid side thereof while said feeler gauge is inserted as aforesaid.

4. A hydraulic valve tappet assembly comprising a cylinder having one end closed and having a chamber at the closed end thereof, a piston slidably supported in said cylinder and having a chamber therein, a port in the end of said piston adjacent the closed end of said cylinder providing communication between said chambers, a seat surrounding said port, a ball valve member supported in a position to engage said seat, a retainer for said ball valve member carried by said piston and having an annular wall encircling said ball valve member and extending away from said seat, the end of said annular wall remote from said seat being open, an adjustable bar extending at least part way across said open end and having at least one end connected to said annular wall, said bar being spaced beyond the remote end of said annular wall to provide sufficient clearance to permit the lateral insertion of a feeler gauge between said ball valve member and bar during adjustment of said bar when said ball valve member is seated against said seat.

5. A hydraulic valve tappet assembly as defined in claim 4 in which said bar is deformable and is adjusted by deforming the same.

6. A hydraulic valve tappet assembly as defined in claim 5 in which said retainer is formed to provide clearance at the side of said bar remote from said ball valve member to permit deforming said bar by striking a blow against the aforesaid side thereof while said feeler gauge is inserted as aforesaid.

7. A hydraulic valve tappet assembly as defined in claim 6 in which both ends of said bar are connected to said annular wall at opposite sides thereof.

8. A hydraulic valve tappet assembly as defined in claim 7 in which said retainer has an annular flange encircling said seat, one side of said flange frictionally engaging said end of said piston, a washer frictionally engaging the opposite side of said flange, and a spring compressed between said washer and the closed end of said cylinder, the frictional contact between said washer and flange being less than that between said flange and piston so that any rotation imparted to said washer by said spring will not induce rotation of said retainer.

9. A hydraulic valve tappet as defined in claim 8 in which the area of contact between said washer and flange is less than that between said flange and piston.

10. A hydraulic valve tappet assembly comprising a cylinder having one end closed and having a chamber at the closed end thereof, a piston slidably supported in said cylinder and having a chamber therein, a port in the

end of said piston adjacent the closed end of said cylinder providing communication between said chambers, a seat surrounding said port, a ball valve member supported in a position to engage said seat, a retainer for said ball valve member carried by said piston and comprising an adjustable bar of deformable, relatively non-resilient material positioned to engage the side of said ball valve member opposite said seat, said retainer being secured directly to said end of said piston and having a part spaced from said end of said piston to provide sufficient lateral clearance to permit the lateral insertion of a feeler gauge between said ball valve member and part during adjustment of said bar when said ball valve member is seated against said seat.

11. A hydraulic valve tappet assembly comprising a cylinder having one end closed and having a chamber at the closed end thereof, a piston slidably supported in said cylinder and having a chamber therein, a port in the end of said piston adjacent the closed end of said cylinder providing communication between said chambers, a seat surrounding said port, a ball valve member supported in a position to engage said seat, a retainer for said ball valve member carried by said piston and comprising an adjustable bar of deformable, relatively non-resilient material positioned to engage the side of said ball valve member opposite said seat, said bar being generally L-shaped having one leg secured directly to said end of said piston and the other leg spaced from said end of said piston to provide sufficient lateral clearance to permit the lateral insertion of a feeler gauge between said ball valve member and said other leg during adjustment of said bar when said ball valve member is adjusted against said seat.

12. A hydraulic valve tappet assembly as defined in claim 11 in which said bar is deformable and is adjusted by being deformed.

13. A hydraulic valve tappet assembly as defined in claim 12 in which said retainer is formed to provide clearance at the side of said one leg remote from said ball valve member to permit deforming said one leg by striking a blow against the aforesaid side thereof while said feeler gauge is inserted as aforesaid.

14. A hydraulic valve tappet assembly comprising a cylinder having a closed end and having a chamber at the closed end thereof, a piston supported in said cylinder for sliding movement from a collapsed position adjacent the closed end of said cylinder to an extended position more remote from said closed end, said piston having a chamber therein communicating with the chamber in said cylinder through a port in the end of said piston adjacent the closed end of said cylinder, valve means controlling communication through said port, an inlet port in one side of said cylinder, porting in said piston arranged to connect said inlet port to said chamber in said piston in all positions of said piston relative to said cylinder, said piston having a head at the opposite end thereof closing said chamber in said piston which is a rigid part of said piston and movable as a unit therewith, and a push rod extending into the opposite end of said cylinder and engageable with said head.

15. A hydraulic valve tappet assembly as defined in claim 14, said head having a vent therein, and a relief valve normally closing said vent and adapted to open said vent when the pressure in said chamber exceeds a predetermined maximum.

16. A hydraulic valve tappet assembly comprising a cylinder having one end closed and having a chamber at the closed end thereof, a piston slidably supported in said cylinder and having a chamber therein, a port in the end of said piston adjacent the closed end of said cylinder providing communication between said chambers, a seat surrounding said port, a ball valve member supported in a position to engage said seat, a retainer for said ball valve member carried by said end of said piston, said retainer being generally of ring shape and encircling said seat, an adjustable bar extending part way across the opening in said retainer and having one end connected to the radially inner margin of said retainer, the major portion of said bar being spaced from said retainer toward the closed end of said cylinder to provide sufficient clearance for the lateral insertion of a feeler gauge between said ball valve member and bar during adjustment of said bar when said ball valve member is seated against said seat.

17. A hydraulic valve tappet assembly as defined in claim 16 in which said bar is deformable and is adjusted by deforming the same.

18. A hydraulic valve tappet assembly as defined in claim 17 in which said retainer has tabs extending into circumferentially spaced recesses in said end of said piston to prevent relative rotation between said piston and retainer.

19. A hydraulic tappet assembly for a valve comprising a cylinder closed at one end to provide a chamber for hydraulic fluid, a piston mounted in said cylinder for longitudinal sliding movement between a collapsed position adjacent the closed end of said cylinder and an extended position spaced axially from the closed end of said cylinder, a passage in said piston, a port in the end of said piston adjacent the closed end of said cylinder connecting said passage and chamber, means for supplying hydraulic fluid to said passage, valve means controlling the flow of hydraulic fluid through said port including an annular seat surrounding said port at the side thereof facing the closed end of said cylinder, a ball member supported in a position to engage said seat in response to an increase in pressure in said chamber, and a retainer for said ball member including a bar extending across said ball member at the side of the latter away from said port and attached at least at one end for movement as a unit with said piston.

20. The tappet assembly defined in claim 19 in which one end only of said bar is attached to further avoid interference during insertion of a feeler gage, said one end being rigidly attached directly to said piston.

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