March 10, 1964 C. VOORHIES 3,124,115

ANTIPUMP-UP DEVICE

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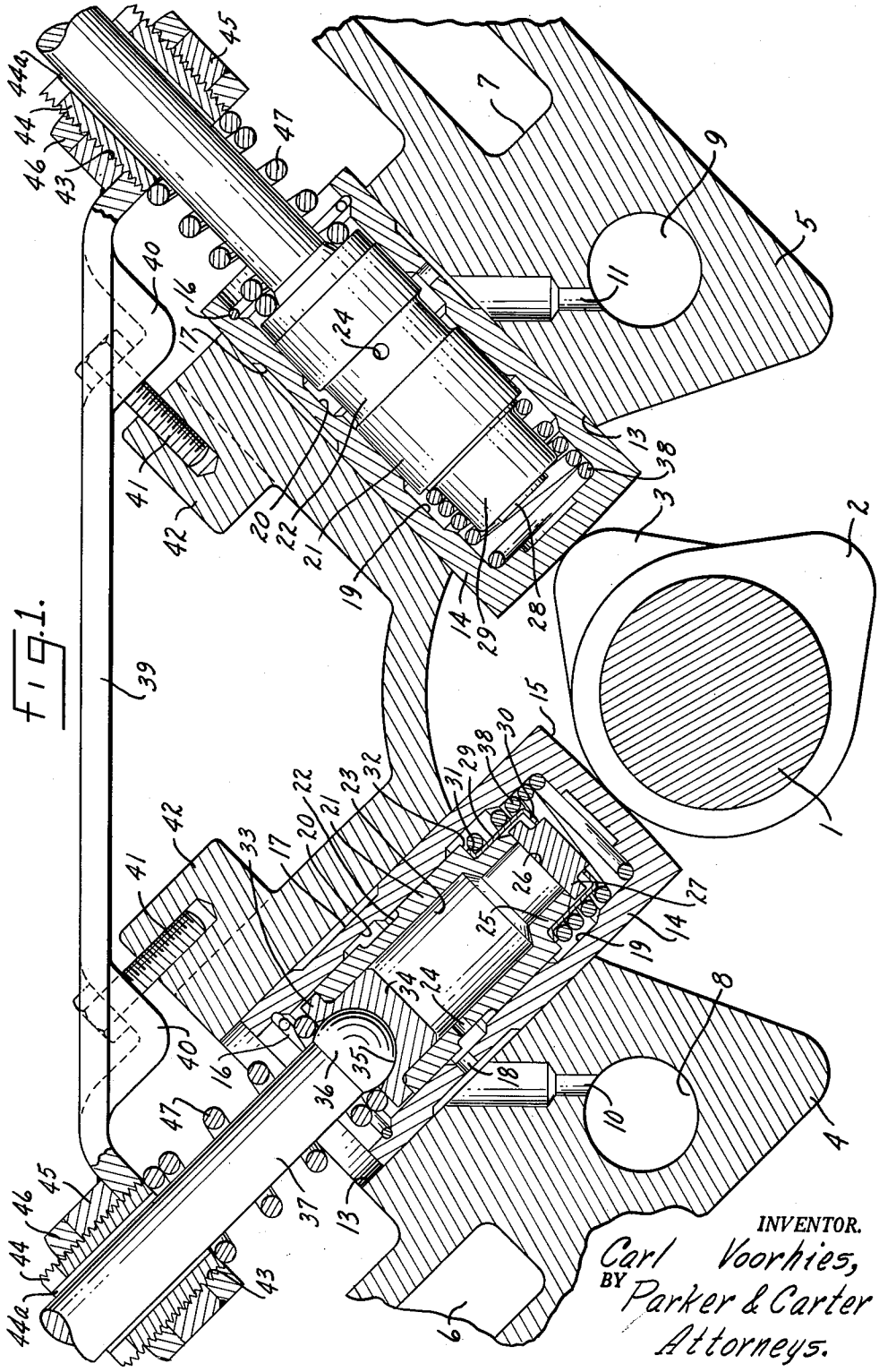

FIG. 1.

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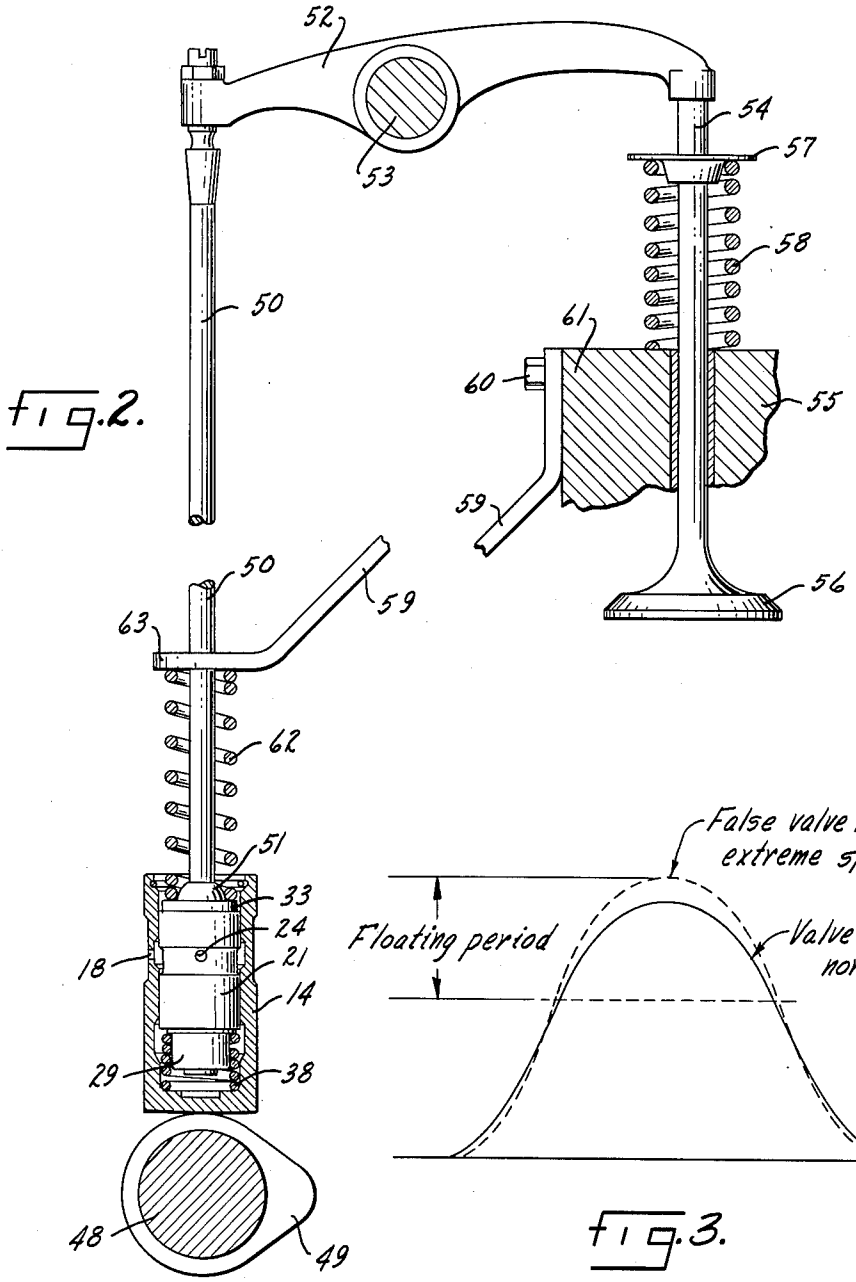

Fig. 2.

Fig. 3.

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3,124,115

ANTIPUMP-UP DEVICE

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This invention relates to a valve gear, and has particular application to the tappet construction and arrangement for an internal combustion engine. It has for one object to prevent the occurrence of a condition known as "pump-up."

Another object is to provide a mounting or positioning means for tappets of an internal combustion engine arranged to provide mechanism to prevent pump-up or overfilling of a hydraulic valve lifter or lash adjuster.

Another object is to provide a spring means and a mounting therefor whereby pump-up or overfilling of a hydraulic lash adjuster or tappet is prevented.

Other objects will appear from time to time throughout the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

FIG. 1 illustrates one form of the device and comprises a transverse section through a cam shaft, parts of the engine and two tappets or lash adjusters;

FIG. 2 illustrates a modified form of the device in which a single tappet or lash adjusted is shown on a smaller scale than that used in FIG. 1; and

FIG. 3 is a diagram illustrating the motion of a tappet or lash adjuster and illustrating particularly the condition known as "false motion" during which the plunger of a tappet or lash adjuster may have a so-called "floating period" and in which, in effect, the parts tend to become "weightless."

Like parts are designated by like characters throughout the specification and drawings.

As shown in FIG. 1, 1 is a cam shaft carrying fixed to it a pair of cams 2 and 3. 4 is a part of the engine construction and 5 is another part of the engine construction. As shown the engine portions 4 and 5 may have water chambers 6 and 7, respectively, of water jackets for cooling. Each of the portions 4 and 5 has a lubricant duct 8 and 9. From each of these lubricant ducts passages 10 and 11, respectively, direct lubricant to a tappet or lash adjuster. Since the tappets are identical in the forms shown, they will be described only once and the same numerals will be used on each of the two tappets shown.

As shown, each tappet operates in a bore 13 formed in a portion of the engine housing or mechanism and each tappet comprises a barrel 14 having a working face 15 formed as a part of the closed end of the barrel, and each working face is positioned to contact one of the cams 2 or 3. The tappets are open at their upper ends, as shown, and are provided with retaining rings 16 which act to prevent accidental displacement of the plunger and associated parts. Each cylinder is preferably provided with an external groove 17 from which one or more passages or openings 18 extend to the interior of the cylinder. The cylinder is generally cylindrical in shape but may be provided interiorly with a groove 19 and a second groove 20.

Positioned within each cylinder 14 is a hollow plunger 21. The plunger is grooved or reduced exteriorly as at 22 and is shaped to provide an interior cavity 23. A perforation or passage 24 leads from the groove 22 to the interior cavity 23 of each plunger 21. The plungers may be reduced at their inner ends as at 25. They are open at the ends 25 and shaped to provide a flat valve seat 26. A valve 27 is adapted to be seated upon the seat 26 and may be provided with an outward or downward

projection 28. A cage or valve retainer 29 is inwardly turned as at 30 to engage and retain the valve 27 in proximity to the valve seat 26. At its opposite end the retainer is flanged as at 31 and seated upon a shoulder 32 formed by the reduced portion 22 of the plunger 21.

Each plunger 21 is closed by a member 33 which is reduced as at 34. The reduced portion 34 extends within the cavity 23 of the plunger 21 and may be held tightly therein by a press fit, or otherwise. Each member 33 is provided with a rounded and generally hemispherical cavity 35 which receives the rounded or hemispherical end 36 of a push rod 37.

Within the cylinder 14 is a spring 38 which bears at one end against the closed portion 15 of the cylinder and at the other end against the plunger 21 being seated upon the shoulder 32 or upon the flange 31 of the valve retainer which is itself seated upon the shoulder 32. The spring 38 is biased to move the plunger outwardly with respect to the cylinder.

39 is a spring support means provided with one or more parts 40 perforated and held by screws 41 to portions 42 of the engine housing or assembly. By means of the screws 41 the spring support 39 is held in place rigidly.

The threads 43 of the adjustable spring base 44 is received in corresponding threads of the nut 45 which is welded to the support 39. A lock nut 46 may be used, if desired, to hold the member 44 in an adjusted position. The member 44 comprises thus an adjusted screw which may be welded or otherwise shaped for an engagement with an adjusting tool. Each spring 47 bears at one end upon its respective hollow adjusting screw 44 and at the other end upon the member 33 which closes the cavity 23 of a plunger 21. The adjusting screws 44 may be moved in and out to vary the compression upon the springs 47 and thus to vary the degree of pressure which the springs are biased to exert upon the plungers of their respective tappets or lash adjusters. The passage or perforations through each of the adjusting screws 44 is of size to permit free movement of the push rods 37 therethrough. 44 are adjusting screws against which one end of the springs 47 abut. They serve as adjusting screws for the springs and are not in contact with the push rods 37. A clearance 44*a* is provided within each of the adjusting screws 44 and this clearance is sufficient to keep the push rods out of contact with the adjusting screws 44.

In the forms shown in FIG. 2 only a single tappet or lash adjuster appears. There is thus a camshaft 48 with a cam 49. The tappet or lash adjuster of this form of the device is identical with that shown in FIG. 1 and described in connection with that figure and need not be described again.

In connection with the tappet is shown a push rod 50 which is rounded as at 51 to engage a suitable rounded cavity or depression in the part 33 of the tappet. At its opposite end the push rod is connected to a rocker arm 52 which is supported upon a shaft 53 for rocking movement. A valve stem 54 is in contact with the rocker arm 52 at a position opposite to the point of contact of the push rod 50 and the rocker arm 52. A portion of the engine housing is shown at 55 and the valve stem 54 carries a valve 56. A collar 57 is fixed upon the valve stem 54. A valve spring 58 is positioned upon the member 55 at one end and at the other end bears against the collar 57. Thus the valve spring is biased to raise the valve by moving the valve stem outwardly with respect to the housing member 55. The rest of the engine is not shown as its details form no part of the invention and the operation of a valve is well understood. Similarly, the guide or guiding means for the cylinder is not shown as it may be the same as that shown in FIG. 1

or an equivalent arrangement. It is sufficient for the purposes of the invention to state that the cylinder is positioned in a portion of the engine assembly which will act as a guide, as shown in FIG. 1, and that lubricant is furnished to the tappet through a passage in the engine assembly from which lubricant moves through the opening 18 to the interior of the cylinder and the interior of the plunger.

59 is a spring support secured as at 60 to a portion of the engine housing 61. This is a rigid member and serves as a base for the spring 62, one end of which bears against the portion 63 and the other end of which bears against the portion 33 of the plunger of the tappet shown. The spring 62 is thus the equivalent of the springs 47 and serves to exert a pressure upon the plunger of the tappet. The springs 62 and 47 have a higher load rate than any of the springs 38 so that the springs 47 and 62 tend always to exert a pressure in the lifted position of the tappet upon their respective plungers to force them inwardly with respect to the cylinders within which they are mounted.

The diagram of FIG. 3 illustrates a condition which occurs during certain operating conditions of an internal combustion engine and particularly during operating conditions at high speed. The solid curve indicates the normal or true and preferred valve motion. The dash curve indicates the so-called "false motion" which may occur at extreme speeds. The two arrows indicate the areas or portions of the curves wherein pump-up or overfilling of the tappet may occur. This is during the so-called "floating period."

During periods of extreme high speeds the valve gear may develop the so-called "false motion." When that occurs the parts are, or act as though they were essentially weightless and the plunger of the tappet or lash adjuster tends to move outwardly excessively with respect to the cylinder in which it is positioned and thus to cause overfilling within the compression space which lies within the cylinder of the tappet and below the plunger of the tappet. The recognition of this false motion and the problem of pump-up and overfilling is not new. Much has been attempted in the past to prevent this condition and to prevent pump-up. Restricted oil feed has been attempted as a solution. Dual rate plunger springs have also been attempted. The device of the present invention is believed to accomplish pump-up prevention better than any previous attempt. The device has been found upon test to prevent pump-up even in engine constructions in which the proper proportion of the controlling forces does not exist. For that reason the device of the present invention will permit a given engine to be operated at higher speeds than previously without any pump-up or overfilling.

We shall refer again to the diagram of FIG. 3. During the floating period when the parts tend to become weightless the load of the plunger springs 38 plus oil pressure within the tappet causes the plunger and the tappet body or cylinder to separate, the plunger moving outwardly excessively, and thereby overfilling the chamber within the tappet cylinder below the plunger.

In the device of this invention this condition is avoided and pump-up is prevented by the spring load of the springs 47 or 62 on the tappet plunger during the floating period. Normal filling of the space below the tappet plunger is permitted by the spring 62 at or near the free length so that the force of the plunger spring 38 is greater than the force of the springs 47 and 62 during the normal filling period. In other words, it is only during the period of operation when the outward movement of the plungers would become excessive because of the high speed of the mechanism that the springs 62 are effective to prevent this excessive movement outwardly and to prevent overfilling or pump-up.

In the form shown in FIG. 2 a complete valve train including the spring 62, as shown, will prevent pump-up.

The load of the valve spring is determined by the load required to close the valve whereas the separate spring 62 bearing only on the plunger applies a load upon it which is effective in preventing pump-up but without changing the required load of the valve spring. This becomes more important in overhead valve gear where the inertia forces may be greater and where the valve is prone to float to the point where the separate parts of the valve gear become, together and individually, in effect "weightless." Under this condition if the springs 62 and 47 were absent the plunger springs of the tappets or lash adjusters would separate their respective plungers and cylinders and this would result in pump-up. The additional springs 47 and 62 pushing against their respective plungers prevent this pump-up causing whatever clearances may occur to occur at points in the valve gear away from the lash adjuster and these springs 47 and 62 accomplish this purpose with much lighter load because their thrust is applied at the most effective point, namely upon the tappet plunger, and their thrust is thus unaffected by the inertia of the rest of the valve gear.

In high speed engine operation the tappet may leave the face of the cam and may thus float under certain conditions of inertia. The added springs 47 and 62 will, under this condition, act upon each tappet plunger so that the plunger spring, which under these conditions tends to move the plunger outwardly in its respective cylinder, will be resisted and the plunger and cylinder will not thus be outwardly separated. This desirable result of resisting excessive plunger and cylinder separation is accomplished by the added springs 47 or 62 and these springs are increasingly effective as the inertia forces increase toward causing weightlessness or floating.

It is recognized that the valve spring under normal conditions applies a load to the plunger of the tappet but during the speeds at which the floating condition occurs in the valve gear this load of the valve spring does not exist at the tappet plunger at intervals in the surge when the parts are essentially "weightless." These separate springs 47 and 62 will be unaffected by this floating condition and will continually under all conditions of inertia apply a load to the plunger and will prevent pump-up during those periods when the load of the valve spring is absent and would thus be ineffective upon the plunger.

The springs 47 and 62 do not bear upon the tappets as a whole but bear only upon the tappet plungers, and hence the springs 47 do not affect the movement of the tappet barrels directly in any sense. In the valve closed position, when the tappet is on the base circle of the cam the spring 38 within each tappet has a greater load than the related spring 47 because the spring 47 is at or near its free length. The load rate of the springs 47 is much higher than that of the spring 38 so that very little motion of the tapet upward, since the plunger tends to move with it, is required to make the load of spring 47 greater than that of spring 38 and this action prevents the outward movement of the plunger with respect to its cylinder or barrel during the valve lift cycle. When the tappet is on the base circle the force of the spring 38 is always greater than that of its corresponding spring 47. When the tappet is on the lift of the cam, even very slightly, the force of the spring 47 is greater than the forces tending to move the plunger outwardly relative to the tappet body and these forces include the action of the spring 38. As pointed out, when the tappet is on the base circle the spring 47 may be at its free length. In fact, under some conditions and in some installations there may be slight clearance between the spring and the points defined by the facing surfaces of the members 33 and 44.

Where we have used the expression "rate of spring" or "load rate of spring" it is with the understanding that the rate of spring is its load per inch of deflection. Thus a 10 pound rate spring compressed one inch pushes or supports 10 pounds.

Although an operative form of the device has been

shown, the invention is not limited to the particular details shown. Many changes may be made in the form, shape and arrangement of parts without departing from the spirit of the invention.

I claim:

1. In combination in a lash adjuster, means for supplying pressure fluid thereto, a cylinder closed at one end, a hollow piston mounted for reciprocation therein, said piston being open at its inner end, a valve positioned to close said inner end, a spring within the cylinder and biased to move the piston outwardly with respect to the cylinder, a second spring of greater load rate than said first mentioned spring, means establishing a base for said spring, fixed in relation to all parts of said lash adjuster, said second spring being at its end opposite said base positioned against said piston in opposition to said first mentioned spring.

2. In combination in a lash adjuster, means for supplying pressure fluid thereto, a cylinder closed at one end, a hollow piston mounted for reciprocation therein, said piston being open at its inner end, a valve positioned to close said inner end, a spring within the cylinder and bearing upon the piston and biased to move the piston outwardly with respect to the cylinder, a second spring of greater load rate than said first mentioned spring, means establishing a base for said second spring, fixed in relation to all parts of said lash adjuster, said second spring being at its end opposite said base positioned against said piston in opposition to said first mentioned spring.

3. In combination in a lash adjuster, means for supplying pressure fluid thereto, a cylinder closed at one end, a hollow piston mounted for reciprocation therein, said piston being open at its inner end, a valve positioned to close said inner end, a spring within the cylinder and biased to move the piston outwardly with respect to the cylinder, a second spring of greater load rate than said first mentioned spring, means establishing a fixed base for said second spring, fixed in relation to all parts of said lash adjuster, said second spring being at its end opposite said base positioned against said piston in opposition to said first mentioned spring.

4. In combination in a lash adjuster, means for supplying pressure fluid thereto, a cylinder closed at one end, a hollow piston mounted for reciprocation therein, said piston being open at its inner end, a valve positioned to close said inner end, a spring within the cylinder and bearing upon the piston and biased to move the piston outwardly with respect to the cylinder, a second spring of greater load rate than said first mentioned spring, means establishing a fixed base for said second spring, fixed in relation to all parts of said lash adjuster, said second spring being at its end opposite said base positioned against said piston in opposition to said first mentioned spring.

5. In combination in a lash adjuster, means for supplying pressure fluid thereto, a cylinder closed at one end, a hollow piston mounted for reciprocation therein, said piston being open at its inner end, a valve positioned to close said inner end, a spring within the cylinder and bearing upon the piston and biased to move the piston outwardly with respect to the cylinder, a second spring of greater load rate than said first mentioned spring, means establishing a fixed base for said second spring, fixed in relation to all parts of said lash adjuster, said second spring being at its end opposite said base positioned against said piston in opposition to said first mentioned spring, and means for adjusting said fixed spring base.

6. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein, said piston having an open end, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said piston and a second spring, means defining a fixed base for one end of said second spring, fixed in relation to all parts of said tappet, said second spring bearing thereagainst and also bearing upon said piston.

7. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein said piston having an open end, a valve positioned to close the open end of said piston, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said piston and a second spring, means defining a fixed base for one end of said second spring, fixed in position in relation to all parts of said tappet, said second spring bearing thereagainst and also bearing upon said piston.

8. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein said piston having an open end, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said piston and a second spring, said second spring being mounted about said push rod, means defining a fixed base for one end of said second spring, fixed in relation to all parts of said tappet, said second spring bearing thereagainst and also bearing upon said piston.

9. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein said piston having an open end, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said piston and a second spring, said second spring being mounted about said push rod, means defining a fixed base for one end of said second spring, fixed in position in relation to all parts of said tappet, said second spring bearing thereagainst, and also bearing upon said piston and means for adjusting said fixed base.

10. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein said piston having an open end, a valve positioned to close the open end of said piston, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said

piston and a second spring, said second spring being mounted about said push rod, means defining a fixed base for one end of said second spring, fixed in relation to all parts of said tappet, said second spring bearing thereagainst and also bearing upon said piston.

11. In combination in an internal combustion engine, a camshaft, a cam thereon and a tappet positioned to be contacted by said cam, said tappet being supported for reciprocation, said tappet comprising a cylinder and a hollow piston slideable therein said piston having an open end, a valve positioned to close the open end of said piston, said engine being provided with a passage furnishing lubricant to said tappet, said tappet and said piston being perforated to provide passage for said fluid into said piston, a spring within said cylinder bearing at one end thereagainst and at the other bearing upon said piston and biased to move said piston outwardly with respect to said cylinder, a push rod in contact with a closed end of said piston and a second spring, said second spring being mounted about said push rod, means defining a fixed base for one end of said second spring, fixed in relation to all parts of said tappet, said second spring bearing thereagainst and also bearing upon said piston and means for adjusting said fixed base.

12. In combination a hydraulic tappet for actuating a valve having a return spring comprising a cylinder closed at one end and a hollow piston positioned therein for reciprocation and a spring biased to move said piston outwardly, said piston being formed to receive a push rod, a second spring additional to the return spring for the valve being positioned bodily outside of said hollow

piston and said cylinder and bearing against said hollow piston and of greater load rate than said first spring and biased to exert pressure inwardly upon said piston, and a base for said second spring, fixed in relation to said cylinder and said piston.

13. In combination a hydraulic tappet for actuating a valve having a return spring comprising a cylinder closed at one end and a hollow piston positioned therein for reciprocation and a spring biased to move said piston outwardly, said piston being formed to receive a push rod, a second spring of greater load rate than said first spring and biased to exert pressure inwardly upon said piston, and a base for said second spring, fixed in relation to said cylinder and said piston, said second spring additional to the return spring for the valve being positioned bodily outside of said hollow piston and said cylinder and bearing against said hollow piston and having a higher rate than said first spring and being so adjusted that its load, when the tappet is on the base circle of a cam, is less than that of the first spring, and greater than that of said first spring when a small amount of travel of said tappet from the base circle has occurred.

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