Jan. 31, 1939. C. E. JOHNSON 2,145,484

HYDRAULIC TAPPET

Filed Jan. 25, 1937 2 Sheets-Sheet 1

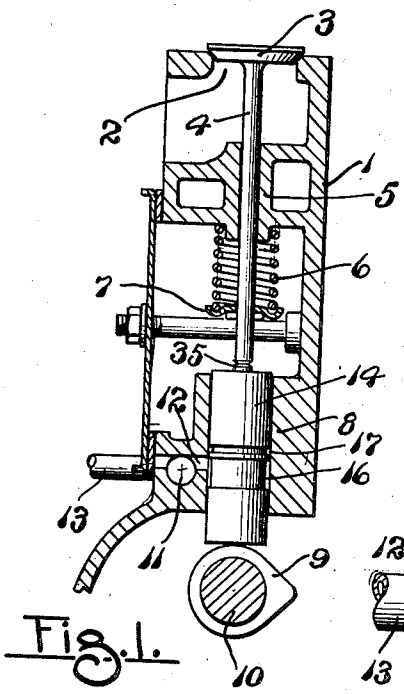


Fig. 1.

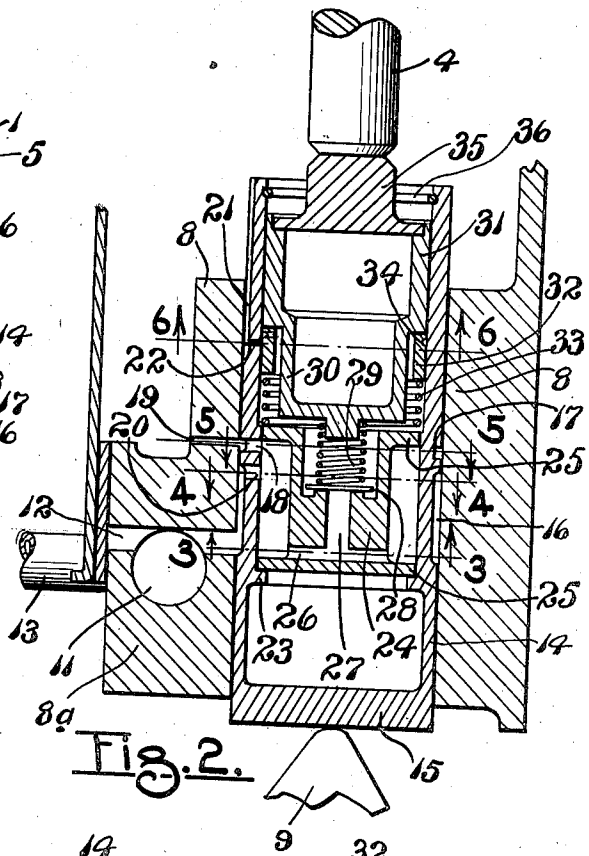


Fig. 2.

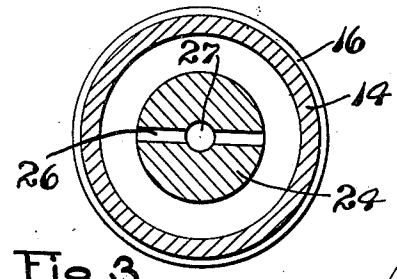


Fig. 3.

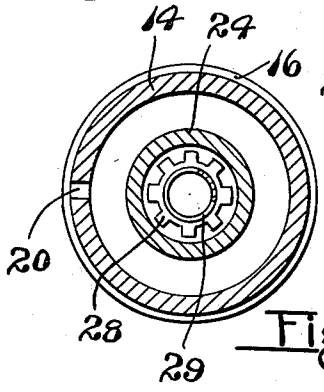


Fig. 4.

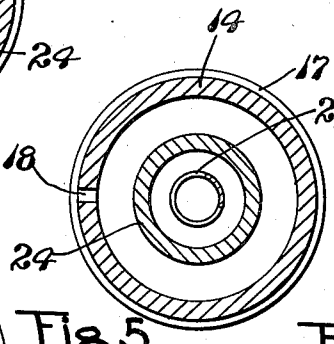


Fig. 5.

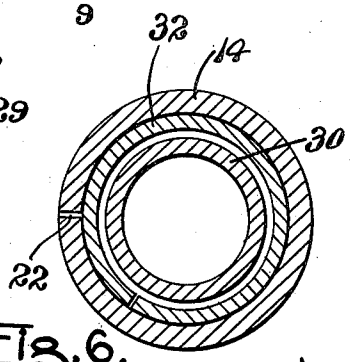


Fig. 6.

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HYDRAULIC TAPPET

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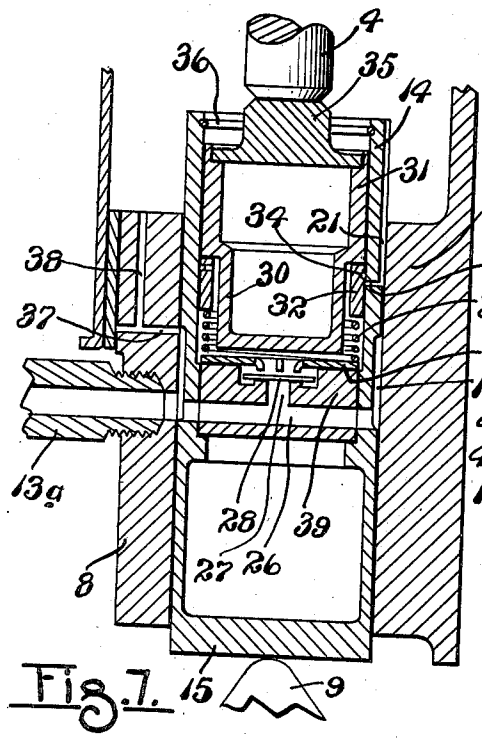


Fig. 7.

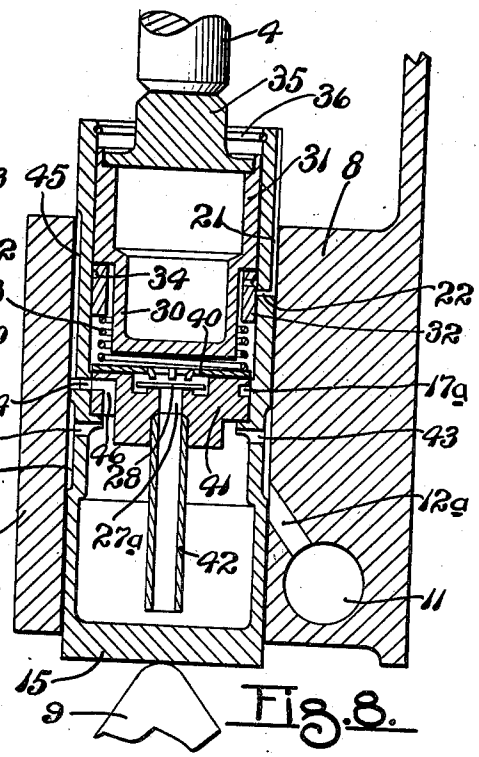


Fig. 8.

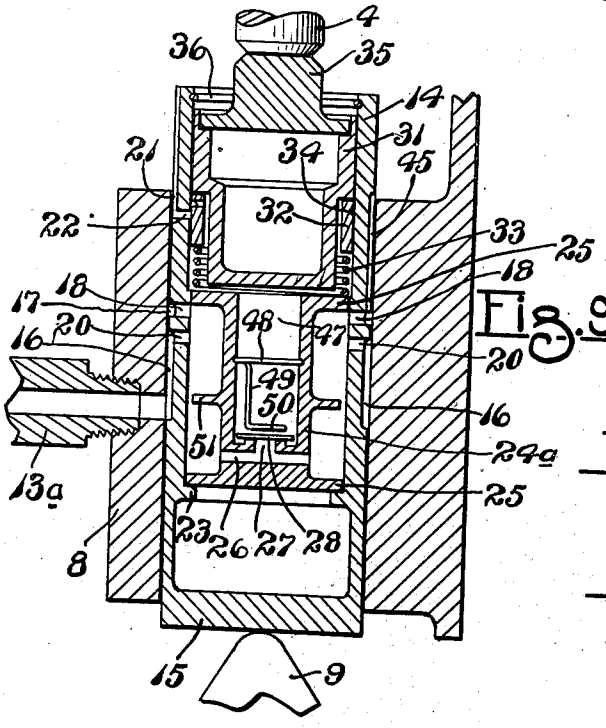


Fig. 9.

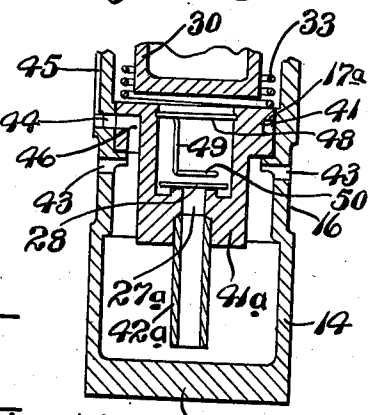


Fig. 10.

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UNITED STATES PATENT OFFICE

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HYDRAULIC TAPPET

Charles E. Johnson, North Muskegon, Mich.

Application January 25, 1937, Serial No. 122,234

8 Claims. (Cl. 123—90)

This invention relates to self-adjusting valve tappets of the hydraulic type for internal combustion engines. I have heretofore obtained United States Letters Patent No. 2,006,641, dated July 2, 1935, which was reissued as Reissue Patent No. 19,761, on November 19, 1935. I have also pending an application for patent, Ser. No. 104,086 filed October 5, 1936, for Hydraulic tappet, issued August 24, 1937 as Patent No. 2,090,795. In both this issued patent and the pending application means are provided for the quick elimination of air from the oil which is held or trapped in the tappet body and which is put under pressure when the valve is lifted and the valve spring compressed, so that with respect to such trapped body or quantity of oil a rapid elimination of any air therein is attained, thus providing an incompressible liquid body of oil and eliminating any emulsion or mixture of oil and air which would be more or less compressible, dependent upon the quantity of air contained in the oil.

In the operation of hydraulic valve tappets in internal combustion engines, the oil in most cases is supplied to the tappets by conducting and forcing it into the tappet body by the oil pump of the engine. When the engine is stopped, there may occur in one or more of the tappets, a return of the oil back through the oil pump with the consequence that the oil carrying conduits which lead to the tappets may become wholly or partly filled with air. Then when the engine is restarted and the oil again pumped by the engine oil pump, there is carried to the tappets and eventually into the chamber of the tappet where the oil is placed under pressure a considerable quantity of air with the oil whereby the working out and elimination of air from the trapped and pressure subjected oil takes a greater time than is desirable; though even under such a condition the air will work out in a relatively short time but which may amount to a few minutes in length. It is very desirable that the clicking noises, which occur when there is the presence of a proportion of air in the trapped oil which is subject to the pressure of the valve spring, shall not take place for even such length of time as a very few minutes.

One object of my invention is to provide a valve tappet structure wherein there may be a substantial removal and elimination of air from the oil coming to the valve tappets before it reaches the chamber where it is subjected to the pressure stated. By doing this and then having the valve tappet further embody the invention first shown in my reissue patent, No. 19,761, so as to quickly eliminate such small quantity of air as may be carried to the pressure chamber within the tappet body, a substantially complete and very practical air elimination is secured such that after starting the engine there are no tappet noises.

In my copending application, Ser. No. 104,086 previously noted, there has been provided a valve tappet structure of a particularly simple and effective design for quantity production. My invention also has for a further object and purpose a change in the structure of the tappet in such previously filed application so that the initial air elimination above noted is obtained, and at the same time all of the advantages of rapid quantity production of the tappet structure are retained.

These and many other objects and purposes will be understood from the following description, taken in connection with the accompanying drawings, in which

Fig. 1 is a vertical section illustrating the valve tappet of my invention in its relation to the ordinary poppet valve used almost universally in internal combustion motor vehicle engines.

Fig. 2 is an enlarged central vertical section through the tappet and the adjacent guide therefor.

Figs. 3, 4, 5 and 6 are horizontal sections taken respectively on the planes of lines 3—3, 4—4, 5—5 and 6—6 of Fig. 2, the sections being taken looking in the directions indicated by the arrows.

Figs. 7, 8 and 9 are central vertical sections, similar to Fig. 2, showing different modifications of structure but all embodying the invention, and

Fig. 10 is a fragmentary vertical section of the lower part of a tappet similar to the tappet shown in Fig. 8, but with some variations in structure.

Like reference characters refer to like parts in the different figures of the drawings.

In Fig. 1 a wall 1 of an engine cylinder is shown with a port 2 for entrance of either fuel mixture or escape of exhaust gases, with a valve 3 of conventional structure associated with the upper end of the port, which valve is lifted from the closed position shown, by the movement of a cam associated therewith which is rotatable with a cam shaft upon which it is mounted. The valve 3 has a downwardly extending vertical stem 4 passing through a guide sleeve 5, and the valve is normally moved in a downward direction by a relatively heavy coiled spring 6, the lower end of which is carried on a valve supporting member 7 in turn mounted on the valve stem in the usual manner, the upper end bearing against the sleeve 5 so that any upward movement of the valve and valve stem compresses spring 6.

The lower end of the valve stem 4 is engaged by the upper end of a tappet to which the present invention is directed. The tappet is mounted for vertical movements in a guide block 8. The tappet, in an internal combustion engine, rests at its lower end against a cam 9, there being

a plurality of such cams on the cam shaft 10 which is rotated continuously in the operation of the engine in timed relation to the rotation of the engine crank shaft and to the movements of the engine pistons.

With my invention oil to be supplied to the hydraulic tappets is preferably carried in a horizontal conduit 11 which runs through the tappet guide block 8 in which a plurality of tappets are mounted. Leads 12 extend from said conduit laterally to the several tappets. The oil may be carried through a pipe 13 to the conduit 11 being under a pressure produced by the engine oil pump. In the construction of the tappet a cylindrical hollow body 14 is provided having a closed bottom 15, the underside of which rests against a cam 9 with which it is associated. A relatively wide and shallow groove 16 is made around the body 14 at a position and of such a width that when the tappet has been raised to its uppermost position, that is, with the cam 9 having its high point against the bottom 15 of the body, the lead 12 communicates with the lowermost portion of the groove 16, and in the reciprocations of the tappets such lead 12 is within the limits of the groove 16 at any position that the tappet may occupy. Therefore, there is a continuous supply of oil to fill the space provided by the groove 16 around the tappet body and between it and the guide 8 in which it moves.

A short distance above the upper limit of the groove 16 a second narrow groove 17 is cut continuously around the body being spaced from the groove 16 by the annular rib shown. An opening 18 is made through the wall of the tappet leading to said groove. Through a wall of the guide 8, a passage 19 is made at a location such that when the tappet is raised to its uppermost position (Fig. 2) communication is made between the groove 17 and the passage 19. A second opening 20 is made through the wall of the tappet at the upper end of the groove 16. While one opening 18 and one opening 20 are shown, it is evident that a plurality of such openings 18 or 20 all in the same horizontal planes may be made, the first openings being in communication with the upper narrow groove 17 and the latter openings in communication with the upper portions of the wide groove 16. Also, in the outside of the tappet body a narrow vertical groove 21 is cut joining at its lower end with an opening 22 made through the wall of the body as shown in Fig. 2, and extending to the top of the tappet.

A horizontal inwardly extending annular ledge 23 is provided integral with the tappet body 14 above which a valve carrying plug 24 is located. This plug in outer form is of substantially spool shape, having a continuous annular flange 25 at each end, the diameter of these flanges being such that the plug is received with a press fit in the body 14, thereby providing a continuous annular chamber between the walls of the body 14, the extending flanges 25 and the central or body portion of the plug 24. A transverse passage 26 is drilled or otherwise provided through the plug 24 immediately above the upper side of the lower flange 25. A central vertical passage 27 connects at its lower end with the horizontal passage 26 and at its upper end with a valve chamber which is made as a downwardly extending cylindrical opening in the upper end of the plug 24. A flat metal plate valve 28 is seated in the lower part of the valve chamber over the upper end of the vertical passage 27, against which a relatively light coiled spring 29 bears at its lower end. The upper end of the spring 29 surrounds a downwardly projecting boss made on the lower end of a reduced portion 30 of a piston 31 which is slidably received in the upper part of the tappet body 14. A split ring 32 surrounds the smaller diameter portion 30 of the piston and is of a size such that it bears snugly against the walls of the tappet body and there is a space between its inner curved side and the part 30 of the piston. At its upper end it is pressed against the shoulder provided between the larger and smaller parts 31 and 30 of the piston, being held thereagainst by a relatively heavy coiled spring 33, the upper end of which bears against the lower end of the split ring 32 and the lower end against the upper flange 25 of the plug 24. The split ring 32 has a small continuous groove 34 around it at its outer curved side and near its upper end (connected by a hole with the space between the ring and piston 30) and in a position such that when the piston is forced down so that the lower end of the part 30 strikes against the upper flange 25 said groove will be in communication with the opening 22 previously described. The piston is of a hollow construction for purposes of reducing weight, is integrally closed at its lower end and has its open upper end closed by a cap 35 having a vertical projection which comes against the lower end of the valve stem 4. A split spring wire snap ring 36 seats in a groove near the upper end and at the inner side of the tappet body 14 for releasably preventing the outward movement of the piston beyond a predetermined position.

With this construction, the chamber which is above the valve 28 and which is below and around the reduced end portion 30 of the piston will be filled with oil. In case air should enter this chamber and be mixed with the oil, air being compressible, the force of the valve spring 6 transmitted to the piston 31 may cause the same to move downwardly so that the lower end of the piston part 30 abuts against the upper end of the plug 24. The air in oil, being lighter than the oil, tends to move upwardly and will pass through the hole leading through the ring 32 into the groove 34, and when the groove comes into conjunction with the opening 22 in the tappet body such air will pass outwardly through said opening and escape through the groove 21. After the reciprocation of the tappet has occurred a few times the oil which is trapped in said chamber above the valve 28 will be free of air.

The air which comes in with the oil into the annular chamber around the central body of the plug 24 and between the upper and lower flanges 25 likewise will tend to separate by rising in said chamber and pass outwardly through the opening or openings 18 to the groove 17 and thence out through the passage 19 at the time that the tappet body reaches its uppermost position as shown in Fig. 2. The oil, passing to the chamber above valve 28, has to enter through the passage at 26, and there will be very little likelihood that any quantity of air will reach such passage because the air will, as previously stated, tend to separate and move upwardly and be eliminated from the tappet by passage outwardly through the opening or openings 18, groove 17 and passage 19.

It will further be apparent that when the engine is at rest, and should oil in the groove 16, the lead

12, conduit 11 and pipe 13 run back either in whole or part, nevertheless the upper level of the oil around the central portion of the plug 24 will not be lowered below the opening 20. Therefore, for resupplying oil to the chamber above valve 28 for that which escapes by seepage or to take the place of air which may be eliminated and pass outwardly through the passage at 21, there will be an amply sufficient body of air-free oil for this purpose during the first part of the engine operation after it has been restarted. Further, such body of oil below the openings 20 will not be entirely consumed before other oil has been pumped thereinto irrespective of how much the oil may be drained back out of the pipe 13, conduit 11, leads 12 and the groove 16, when the engine is at rest. Accordingly, with a tappet made of the construction described, there will be little possibility of air ever reaching the chamber above the valve 28.

In Fig. 7, horizontal and vertical passages 37 and 38, joining each other and with the inner end of the horizontal passage connecting with the upper end of the groove 16 when the tappet body is in uppermost position, are provided for the initial escape of air before it goes past the valve 28. The plug 39 is of the same type and character shown in the copending application, Ser. No. 104,086. In such structure there is no light spring similar to the spring 29 in Fig. 2 between the lower end of the piston and the valve 28 to hold the valve against too great an upward movement, but a plate 40 is laid upon the plug 39 between the plug and the spring 33, said plate having a central opening with downwardly extending fingers which prevent too great an upward movement of the valve 28. In this construction the initial separation of air from the oil is not quite so effective as it is in the construction shown in Fig. 2; nevertheless there is a relatively large initial air elimination before the oil has passed to the valve 28.

In Fig. 8 the plug 41, which takes the place of the plug 39 in Fig. 7 and the plug 24 in Fig. 2, has a central opening 27a therethrough at the upper end of which the valve 28 is located. A tube 42 having a vertical passage in alinement with the passage 27a extends nearly to the lower end of the tappet body 14. The passage of oil from the conduit 11, through the lead 12a and to the groove 16 and thence into the tappet body, is through openings 43 located below the plug 41 so that the tappet body 14 at all times carries a considerable reservoir of oil, such oil not receding to a level below the lower side of the openings 43 when the engine is stopped. There is a groove 17a around the plug 41 a short distance below its upper side which communicates with a passage 44 through the wall of the body 14, which passage at its outer end connects with a vertical groove 45 in the body 14, the upper end of which comes just above the upper end of the tappet guide 8 when the tappet has been lifted to its uppermost position. Further, there is a passage 46 leading from the lower side of the plug body into the groove 17a whereby, when mixed air and oil are conducted into said reservoir for oil, the major portion of air initially separates, rises, passes through the passage 46 and eventually out through the groove 45. The elimination of the air from that part of the oil which is trapped between the valve 28 and the piston is effected in the same manner through the groove 21, passage 22 and the groove 34 as it is in the structure shown in Fig. 2.

In Fig. 9 the structure shown is very much like that illustrated in Fig. 2. The plug 24a, corresponding with the plug 24 in Fig. 2, has the same upper and lower flanges 25, the openings 18 and 20, the groove 17 and the passage 26 are the same. The valve chamber is considerably enlarged and elongated in a downward direction so that the vertical passage 27 is decreased in length and the valve 28 is located a considerable distance below the level of the oil carried in the reservoir around the central part of the plug 24a, and which oil level does not normally get below the lower side of the openings 20. The retention of the valve 28 in its lower position in this structure is through the medium of a split wire spring ring 48 inserted in the elongated recess 47 in the plug 24a, one end of the ring extending vertically downward as at 49 and terminating in a second ring 50 of smaller diameter and located horizontally a short distance over the valve 28. The elimination and escape of the air is substantially the same as in Fig. 2, except that the passage for the outer escape of the air initially entered into the tappet body is through the vertical groove 45 communicating with the groove 17 instead of the horizontal passage 19 as shown in Fig. 2.

The middle portion of the spool-like body 24a carries an annular fin or flange 51, the edges of which are spaced a very short distance from the adjacent inner wall of the tappet body 14, in practice approximately $\frac{1}{32}$ of an inch. This permits the oil, which enters through the openings 20 to flow downwardly and go to the passage 26, but will tend to obstruct any large bubbles of air moving in a downwardly direction, thereby additionally safeguarding against any excess amount of air coming to and passing by the valve 28.

In Fig. 10 the plug 41a is similar to that shown at 41 in Fig. 8. The passages 43 for oil entrance below the plug are the same as in Fig. 8. The plug has a central relatively long downward extension to which a shorter tube 42a is secured, and with this structure the chamber in which the valve is located is of greater length and extends downwardly to a lower position so that the valve 28 is positioned lower than in Fig. 8 and below the horizontal plane of the oil entrance openings 43. The same valve retaining member, having the parts 48, 49 and 50, that is shown in Fig. 9, is used herein. The escape of air from the reservoir of oil is through the passage 46, groove 17a and groove 45 as in Fig. 8.

The constructions of valve tappets described are all of particular utility in perfecting air elimination and escape from the oil which is used in the hydraulic, automatic adjustment of the tappets with relation to the valve stems 4 with which they are associated. The presence of air in the oil has been a very detrimental factor in conjunction with hydraulic valve tappet adjustment. That such air may work out eventually in hydraulic tappets is not the answer to the problem as in a practical tappet of this type, and one that manufacturers will adopt and with which the motor using public will be satisfied, the air should be eliminated very quickly so as to avoid the very undesirable clicking and other knocking noises present in tappets when there is air mixed with the oil. As previously stated my early patent eliminated air in one part of the tappet very satisfactorily and improved hydraulic tappets to that extent. The present invention eliminates the air which is substantially inevitable as coming with the oil to one or more

of the tappets when an engine is started after it has had a period of rest and wherein the oil pumped by the engine oil pump has run back, leaving the oil carrying conduits and passages either wholly or partly filled with air.

Furthermore, with this invention the tappet structure is one which lends itself admirably to large quantity production methods of manufacture for the building of tappets at low cost. All of the parts are easily machined and very quickly assembled at a minimum of cost for devices of this character.

The invention is defined in the appended claims and is to be considered comprehensive of all forms of structure coming within their scope.

I claim:

1. A valve tappet of the class described comprising, a hollow cylindrical tappet body closed at its lower end and having an inwardly extending stop within the same above its lower end, a plug of substantially spool-like form with a central portion and an annular flange at each end located within said body, one flange bearing against said stop, said plug from its upper end downwardly having a longitudinal centrally disposed elongated opening therein and below said opening having a passage leading to said opening from a side of the plug, a valve in the bottom of said opening covering said passage, a piston mounted within the tappet body above the plug, said tappet body having an oil passage opening in the wall thereof for passage of oil into the space enclosed between the plug and the adjacent walls of the tappet body.

2. In combination, a hollow tappet body having a closed lower end, a plug of spool-like form having a press fit in said body and located between the ends and within the body, said plug having upper and lower flanges and also having an oil passage therethrough from a point adjacent the lower flange upwardly through the central part of the plug, a valve located within said plug across the oil passage, and means for carrying oil into the tappet body member into the space around said plug and between the upper and lower flanges thereof.

3. A hollow tappet body of substantially cylindrical form closed at its lower end, a spool-like plug having a press fit into said body between the ends thereof, said plug having annular flanges one at each end and an intermediate portion of a diameter less than the diameter of said flanges, said intermediate portion being provided with a downwardly extending opening or recess therein and with a vertical passage extending from said recess nearly to the lower flange and with a horizontal passage connected with said vertical passage and located above said lower flange, a valve within said recess closing the upper end of the vertical passage, means for admitting oil through a wall of a tappet into the annular space around the plug and between the flanges thereof, said oil admission being near but below the upper end of said space, means located above said oil inlet for venting air coming in to said annular space with said oil, said air normally rising above said oil to said air venting means, and a piston above said plug within said tappet body between which and said valve oil passing above the valve is retained.

4. A hollow substantially cylindrical valve tappet having a closed lower end, a spool-like plug within the tappet body having an intermediate portion of reduced diameter and a flange at each end of a larger diameter, both flanges being of a diameter to press fit within the tappet body, there being provided an annular oil receiving chamber around the intermediate portion of the plug and between said flanges, said tappet body having openings through the walls thereof, the first of said openings communicating with the extreme upper portion of said chamber and the other of said openings located a short distance below said first opening, means for carrying oil into said chamber through the lowermost of said openings, and means for the escape of air from said chamber through the uppermost of said openings, as and for the purposes described.

5. A valve tappet of the class described comprising, a hollow tappet body member having a closed lower end, a plug having a press fit located within said body member a distance above the lower end thereof, said plug having an oil passage therethrough, a piston mounted for vertical movements within the body member above said plug, a valve disposed across said passage below the piston, means for carrying oil to and within the tappet body member and to the passage through said plug, a guide for said tappet body in which it is mounted for vertical reciprocating movements, means for effecting a separation of air from the oil before the same passes by said valve, means for separating air from oil located between said valve and piston, the separation of air from the oil before it reaches the valve and also from the oil located between the valve and piston occurring when the tappet body has been lifted to its uppermost position in the tappet guide.

6. A valve tappet of the class described comprising a hollow tappet body having a closed lower end and an annular inwardly extending stop therein, a plug having a central portion and an annular flange at each end located within said body, said plug having a longitudinal opening therein and a passage leading to the bottom of said opening from a side of said plug, a valve in the bottom of said opening covering said passage and a valve retainer in said opening above the valve whereby a limited upward movement of the valve is permitted.

7. A valve tappet of the class described comprising a hollow tappet body having an inwardly extending stop therein, a plug having a central portion and an annular flange at each end and an outwardly extending annular vane between said flanges around said central portion, said stop supporting one of said flanges, a longitudinal opening in said plug, a passageway leading to said opening from a side of said plug, a valve in the bottom of said opening covering said passage, a piston mounted within said tappet body above the plug, said tappet body having an oil passage opening in the wall thereof for passage of oil into the space enclosed between the plug and the adjacent walls of the tappet body.

8. A hollow valve tappet having a closed lower end, a plug within the tappet body, an annular flange at each end of said plug and an annular fin extending from the intermediate portion of the plug at a point between the end flanges thereof, an annular oil receiving chamber around the intermediate portion of the plug and between said flanges, said tappet body having upper and lower openings in the walls thereof, and means for carrying oil into said chamber through the lowermost of said openings.

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