Aug. 27, 1957 P. F. BERGMANN 2,804,060

SELF-CONTAINED HYDRAULIC TAPPET

Filed Nov. 22, 1954

FIG. 1

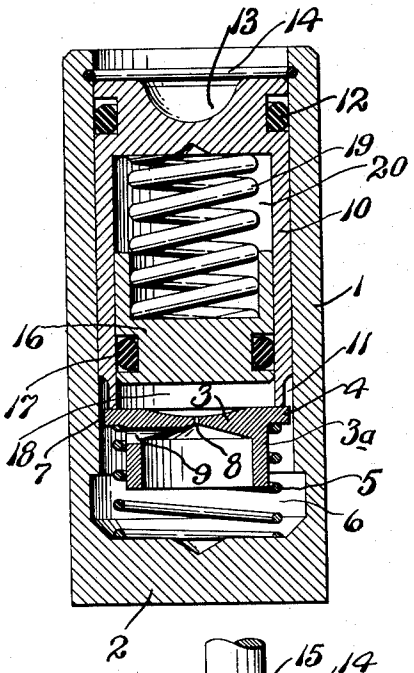
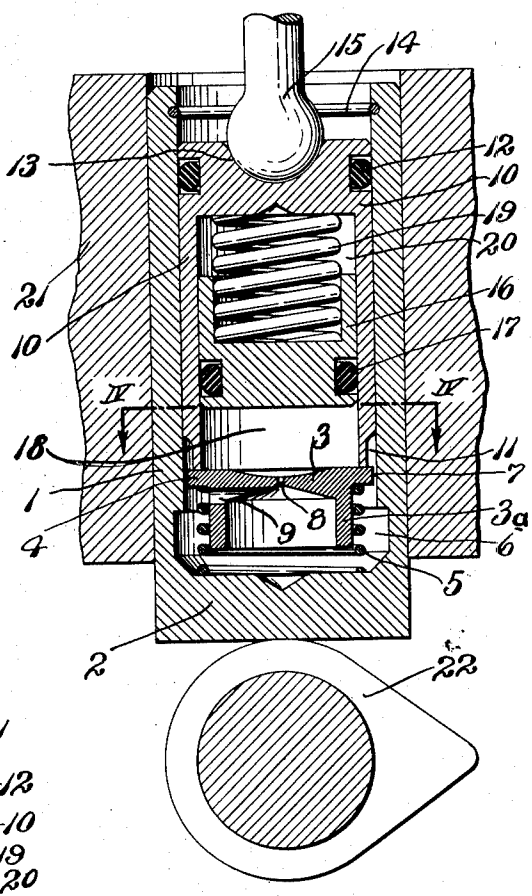


FIG. 2



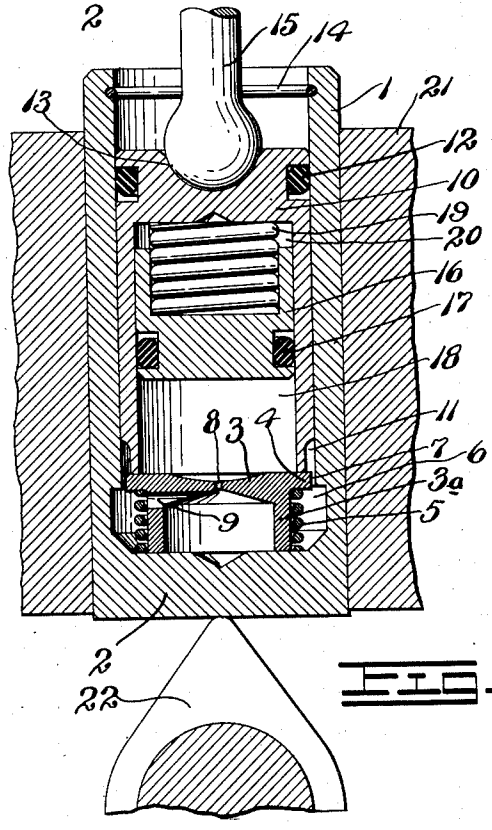


FIG. 4

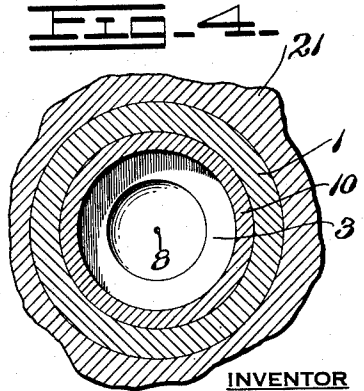


FIG. 3

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SELF-CONTAINED HYDRAULIC TAPPET

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7 Claims. (Cl. 123—90)

The present invention relates to hydraulic tappets for internal combustion engines, which tappets are self-adjusting and carry within the body of the tappet a fixed quantity of hydraulic liquid. It is a primary object and purpose of the present invention to provide a practical, economical and simple hydraulic tappet, the liquid which is used being placed within the tappet when it is assembled, and which does not need to be replenished or replaced during the life of the engine.

The present tappet of my invention, differing from hydraulic tappets wherein the oil is continuously supplied from the lubricating system of the engine, does not require that the guides for the moving tappets have oil conducting passages leading thereto to supply them with oil from the engine lubricating system under pressure.

With the hydraulic tappets in general use today, it is necessary to use whatever oil may be in the engine at whatever condition the oil may be, and dirty or deteriorated oil frequently causes hydraulic tappet failures. In the present invention the lubricating oil of the engine is of no importance with relation to the tappets, their operation and functioning.

One feature of the present invention is that the hydraulic liquid which is used is a silicone oil, or silicone fluid. This is a synthetic oil which has certan propertes partcularly suitable for use in a hydraulic tappet. For one thing, the viscosity is almost uniform from the low temperatures encountered in our northern climate to the high temperatures to which oil is subjected in an internal combustion engine. While there is some change in viscosity over this range of temperature, it is so much less than the variation in viscosity of petroleum oil over the same temperature range, that the problem of metering the "leak-by" of oil from the pressure chamber to the reservoir chamber of a hydraulic tappet is much simplified. Furthermore, this fluid does not carbonize or decompose at high temperatures, does not evaporate and produce gases under the action of high temperatures or lowering of pressure. In other words, it is intended to use a high quality oil in the tappet, that retains its good properties almost permanently.

An understanding of the invention may be had from the following description taken in connection with the accompanying drawing, in which,

Fig. 1 is a central vertical longitudinal section through a tappet made in accordance with my invention as it is assembled and before installation.

Fig. 2 is a similar section showing the tappet in operating position as installed in the engine and with its lower end bearing against an actuating cam.

Fig. 3 is a view like that shown in Fig. 2 showing the collapsed position of the tappet which occurs when the engine is stopped with the actuating cam for the tappet at its extreme "up" position, and

Fig. 4 is a fragmentary transverse section substantially on the plane of line IV—IV of Fig. 2 looking downwardly.

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

In a preferred structural embodiment of my invention, a tappet body **1** of cylindrical form is provided bored downwardly from its upper end but short of the lower end thereof, the lower end of the body having a closed end **2**. Within the body and at the lower portion thereof is a spring actuated valve **3** of the form shown having a horizontal top and a depending cylindrical skirt **3***a*, the top at its edges extending outwardly beyond the skirt **3***a*, providing a continuous annular flange **4** as shown. A coiled compression spring **5** at its lower end seats against the bottom **2** of the tappet and at its upper end is against the under side of the flange **4**. The spring **5** is of a relatively light strength and may approximate four pounds. There is thus provided between the valve **3** and the bottom of the tappet a chamber **6**. Such chamber is not closed at its upper portions, there being a narrow annular space **7** between the peripheral edges of the flanges **4** and the walls **1** of the tappet body. Also centrally of the top of the valve **3** a vertical opening **8** of restricted size is made. There is also a conducting passage **9** made through the depending skirt **3***a* of the valve **3** immediately below the top of the valve as shown in Figs. 1 to 3 inclusive, such passage connecting the space surrounded by the depending wall or skirt *3a* of the tappet **3** with the upper portion of the chamber **6**.

Within the upper portion of the tappet body **1** an outer piston is mounted for up and down movements having a closed upper end or head and a relatively long cylindrical depending skirt as shown, the lower end of which serves as a valve seat for the upper side of the flange **4** of valve **3**. The lower end portion of the skirt is reduced exteriorly in diameter providing an annular space at **11** around its lower portion. Adjacent the upper closed end of the outer piston **10** an annular groove is made in which a sealing ring **12** of silicone rubber is located which snugly engages the bottom of the groove and the inner side of the vertical wall of the tappet body **1** to provide a secure seal against upward passage of the oil which is used in the tappet. A silicone rubber seal is used because it is a material that is most resistant to the effects of heat and oil, thus providing an effective seal for a long period of time.

The upper end of the piston **10** has a generally semi-spherical recess **13** therein to receive the lower rounded end of a push rod **15**, which actuates the usual rocker arm, and in turn, the engine valve, of an overhead valve engine. A retaining split ring of spring wire material, as at **14**, seats in an interior horizontal groove of the wall of the tappet body **1** to limit the upward movement of the piston **10**, and hold the assembly together.

An inner piston **16** is within the outer piston **10**, having reciprocating movements within the depending skirt thereof. It has a lower head and an upwardly extending cylindrical skirt. In the lower head an annular groove is made and a second sealing ring **17** of silicone rubber is therein to make a seal between the chamber at **18** which is between the lower end of the head of the piston **16** and the upper side of the valve **3**.

A heavy coiled compression spring **19** has its lower end portion received within the upwardly extending skirt of the piston **16**, at its upper end bearing against the under side of the head of the piston **10**. Such heavy spring, of approximately fifteen pounds weight under compression, when the tappet is in operation, has a tendency to force the inner piston **16** in a downward direction. The chamber **20** within which the spring **19** is located has air therein.

In assembling the tappet, the body **1** is partially filled with silicone oil sufficient that it will fill the chambers

6 and 18. The valve 3 with the spring 5 thereon is dropped into the body. The air trapped under the valve 3 will escape upwardly through holes 8 and 9, after a short time. The piston 16 is assembled into piston 10 before the latter is put into the tappet body, and they will be located with reference to each other such that the lower side of the head of the piston 16 will reach to and project slightly beyond the lower open end of the skirt of piston 10. When this piston assembly is put into the body 1, air is forced out of the body. When the lower face of inner piston 16 reaches the top surface of the oil, any air remaining in the body is in the annular space 11, from where it can be forced out past the piston 10. It is important that all of the air be removed from the oil chamber and if necessary, this can be done by creating a vacuum above the tappet to suck out the last traces of air. After this is done, and with the lower face of piston 16 on the oil, any further downward movement of piston 10 causes a relative upward movement of piston 16, and compression of spring 19, to provide room for oil moving from chamber 6, through hole 8, into chamber 18. The air in chamber 20 is also compressed slightly by the upward movement of piston 16.

When the outer piston 10 is forced downwardly a sufficient distance to bring its top surface below the groove that receives locking ring 14, the ring is put into position and the assembly is completed.

The assembled tapped, as shown in Fig. 1, is installed in an engine, and arranged for reciprocation in a bored hole in the block, fragmentarily indicated at 21 in Fig. 2. The lower end of the engine push rod 15 is seated in the seat 13, and the base 2 of the tappet body 1 rides against the engine cam 22 below it, which, upon rotation of the shaft raises and lowers the tappet, thereby opening and closing the engine valve, through the action of the push rod and rocker arm. In opening the valve, the engine valve spring associated with the valve exerts a pressure of 100 pounds or more through the push rod 15 to the tappet. This force against piston 10 causes it to move downward, but only a small amount because of the rapid rotation of the camshaft, which may vary from 200 R. P. M. at idle speed to 2000 R. P. M. at fast speed. Downward movement of the piston 10 is controlled by the amount of oil that can pass through small hole 8 during the short interval of time the cam is in the "up" position.

When the cam is lowered, permitting the engine valve to close, there is no longer any pressure downwardly against piston 10; in fact, due to the passage of oil through hole 8 while the cam was up, there is now a slight clearance between the socket 13 and push rod 16. Under this condition, spring 19 expands and takes up this clearance by pushing outer piston 10 upward and inner piston 16 downward. The downward movement of piston 16 causes valve 3 to separate from its seat, thus permitting oil to flow quickly from chamber 18 back to chamber 6. When the pressures are substantially equalized, spring 5 forces valve 3 against the seat, and the tappet is again ready for the next lifting of the cam. The transfer of oil from chamber 6 to chamber 18 through small hole 8, during the lifting of the cams, is very small in amount; the downward movement of piston 10 during this cycle might range from .001" to .008" depending on the temperature of the engine and the speed at which the engine is running. This slight leakage of oil prevents the engine valve from being held open as the various parts of the engine increase in temperature and consequently in size, in running an engine from cold to maximum operating temperature.

When an engine is stopped, certain cams on the camshaft come to rest in the "up" position, or partially so. Such a condition is shown in Fig. 3. When this happens, the tappet on that cam stops with the engine valve spring pressure steadily forcing the piston 10 downward. As oil leaks through the small opening 8 from chamber

6 to chamber 18, due to the steady pressure of the valve spring, piston 10 and valve 3 are forced to the bottom of the tappet body, to the position shown in Fig. 3. To provide room for the oil that was forced from chamber 6 to chamber 18, inner piston 16 is forced upward, further compressing spring 19, and the air between the two pistons. The silicone rings keep the oil from leaking past the pistons.

When the engine is started and the cam 22 turns to the "down" position, spring 19 quickly expands, keeping piston 10 in contact with the push rod, forcing the inner piston 16 downward, and causing the valve 3 to separate from the valve seat at the bottom of piston 10. This separation allows chamber 6 to be rapidly filled again, then spring 5 closes valve 3 against its seat.

During operation of the engine, any flow of oil through the passage 8 in either direction is minor and inconsequential in its effects, but at all times a balancing of pressures in the chambers 6 and 18 is substantially maintained.

The construction described is very practical and economical from both utility and production standpoints. The sealing rings 7 and 12, of silicone rubber, are durable, and are not dissolved or otherwise adversely affected by the heat of the engine, or by the silicone oil inside of the tappet, or the engine oil that might come in contact with it from the outside. By means of one piston sliding within the other, a constant volume of space is maintained for the fixed volume of oil contained in the tappet. The tappet is self-adjustable and eliminates tappet noises during engine operation.

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 hollow cylindrical tappet body open at its upper end and closed at its lower end, a valve within the lower portion of said body having a horizontal closed upper end and a downwardly extending annular skirt, said closed upper end having a generally centrally disposed restricted opening therethrough, a relatively light coiled compression spring between said valve and the closed end of said body, an outer piston within the body having an upper closed head and a depending cylindrical skirt extending to said valve, said valve being normally lifted by said spring to engage against the lower end of said skirt, an annular sealing ring between said piston and the tappet body, an inner piston within the skirt of the first piston having a lower closed head and an upwardly extending skirt, an annular sealing ring between the inner piston and skirt of said outer piston, and a relatively heavy coiled compression spring between the heads of said inner and outer pistons, said tappet body, from its closed lower end to the lower side of the head of said inner piston being filled with liquid, and the space between the heads of said pistons with air.

2. A hollow cylindrical tappet body open at its upper end and closed at its lower end, an outer piston within said body against the upper end of which an engine valve stem is adapted to pressure engage, an inner piston within and vertically movable with respect to the outer piston, spring means between said pistons tending to normally move the inner piston toward the inner end of said outer piston, sealing means between the outer piston and said tappet body, sealing means between the pistons, a horizontal valve within and across the tappet body at the inner end of the outer piston, said valve having a restricted passage therethrough from lower to upper side below the inner piston, spring means between the valve and closed end of said tappet body pressing said valve against the lower end of said outer piston, the lower portion of said tappet body below the inner piston being filled with liquid, and said valve at its edges being spaced a short distance from the inner sides of the tappet body.

3. Structure having the elements in combination de-

fined in claim 2, said outer piston at its lower end portion having reduced thickness to provide an annular space between the lower end of said piston and the tappet body, and said valve having downwardly extending support means adapted, at the lowermost position of the valve to rest against the closed end of said tappet body.

4. A hollow cylindrical tappet body open at its upper end and closed at its lower end, a piston movable within said body against the upper end of which an engine valve stem is adapted to pressure engage, a second piston within the first piston, a relatively strong compression spring between said pistons, said pistons being above the closed end of said body, the space between said pistons and closed end of the body being filled with liquid, and the space between the pistons with air, a spring actuated valve pressing upwardly against the lower end of the first piston dividing the liquid filled space into two chambers, said valve having a restricted liquid vent passage therethrough connecting said chambers, and sealing means operatively associated with each piston preventing passage of fluid past said pistons.

5. In a hydraulic tappet, a hollow tappet body, a piston located in said body against the upper end of which the lower end of an engine valve stem is adapted to bear, movable means within said piston closing an expansible and contractable air chamber therein in its upper portion, there being a liquid chamber between said means and the tappet body below said air chamber, spring means tending to move said means to expand the air chamber, a valve dividing the liquid chamber into two parts, one in the piston below the air chamber and closed by said valve and the other between the valve and the lower end of said tappet, spring in closed position normally holding the valve means against said piston, said valve having a restricted liquid control passage therethrough connecting the two divided parts of said liquid chamber, and means sealing

against escape of liquid or air from said liquid and air chambers.

6. Structure as defined in claim 5, said liquid within the tappet body being silicone oil having low viscosity change under temperature changes, and high stability under normal internal combustion engine conditions.

7. A valve tappet comprising, a hollow body closed at its lower end, a piston in said body against which an engine valve stem is adapted to engage at the upper end thereof, a second piston in the body between which and the first piston an air chamber is made and between the second piston and the lower end of the tappet body a liquid chamber is made, a compression spring between the pistons, a valve dividing the liquid chamber into upper and lower parts, said valve having a liquid metering passage of restricted area connecting the two parts of the liquid chamber, a compression spring of less strength than the first spring between said valve and the lower end of said body normally holding said valve against the lower end of said first piston, said first piston at its lower end reaching to and bearing against the upper side of the valve, and sealing means for preventing escape of air or liquid from said chambers.

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