HYDRAULIC VALVE LIFTER MECHANISM

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Broadly, this invention relates to hydraulic valve lifters, but more specifically, pertains to an improved plunger design and construction of a tappet mechanism which insures a longer tappet life and proper functioning of the elements thereof.

The fundamental objective of a hydraulic tappet of the type referred to herein is to compensate for operational wear and valve extension to consistently insure the proper engagement of the valve face with its corresponding seat. Coupled with this function is the additional feature of compensating for any excess lash or clearance in the valve gear train occurring as a result of the valve extension. To provide these features, a hydraulic tappet must be able to maintain a volume of fluid enclosed within a chamber formed by the plunger and the tappet body at a predetermined pressure for a sufficient length of time to adequately impart therethrough the reciprocating motion resulting from the rotation of a cam member in engagement with the tappet body. This reciprocating motion is in turn transferred to a pushrod, a rocker arm and finally, to the valve stem to open and close the engine valves at a predetermined rate. The valve train above set forth is merely illustrative of one type of valve actuating mechanism utilized in internal combustion engines and is referred to merely as an application for the concept presented herein.

Under normal operating temperatures, the valve stem expands tending to lengthen the overall gear train. The expansion, if not compensated for, will prevent the valve face from sealing and result in a power loss in the engine operation. To insure valve closing, the tappet is designed to relieve the pressure of the enclosed fluid by allowing a minimum amount of fluid to escape from the tappet body chamber into the passage existing between the plunger and the tappet body at a predetermined rate. This operation is referred to in the art as hydraulic tappet “leak down.” This rate must be effective to deliver the transmittal of force from the cam member to the valve body when the plunger is under compression from the valve spring and at a rate sufficient to prevent the plunger from collapsing within the tappet body. Therefore, the “leak down” rate of a typical unit determines the effectiveness of a tappet to compensate for valve expansion while fluid pressure and a return spring within the tappet body is effective to prevent the existence of excessive lash or clearance in the gear train.

It is essential therefore to provide maximum control over the rate of “leak down.” In normal tappet operation, the problem of wear and corrosion occurs between the plunger O.D. and the tappet body I.D. resulting in the decrease of “leak down” time to the point where the gear train operation is quite audible and the tappet is no longer able to adequately hold its pumped-up length under pressure. The effects of corrosion are even more severe in low temperature and intermittent low mileage type of engine operation where moisture in the crank case which has not been dissipated away with exhaust gases and gasoline are effective to create an acidic condition in the engine oil.

The selection of the material for the construction of a tappet of the type herein proposed is based upon consideration of wear resistance, machinability, and economical costs of production. The tappet body as set forth herein is formed from a cast iron alloy material which is wear resistant in order to withstand the constant engagement with the cam member of the valve gear train mechanism. This cast iron alloy is comparatively corrosion resistant but is a relatively expensive material.

The plunger member is formed from a case hardened steel which, being relatively inexpensive, is highly machinable in order to readily obtain the integral channels and close tolerance of its outside diameter portion but is not corrosion resistant. From an economical standpoint, use of a material which is not highly machinable but having corrosion and wear resistance is prohibitive in cost to remain in the tappet producing field and still be competitive. Such desirable materials are stainless steels, chromium, aluminum, nickel, or combinations of such metals or similar metals, and platinum which readily lend themselves to the plunger application and “leak facture the entire unit from any of these materials is too costly.

From extensive testing on standard material tappets and in view of the above material analysis, the effects of corrosion are readily found on the plunger member and the necessity of preventing these effects centers upon the formation of an inexpensive plunger member by utilizing a corrosion resistant material as a protective coating for the plunger member. The effects of corrosion by applying this coating can be controlled as well as reduce the overall tappet cost.

To satisfy the problem of selecting a usable material within the above desired range of properties, a plunger material of steel was utilized as the base metal and a coating of corrosion and wear resistant material placed on the outside diameter portion of the base metal. Material which can be readily adapted as a coating comprises anodized aluminum, diffused or electroplated to the base metal, ceramic material, nickel, chrome and others. The effects of corrosion and wear on the plunger member increases the clearance between the tappet body and plunger thereby reducing the effective restriction of the fluid flowing therethrough. Accordingly, with continued corrosion, the effects thereof are progressively increased on the plunger during tappet operation until the clearance between the members is expanded well beyond the predetermined amount and continues to increase ultimately reaching the point of tappet collapse. For example, testing of hydraulic lifters substantiates that diametral wear of .0008 inch resulting from the effects of corrosion on the plunger surface and the abrasive effect of this corroded material is sufficient to cause an unworked tappet assembly having a 100 second “leak down” time to become only one or two seconds after wear occurs.

Further, diametral wear of .0003 in a tappet utilizing standard materials is sufficient to reduce a high limit lifter in an unworn condition having a 45 second “leak down” time, based upon calculations made with kerosene as the lubricant, to approximately 7 seconds after this wear occurs. Thus in most valve gear train mechanisms where a minimum “leak down” time of greater than 10 seconds is required, an abnormal diametral wear occurs, the lifter will collapse permitting hard valve seating resulting in an audible gear train operation.

Therefore, it is a principal object of this invention to provide a hydraulic tappet plunger member outside lateral surface with a non-corrosive coating to resist the effects of corrosion from contaminants in lubricating oils and thereby prevent excessive “leak down” during engine operation.

It is another object of this invention to provide a hydraulic tappet plunger with a coating of corrosion resistant material whereby the overall cost of the tappet is not substantially increased by the novel improvement.
These and other objects of the invention will become more apparent from the following description taken in conjunction with the drawings forming a part of the specification and in which:

FIGURE 1 is a cross-sectional view of the hydraulic tappet.

FIGURE 2 is an enlarged cross-sectional view of the tappet body and plunger illustrating the coating of corrosion resistant material on the outside diameter surface of the plunger.

Referring directly to FIGURE 1 of the drawing, the hydraulic tappet mechanism 10 comprises a substantially tubular body member 12 having a closed end portion 14 thereon and an open end portion 16 remote therefrom. The closed end 14 of the body has a surface 18 thereon adaptable to engage a cam member 20 having a rise 22, a fall 24 and dwell 26 portion thereon rotatably fixed to a cam shaft 28. The tappet is responsive to the cam rotation which effects a reciprocating motion to the tappet imparting an axial force in the valve gear train operable to open and close an engine valve (not shown). The tappet is guided in this motion by the walls 30 of a bore 32 formed in the engine block 34. A hollow plunger member 35 main body portion 36 is receivable within the tappet body and is operable to reciprocably move therein responsive to fluid pressure exerted on the plunger member through the rotation of the cam 20.

The tappet body is internally constructed so as to have a pair of unequal diametered bores 38 and 40 forming a boss or shoulder 42 therewith. The boss 42 acts as a movement restricting means for the plunger member in a downward axial direction while the bore 38 has an annular recessed area 44 adaptable to receive a clip 46 thereon restricting axial movement of the plunger in an outward direction. At such time when one end of the plunger engages the boss 42, the tappet is said to be bottomed.

The plunger member main body portion 36 has a cap portion 48 receivable on one end thereof axially movable with the plunger and engageable with one end 50 of a push rod by a socket 52 formed therein. A portion of the push rod is shown in FIGURE 1 of the drawing. The cap and plunger walls define a reservoir 54 for hydraulic fluid whereby a passageway 56 is formed by an opening 58 in one end of the plunger member remote from the cap 48. The passageway 56 connects the reservoir 54 with a high pressure chamber 60 formed between the end portion of the plunger and the tappet body.

A check valve housing 62 is mounted on the plunger and extends into the high pressure chamber 60. A compression spring 64 is disposed in the chamber 60 in engagement with a flange 66 of the cup-shaped valve housing and the tappet body 72 effective to resiliently urge the housing and the plunger axially outwardly from the closed end of the tappet body.

Within the check valve housing 62 and sealed against an annular boss 68 surrounding the opening 58 forming the passageway 56, is a check valve 70 which is the form of a disc. A biasing leaf spring 72 formed from the valve housing 62 is in engagement with the disc and is operable to maintain the valve in engagement with the boss in a seated position. The formation of the spring 72 leaves an opening 74 in the valve housing further communicating fluid from chamber 54 with high pressure chamber 60.

The bottoming of the plunger onto the boss 42 of the tappet body maintains the valve housing 72 in a spaced relation to the end 34 of the tappet body preventing damage to the valve housing and obstruction of the opening 74 in the valve housing 62.

Hydraulic fluid such as lubricating oil for the engine under pressure is received by the tappet through an inlet port 76 located in the tappet body and a relieved annular area 78 formed on the inside diameter of the body. A similar relieved annular area 80 is formed in the outside diameter of the plunger and communicates with a port 82 extending through the plunger wall portion to further communicate chamber 54 with the inlet port 76 and the corresponding supply of hydraulic fluid.

The fluid pressure is sufficient to overcome the force of spring 72 and opens the check valve 70 to allow communication with high pressure chamber 60. This occurs when the closed end of the tappet body is riding the dwell portion 26 of the cam 20. As the high pressure chamber is supplied with fluid and with the aid of the compression spring 64, the plunger is axially moved in the bore 38 of the tappet body until excess lash or clearance in the valve gear train is completely eliminated, thus providing the valve stem extension compensating feature.

On the rise portion of the cam, the non-compressible fluid in the high pressure chamber effectively transfers the reciprocatory movement of the tappet body in the form of a thrust motion imparted to the tappet through the plunger to the push rod and thus to the valve itself, opening same for engine operating purposes. During each thrust movement of the tappet, a small quantity of fluid escapes from the high pressure chamber 60 and passes between the plunger main body portion 36 and the tappet body bore 38 back into the reservoir 54.

To control the passage of fluid between the plunger and body bore 54, the dimensional relationship between the outside diameter of the plunger and the inside diameter of the tappet body bore must be maintained constant. In intermittent low mileage type of service of an engine utilizing hydraulic tappets, the lubrication oil becomes contaminated causing an acidic condition therein affecting the outside diameter surface of the plunger member.

This acidic condition results in corrosion of the plunger surface whereby corrosion products act as an abrasive increasing the wear between these members. Increased wear correspondingly increases the size of the passage way between the tappet body bore and plunger thus increasing the oil flow from the high pressure chamber. The normal clearance between the tappet body bore and plunger member is .0005 inch or less. If clearance between these elements is increased to the same dimensional difference of .0008 inch, valve seating becomes increasingly audible and continued hard seating of the valve can lead to the destroying of the seat along with breakage of the valve itself.

To obviate this problem, a coating of chromium, the preferred embodiment of the invention, is deposited on the tappet outside diameter surface by any suitable method such as electroplating or diffusion of the chromium into the base metal.

FIGURE 2 is an enlarged cross-sectional view of the tappet mechanism illustrating a chromium coating material 84 on the outside diameter surface of the plunger member main body portion. This coating is preferably of a minimum thickness of approximately .00005 inch. The characteristics of chromium are most suitable for this specific embodiment of the invention in that chromium is a hard material which can readily withstand wear along with its corrosion resistant and protective properties.

While the invention has been described in connection with certain specific embodiments, the principle involved is capable of numerous other applications that would readily occur to persons skilled in the art. The invention, therefore, is limited only as indicated by the scope of the appended claims.

I claim:

1. A hydraulic tappet comprising a cast iron body member including a corrosion resistant tubular portion and a cam engageable wear resistant end portion, a steel plunger member having a main body portion and being reciprocably mounted in said body member and being subject to corrosion and wear relative to said body member, a fluid chamber formed between said body and
said plunger members, fluid in said chamber operable to impart a reciprocable movement to said plunger member under load, a predetermined clearance provided between said plunger and body members forming a passageway therebetween operable to allow a predetermined minimum of fluid flow therein from said chamber, said steel plunger main body portion having a wear and corrosion resistant chromium surface thereon forming a part of said passageway operable to maintain said predetermined clearance in said passageway and control said fluid flow therein.

2. A hydraulic tappet comprising a cast iron body member including a corrosion resistant tubular portion and a cam engageable wear resistant end portion, a steel plunger member having a main body portion and being reciprocably mounted in said body member and being subject to corrosion and wear relative to said body member, a fluid chamber formed between said body and said plunger members, fluid in said chamber operable to impart a reciprocable movement to said plunger member under load, a predetermined clearance provided between said plunger and body members forming a passageway therebetween operable to allow a predetermined minimum of fluid flow therein from said chamber, said steel plunger main body portion having a wear and corrosion resistant chrome surface thereon forming a part of said passageway and having approximately .00005 inch minimum thickness operable to maintain said predetermined clearance in said passageway and control said fluid flow therein.

3. A hydraulic tappet comprising a cast iron body member including a corrosion resistant tubular portion and a cam engageable wear resistant end portion, a steel plunger member having a main body portion and being reciprocably mounted in said body member and being subject to corrosion and wear relative to said body member, a fluid chamber formed between said body and said plunger members, fluid in said chamber operable to impart a reciprocable movement to said plunger member under load, a predetermined maximum clearance of approximately .0005 inch provided between said plunger and body members forming a passageway therebetween operable to allow a predetermined minimum of fluid flow therein from said chamber, said steel plunger main body portion having a wear and corrosion resistant chrome surface thereon forming a part of said passageway and having approximately .00005 inch minimum thickness operable to maintain said predetermined clearance in said passageway and control said fluid flow therein.

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