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2,570,854

SELF-ADJUSTING TAPPET FOR INTERNAL-COMBUSTION ENGINES

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This invention relates to a yielding spacer between two or more relatively movable impact members and more particularly to a spacer for motion transmitting devices, for example, in a valve operating means for engines, commonly referred to as "valve tappets" or dampening and slack adjusting devices such as shock absorbers, door checks or the like and is a continuation in part of my co-pending application, Ser. No. 44,620, filed August 17, 1948.

The invention primarily relates to improvements illustrated and described in United States Patent 2,120,384, issued to Jacob Wohlfeld June 14, 1938, wherein a yieldable clutching means is disclosed for use in the valve operating mechanism of an internal combustion engine to compensate for the variations in length of the valve stem caused by temperature changes and wear.

An object of the present invention is to provide a structure wherein the relatively movable parts are spaced by a confined, flowable material of viscous quality while loads are applied yet having resistance characteristics when sudden forces or stresses are applied to the material.

Another object of the invention is to provide means for permitting a restricted flow of material from one chamber of variable capacity to another chamber of variable capacity.

A further object of the invention is to provide a movable wall structure for intercommunicating chambers which will permit displacement of the contents of one chamber to the other chamber.

A still further object of the invention is to provide a movable wall structure, operable, in conjunction with intercommunicating chambers, so constructed and arranged that the material in one chamber will gradually displace the material in the other chamber to produce a slow circulation of the material from one chamber to the other.

Other objects and advantages of the invention will more fully appear from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a sectional view of a valve operating mechanism embodying my improved connection between a valve stem and a tappet of an internal combustion engine, parts being shown broken away and in elevation;

Fig. 2 is a cross sectional view taken on line 2-2 of Fig. 1;

Fig. 3 is a cross sectional view taken on line 3-3 of Fig. 1;

Fig. 4 is a cross sectional view of a modified form of my invention shown in Fig. 1;

Fig. 5 is a cross sectional view taken on line 5-5 of Fig. 4; and

Fig. 6 is a cross sectional view corresponding to Fig. 5 showing a modified form of the movable wall structure; and

Fig. 7 is a cross sectional view showing a further modification of the invention; and

Fig. 8 is a diagrammatic view in enlarged scale showing the cross sectional shape of the piston illustrated in Fig. 4.

In the drawings I have illustrated the invention as applied to the valve tappet of an internal combustion engine. The cylinder block 10 of the engine is provided with the usual combustion port 12 having a valve seat 14 engageable with the usual poppet valve 16. The valve stem 18 is slidably mounted in the block 10 and is urged to valve closing position by the compression spring 20 surrounding the valve stem 18 and bearing between the block 10 and a washer 22 held on the stem 18 by a key 24.

A tappet member 26 embodying my improved construction, is slidably mounted in the cylinder block 10, below and in axial alignment with the valve stem 18. The valve 16 and tappet 26 are periodically lifted by a cam 28 on a cam shaft 30.

In the operation of the valve mechanism the parts are elongated by heat and the valve 16 moves away from the cam, consequently not properly seating on the valve seat 14, unless sufficient clearance is provided between the bottom of the valve stem 18 and the top of the valve tappet 26. This clearance results in noisy operation of the parts as well as wearing, reducing the overall length of the parts.

The present invention is directed to a self-contained tappet which maintains a constant overall dimension for the moving parts irrespective of temperature or wear conditions.

The plunger body of the tappet 26 is formed as a cylinder having a tubular side wall 32 and a closed bottom portion 34; the upper end of the tube being open and the closed bottom 34 adapted to seat on the cam 28. A piston 36 is slidably mounted in the tubular portion 32 and has its inner end formed as an open cylinder 38. The outer closed end of the piston 36 bears against the free end of the valve stem 18.

The cylinder portion 39 fits over a piston head 40 for relative movement therewith. The outer surface of the piston head 40 is supported in spaced relation to the closed end of the cylinder portion 38 to provide a chamber A and the inner surface of the piston head 40 carries a stem 42 which supports the piston head 40 on the closed

end 34 of the tappet body 26. This stem carries a sliding piston 44 which fits the cylinder 38 in spaced relation to the inner surface of the piston head 40 providing a chamber B. A sealing disc 46, preferably of a pliable material, such as rubber or the like, is received on the top of the piston 44 to prevent leakage past the piston 44 and side walls of the cylinder 38. A guide sleeve 48, carried by a part of the piston 44, serves as a stop against a guide sleeve 50 at the closed end 34 of the tappet body 26. A compression spring 52 is arranged between the piston 44 and the guide sleeve 50 for urging the piston 44 toward the piston head 40 and closed end of the piston 36 to compress any material within the chambers A and B.

After tappet parts have been assembled, they are held in position by a spring ring 54 snapped into a groove in the inner periphery of the cylinder wall 32 and bearing against the outer surface of the piston 36. Thus, the tappet and its associated parts is a unitary assembly.

A vent 56 is provided in the tappet to permit displacement of the air below the piston 44 when the piston 44 is moved downwardly.

In the form of the invention shown in Fig. 1, I have shown the piston head 40 having a diameter of less dimension than the inner diameter of the cylinder 38 so that the two chambers A and B are inter-connected through the space between the piston head 40 and the cylinder 38. This space is predetermined and may be varied by changing relative diameters of the piston head and cylinder. The outer periphery of the piston head 40 is preferably tapered and converges toward the inner face of the piston head 40. The purpose of this will be more clearly understood from the following description of the material used in the chambers and the operation of the parts.

A predetermined quantity of a flowable material is placed in the chambers A and B at the opposite sides of the piston head 40. The material which I have selected as a suitable means is illustrated at 58. The material is commercially available on the market and is commonly known as "bouncing putty."

The material is a silicone elastic polymer compound and best can be described by reference to its characteristics. It is a material having marked cold flow characteristics. It is a high molecular weight polymer having long chain molecules. The material is highly resistant to sudden or quick changes of its shape, yet will flow when unconfined and given ample time. If the material is in mass form as a ball or confined in a chamber the long chain molecules are held to each other by attraction and resist with considerable force a sudden change in shape. If given more time the molecules tend to readjust themselves to a new shape requiring the least force between the chain molecules; for example, when the material is rolled into a ball it will rebound from a solid surface a distance approximately sixty to eighty percent of its dropped height, indicating a strong resistance to change in shape. If however, the ball is permitted to rest on the surface for a period of time, it will eventually flatten out into a thin sheet, indicating its ability to flow.

The material is a doughy, rubber-like compound free from vulcanizing agents and is uncured. Its properties are not materially affected by temperatures far above and below the serviceable limits of natural or synthetic organic rubbers. This material shows slight property

changes in temperatures ranging from approximately minus 75° F. to plus 450° F. It is therefore suitable for working temperatures in an internal combustion engine.

The plasticity of the material may be defined by A. S. T. M. 72 which is a measurement of depth in mils of a 4 gram sample after one minute using a Scott plasticity tester. Its rebound characteristic is approximately 23.5 inches measured by dropping a four gram ball thirty inches upon a steel plate. This is approximately 78 percent.

When the parts are assembled, the dough-like material is placed in the chambers A and B on opposite sides of the piston head 40 with the spring 52 having a load force on the piston 44 less than the load of the spring 20 on the valve 16. The cylinder 38 and stem 42 are then placed in the cylinder 32 and spring ring 54 positioned in the groove for locking the parts in assembled relation. The tappet assembly 26 is placed between the valve stem 18 and the cam 28. If there is any clearance between the lower end of the valve stem and the outer end of the piston 36, the spring 52 forces a portion of the material in chamber B around the piston head 40 into the chamber A. This raises the piston 36 into contact with the valve stem.

Sudden shock or a blow on the material, as caused by lifting the valve 16, will be transmitted through the material without appreciable flow, but there will be a slight extrusion of the material through the space between the cylinder wall 38 and the outer periphery of the piston head 40, transferring the material from one chamber to the other, that is, from chamber A to chamber B.

Assuming that the valve train linkage is in zero lash position, the amount of material extruded from chamber A to chamber B, during the valve lifting period, is exceedingly small and is immediately transferred back to chamber A during the closed position of the valve due to the pressure of the piston 44 exceeding the pressure on the piston 36. The compensating action causes relative axial movement of the cylinder 32 and piston 36, increasing or decreasing the overall length of the valve operating means or tappet assembly.

Assuming that there is clearance between the end of the valve stem 18 and the valve tappet 26, the spring 52 will urge the piston 44 axially of the bore and force the material in chamber B around the piston head 40 into chamber A, thereby raising the piston 36 to contact the end of the valve stem 18 and compensate for the clearance.

When the valve operating means lengthens, due to heat expansion or other factors, the effective load in the valve tappet 26, caused by the valve spring 20, exceeds the load on the spring pressed piston 44. The material is then forced from the chamber A to chamber B thereby lowering the piston 36 to compensate for the overall length. This action continues until the valve is seated and the forces in opposite directions are substantially balanced.

The impact pressures are from the cam 28, to tappet end 34, body 26, stem 42, piston head 40, to the dough-like material 58 in chamber A, to piston 36 and to valve stem 18.

In general, the tappet assembly herein described will automatically, when in action, increase or decrease in over-all length to suit the variations in distance between the cam and the end of the valve stem 18, so that the valve will seat positively and at the same time will have zero tappet clearance.

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In the form of the invention shown in Fig. 4 the tappet body 26' is constructed with a tubular wall 60 having a head 62 secured to one end thereof forming a cylinder which is open at its opposite end. A plunger 64 is carried in the open end of the tube and is held therein by a spring ring 66 in a groove 68 formed on the outer periphery of the plunger 64. The groove is wider than the thickness of the ring 66 so that there is limited axial movement of the plunger 64 relative to the tube 60 to permit variations in the distance between the outer ends of the plunger 64 and head 62.

The plunger 64 carries a stem 70 which extends axially within the tube 60 and the stem 70 carries a piston 72 spaced from the head 62 and the inner face of the piston 72. A sliding end wall 74 and a sealing washer 76 are positioned on the stem 70 above the piston 72 forming a chamber B'. The end wall 74 forms a guide for the stem 70 and the washer 76 seals the end of the chamber B'. A coil compression spring 78 between the plunger 64 and end wall 74 urges the end wall 74 toward the piston 72. A vent 80 is provided in the wall of the tube 60.

The diameter of the piston 72 is less than the inner diameter of the tube 60 by a predetermined amount to permit flow of material around the piston from one chamber to the other; the amount of flow depending upon the kind of material used in the chambers and the load of the spring 78. The material in the chambers A' and B' is the same dough-like material used in the chambers A and B of Fig. 1.

The piston 72 is provided with an inwardly extending plate 82 projecting from the inner face of the piston. This plate 82 extends diametrically across the bottom of the piston 72 and serves as a baffle and as a stop for contacting the head 62 to limit inward movement of the piston.

The opposite faces of the piston 72 are beveled at the edge of the piston providing a relatively thin outer peripheral portion. The beveled edge is not symmetrical around the piston and the opposite faces, while they are alike, are diametrically reversed.

Referring to Figs. 5, 6 and 8, one face of the piston 72 is formed having a bevel 84 at one side of its diameter. This bevel increases in diameter to produce a beveled area of greater extent, as indicated at 86, diametrically opposite to the beveled area 84. Thus, one portion of the upper face of the piston has a predetermined beveled area and a diametrically opposite portion of greater beveled area. The opposite face of the piston 72 is substantially the same as the above described face except that the beveled areas are oppositely disposed. The larger beveled area 86' underlies the beveled area 84 and the lesser beveled area 84' underlies the beveled area 86. The piston faces are so formed to produce a circulatory flow of the material in the chambers around the piston when the material in one chamber is displacing the material in the other chamber. The baffle 82 has been provided to prevent the material from confining its circulatory path within close limits to the piston body. It is desirable to circulate the entire material through the chambers so that the material, in passing through the space between the piston 72 and the tube wall, is not merely surged back and forth through the opening, leaving the remainder of the material in the chambers inert. The beveled edges together with the baffle cause the material

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to circulate through the entire chambers. The circulation of fluid prevents overheating of the fluid at any one point as it passes between the piston 72 and the tube wall and maintains a uniform viscosity without leaving inert portions of fluid.

It is highly desirable to have the described circulation of material throughout the entirety of each chamber to thereby bring all of the material therein into active use without any portions thereof lying dormant during the life of the tappet. It is possible that foreign matter may enter the compartments or chambers and mingle with the material therein, thus changing its physical characteristics in some degree. By insuring constant, complete mixture and circulation of the material, such impurities or foreign matter will be distributed throughout the body and prevent sudden changes in its characteristics during operation.

In Fig. 5, I have indicated two different areas at opposite sides of the piston but any number may be provided. In Fig. 6, I have shown the beveled areas as divided into four sections as indicated by the numerals 88 and 90; the sections 88 being alike and oppositely disposed and the sections 90 being larger, oppositely disposed and arranged between the sections 88. I have also shown two baffles 92 and 94 in planes at right angles to each other.

Referring to Fig. 7, I have shown a modified form of sealing means between the movable piston and the cylinder. Here a flexible diaphragm such as a bellows 96 has an inner peripheral portion secured to the stem 70' and an outer peripheral portion secured to the inner periphery of the tube 60'. This provides a positively closed chamber and a flexible wall which will permit expansion of the chamber required by the displacement in volume caused by the movable piston and stem when they are moving into the chamber.

From the above it will be apparent that I have provided a piston construction which displaces material from one chamber to another chamber by circulating or flowing the material through the entire chamber; thus, preventing any portion of the material from remaining dormant. By the flow of the material in a definite path around the piston in its travel from one chamber to the other and back again, no portion of the material is permitted to surge back and forth through the opening.

The size of the passage between the outer periphery of the piston and the chamber wall may be varied to increase or decrease the amount of material passing from one chamber to the other during a predetermined time interval.

While I have illustrated and described what I deem to be a preferred embodiment of my invention, it will be understood that various changes including the size, shape, and arrangement of parts may be made without departing from the spirit of my invention and it is not my intention to limit its scope other than by the terms of the appended claims.

I claim:

1. In a valve tappet for use in an internal combustion engine, the combination of a body having a bore therein which is closed at one end and open at its opposite end, a piston within said bore having oppositely disposed side walls and having a diameter only slightly less than the diameter of the bore to permit a restricted flow of viscous material between said piston and the

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wall of the bore, a movable end wall sealing the open end of the bore, resilient means urging said wall inwardly, a piston rod connected to said piston and extending through said movable end wall, and a mass of soft, solid but flowable viscous material in the bore on opposite sides of said piston, said material being highly resistant to sudden deformation but freely flowable under sustained pressure whereby forces applied to said body are transmitted to said piston and rod through said material.

2. In a valve tappet for use in an internal combustion engine, the combination of a body having a bore therein which is closed at one end and open at its opposite end, a piston within said bore having its outer periphery spaced from the inner periphery of the bore to permit a flow of material between said piston and the wall of the bore, a movable end wall sealing the open end of the bore, resilient means urging said wall inwardly, a piston rod connected to said piston and extending through said movable end wall, a mass of soft, solid but flowable viscous material in the bore on opposite sides of said piston, said material being highly resistant to sudden deformation but freely flowable under sustained pressure, a sleeve slidably mounted over said body and having a closed end over the open end of the bore, and a yielding member between said movable wall and the closed end of said sleeve, said piston rod engaging said sleeve whereby forces applied to said sleeve are transmitted from said piston and rod to said body through said material.

3. A valve tappet comprising a body portion having a closed chamber therein, a piston within the chamber dividing it into two compartments and having relative movement with the ends of the closed chamber, a piston rod connected to said piston and extending through an end wall of said chamber, said piston and chamber being dimensioned to permit a flow of viscous material in the chamber around said piston from one compartment to the other, the periphery of the piston being so shaped that the rate of flow of said material is different at opposite sides of said piston.

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4. A valve tappet comprising a body portion having a closed chamber therein, a piston within said chamber dividing it into two compartments and having relative movement with the ends of the closed chamber, a piston rod connected to said piston and extending through an end wall of said chamber, said piston having its oppositely disposed faces tapered toward its outer peripheral portion which is spaced from the chamber wall to permit a flow of viscous material between the chamber wall and the piston.

5. A valve tappet comprising a body portion having a closed chamber therein, a piston within said chamber dividing it into two compartments and having relative movement with the ends of the closed chamber, a piston rod connected to said piston and extending through an end wall of said chamber, said piston having its oppositely disposed faces tapered toward its outer peripheral portion which is spaced from the chamber wall to permit a flow of viscous material between the chamber wall and the piston, and a baffle plate projecting from one face of said piston and diametrically positioned on said piston.

6. A valve tappet comprising a body portion having a closed chamber therein, a piston within said chamber dividing it into two compartments and having relative movement with the ends of the closed chamber, a piston rod connected to said piston and extending through an end wall of said chamber, said piston having one of its faces tapered at its outer periphery, which is spaced from the chamber wall, to define a tapered annular space between said piston and chamber wall to permit a flow of viscous material between the chamber wall and the piston.

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REFERENCES CITED

The following references are of record in the file of this patent:

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