Feb. 14, 1956 D. H. PIERCE 2,734,495

YIELDING SPACER

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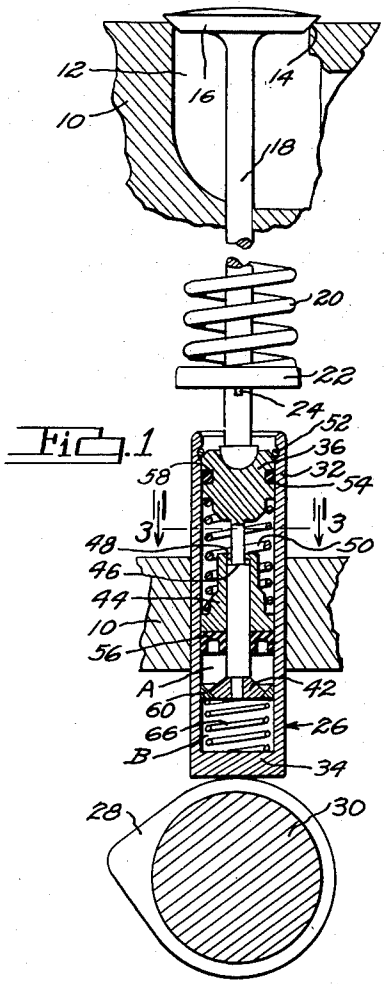


Fig. 1

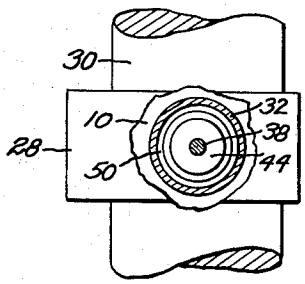


Fig. 3

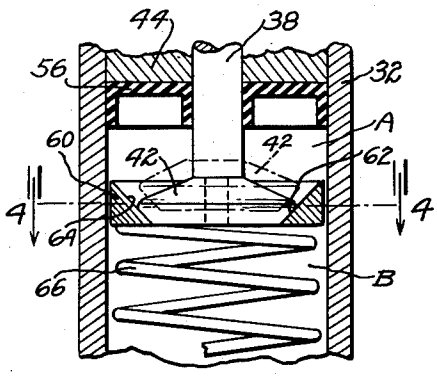


Fig. 2

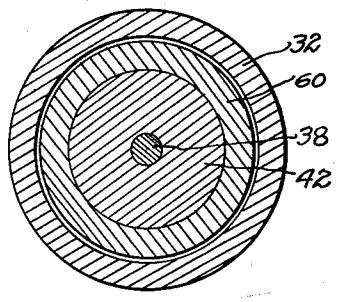


Fig. 4

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YIELDING SPACER

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8 Claims. (Cl. 123—90)

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.

The invention primarily relates to improvements illustrated and described in my United States Patents 2,570,853 and 2,570,854, issued October 9, 1951, wherein a yielding 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.

In the above identified patents there is disclosed a pair of intercommunicating chambers, each of variable capacity, having a means for permitting restricted flow of material from one chamber to the other. The material in the chambers is described as a mass of soft, solid but flowable, viscous material which is highly resistant to sudden deformation but freely flowable under sustained pressure.

It is an object of the present invention to provide improved means for regulating the flow of material from one chamber to the other.

It is a further object of the invention to provide a restriction between the two chambers which will permit a predetermined rate of flow of the material in one direction and a different rate of flow in an opposite direction.

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 in section and parts in elevation;

Fig. 2 is an enlarged, fragmentary view of the restriction means between the interconnected chambers, shown in Fig. 1;

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

Fig. 4 is a cross sectional view taken on line 4—4 of Fig. 2.

Referring to the drawings, I have illustrated the invention as applied to a 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 28, 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. Sufficient clearance, to eliminate over expansion by heating, results in noisy operation of the parts and wear, reducing the overall length of the parts, causes noise as well as inefficient operation.

The present invention is directed to a self-contained tappet which compensates for wear and expansion of the parts, maintaining zero clearance between the valve stem and the tappet at all times.

The tappet 26 is formed as a cylinder having a tubular side wall 32 and a closed bottom portion 34, the latter adapted to seat on the cam 28. An upper plunger 36 is slidably mounted in the open end of the tubular portion 32. The plunger 36 carries a tappet valve stem 38. The inner end of the tappet valve stem 38 is provided with a tappet valve head 42. A lower plunger 44 is slidably mounted on the tappet valve stem 38 and is arranged between the tappet valve head 42 and the upper plunger 36. A shoulder 46 is provided on the tappet valve stem 38 and a pressure deformable flange 48 is provided on the lower plunger 44 co-operating with the shoulder 46 to provide a stop for limiting the sliding movement of the lower plunger 44 on the tappet valve stem 38 toward the tappet valve head 42. A compression spring 50 is arranged between the upper and lower plungers 36 and 44. A lock ring 52 is provided in the inner wall of the tubular side wall 32 for limiting the outer movement of the upper plunger 36. A sealing ring 54, of flexible material such as rubber, is carried in a groove 58 in the wall of the plunger 36 for sealing engagement with the inner periphery of the tubular side wall 32, at its outer open end.

The lower plunger 44 forms a chamber with the tubular side wall 32 and its closed end 34. This chamber is divided into an upper chamber A and a lower chamber B by the tappet valve head 42.

A predetermined quantity of flowable material is placed in the chambers A and B at the opposite sides of the tappet valve head 42. As one example of the flowable material which may be successfully used, reference is again made to my patents, above referred to, wherein I have used a silicone elastic polymer compound which has a marked cold flow characteristic.

The material is a doughy, putty like compound, largely inorganic composition, free from vulcanizing agents and is cured, thereby not breaking down from use or age. 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.

It is highly desirable to vary the rate of flow of the flowable material during operation, that is, there should be an increased flow of material from chamber A to chamber B during the period in which the valve 16 is closed over the period in which the valve 16 is open.

Referring more specifically to Fig. 2, I have shown a means for accomplishing the above result. The tappet valve head 42 has an outer diameter less than the diameter of the inner periphery of the cylinder 32 so that the material may flow around the valve head 42 from chamber A to chamber B, or vice versa. To increase the flow of material from chamber A to chamber B, I have provided a choke ring 60 co-operating with the valve

head 42. The valve head 42 has its inner face provided with a tapered seat 62 for contact with a correspondingly tapered face 64 on the choke ring 60. A compression spring 66, exerting a force less than the spring 50, is arranged in the chamber B between the choke ring 60 and the bottom wall 34 of the tappet 26 for urging the tapered face 64 of the choke ring 60 normally into contact with the tapered seat 62 of the valve head 42.

The outer diameter of the choke ring 60 is greater than the outer diameter of the valve head 42 but is less than the diameter of the inner wall of the cylinder 32 so that there may be a flow of the material around the outside of the choke ring 60 but less than the flow of material around the valve head 42 when the choke ring surface 64 is moved away from the valve head seat 62. Thus, the material may flow from the chamber A to chamber B in greater volume than in flowing from chamber B to chamber A.

When the parts are assembled, the dough-like material is placed in the chambers A and B on opposite sides of the tappet valve head 42. The lower plunger 44, with the lock ring 48 in place, is then slid in the cylinder with the upper plunger 36. A sealing ring 56 is provided between the lower plunger 44 and the flowable material to prevent leakage around the valve stem 38 and the side wall of the cylinder 32. If desired, the flowable material may be placed in the chamber B, then the spring 66, choke ring 60, and valve head 42 with its assembled stem 38, lower plunger 44, spring 50 and upper plunger 36. Pressure on the valve stem 38 will cause the spring 66, choke ring 60, and valve head 42 to sink into the flowable material, so that the latter is on opposite sides of the valve head 42 and the parts are immersed in the material.

This assembly is done in a vacuum so that all air is removed from the chambers A and B and the flowable material.

The spring 50, after the tappet parts are assembled into a self-contained unit, urges the upper plunger 36 outwardly into engagement with the locking ring 52 and the lower plunger 44 into pressure engagement with the flowable material in chambers A and B.

When the tappet assembly is in operating position between the valve stem 18 and the cam 28, the upper plunger 36 is moved inwardly of the tappet cylinder 32 by the pressure of the spring 20. The load force of the spring 50 on the plunger 36 is less than the load of the spring 20 on the valve stem 18 so that the plunger 36 is moved inwardly of the tappet cylinder, thereby adjusting the overall dimension of the tappet to a distance corresponding to the distance between the lower end of the valve stem 18 and the outer surface of the cam 28.

The inward movement of the plunger 36 causes inward movement of the tappet valve head 42. The outer diameter of the valve head 42 is less than the inner diameter of the chamber A and B. As the valve head 42 is moved inwardly, the flowable material in chamber B is moved through the passage between the outside diameter of the choke ring 60 and the cylinder 32 into the chamber A.

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 32 and the outer periphery of the choke ring 60, transferring the material from chamber B to chamber A.

Assuming that the valve train linkage is in zero lash position, the amount of material extruded from chamber B to chamber A, during the valve lifting period, is exceedingly small and is immediately transferred back to chamber B during the closed position of the valve 16 due to the pressure of the spring 50 urging the plunger 44 inwardly and the valve head 42 outwardly. The compensating action causes relative axial movement of the

cylinder 32 and the upper plunger 36, increasing or decreasing the overall length of the tappet assembly.

If there is clearance between the end of the valve stem 18 and the valve tappet 26, the spring 50 will urge the plunger 36 and valve head 42 axially of the cylinder 32 and force the material in chamber A around the valve head 42 and choke ring 60 into chamber B, thereby raising the plunger 36 to contact the end of the valve stem 18, and compensate for the clearance. Continued outward movement of the plunger 36 is resisted by the pressure of the spring 20 which is greater than the pressure of the spring 50. The material may flow from the chamber A to the chamber B in greater volume than in flowing from chamber B to chamber A. The plunger 36 is moved outwardly of the cylinder 32 more rapidly than it is moved inwardly of the cylinder.

The operation of the device is as follows: When the valve 16 opens an impact load is transmitted from the upper plunger 36 to the flowable material in chamber B. This impact is resisted by the rheological charactertistics of the flowable material and the restriction caused by the choke ring 60 in the annular orifice around the tappet valve head 42. Some leak-down will occur by passage of the material around the outside of the choke ring 60, the latter now in pressure contact with the tappet valve head 42 and the pressure of the spring 66 during the time that the engine valve 16 is open. When the valve 16 closes, adjustment in length must be made to compensate for this leak-down and to accomplish the same at a faster rate of flow. With no load on the upper plunger 36, the spring 20 resisted by the closed valve 16, the tappet spring 50 drives the upper plunger 36 and valve head 42 upwardly and the lower plunger 44 downwardly, forcing the flowable material from chamber A to chamber B through the large orifice between the valve head 42 and the inner surface 64 of the choke ring 60, opened by the fluid pressure moving the choke ring 60 away from the valve head seat 62 against the pressure of the spring 66, as shown by the dotted lines in Fig. 2.

After compensating for the leak-down, contact is made between the upper plunger 36 and the valve stem 18. The choke ring spring 66 now closes the orifice between the choke ring 60 and the valve head 42 by moving the choke ring 60 into contact with the valve head 42 and the tappet is ready for another cycle.

The size of the orifice between the outer periphery of the valve head 42 and the wall 32 may be varied to increase or decrease the amount of material passing from one chamber to the other during a predetermined time interval, and the size of the orifice between the outer periphery of the choke ring 60 and the wall 32 may be varied to increase or decrease the rate of flow of the material from one chamber to the other.

While I have illustrated and described what I deem to be a preferred embodiment of the 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 valve within said bore having oppositely disposed side walls and having a diameter less than the diameter of the bore to permit a restricted flow of viscous material between said valve and the wall of the bore, a movable end wall sealing the open end of the bore, resilient means urging said end wall inwardly, a valve rod connected to said valve and extending through said movable end wall, a choke ring co-operating with said valve on the side of said valve adjacent the closed end of the bore, said choke ring having an outer diameter greater than the diameter of said valve and only slightly less than the diameter of

the bore, resilient means for urging said choke ring into sealing relation with said valve, and a mass of soft, solid but flowable viscous material in the bore on opposite sides of said valve.

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, an inner movable plunger within the bore forming a chamber with the walls and closed end of the bore, an outer movable plunger within the outer open end of the bore, a compression spring between said plungers for urging said inner plunger inwardly and said outer plunger outwardly, a valve stem movable inwardly by said outer plunger and extending through said inner plunger, a valve carried by said valve stem and within the chamber between said inner plunger and the closed end of the bore, the diameter of said valve being less than the diameter of the bore to permit a restricted flow of viscous material between said valve and the wall of the bore, a choke ring having an outer diameter greater than the outer diameter of said valve but slightly less than the diameter of the bore and co-operating with said valve, a compression spring between said choke ring and the closed end of the bore for urging said choke ring into seating engagement with said valve, and a mass of soft, solid but flowable viscous material in the bore on opposite sides of said valve.

3. An automatic self-adjusting self-contained valve tappet comprising, a housing, a body of fluid in the housing, yieldable loading means confining the fluid in a closed area of the housing, a choke ring immersed in the body of fluid and adapted to receive fluid therearound and therethrough, a thrust load transmitting valve coacting with said ring and controlling flow of fluid therethrough, and a relatively weak spring urging the choke ring toward the valve whereby thrust imparted to the housing will be transmitted to the choke ring through the body of fluid for transfer to the valve while permitting leakdown of fluid around the choke ring while release of said thrust will permit the valve and ring to separate for rapid flow of fluid through the ring under the influence of the loading means to quickly establish the desired level for the ring in the fluid without transfer of fluid out of the confined area of the housing.

4. A clearance regulator which comprises, a body having a closed bottom and an open top, a choke ring having a free sliding fit in said body, a thrust load transmitting member in said body coacting with said choke ring to provide a valve, a seal slidable on said member in said body and adapted to confine hydraulic fluid in the bottom portion of the body, a lower plunger slidable on said member in said body and acting on said seal, an upper plunger in said body on said member, a return spring between said upper and lower plungers and acting thereon to simultaneously bottom the seal on hydraulic fluid in the body and extend the member to take up slack in the regulator, and a light spring acting on said choke ring for urging said ring against said member to close the valve.

5. A hydraulic clearance regulator which comprises, a body having a closed bottom and an open top, a light spring in said body on said bottom, a ring member freely slidable in said body and bottomed on said light spring, a stemmed valve member having a head coacting with said ring member to provide a valve, the stem of said valve projecting centrally through said body, a seal slidably engaging said stem and sealingly engaging said body, a lower plunger slidably engaging said stem and backing up said seal, and stem having a reduced diameter portion

and a shoulder adjacent said portion, said lower plunger having a reduced end portion receiving the reduced diameter portion of the stem therethrough and forming an abutment for said shoulder, an upper plunger on said stem above said reduced diameter portion of the stem, a return spring held under compression between said plungers in said body, a seal carried by said upper plunger coacting with said body, said body having an internal groove adjacent the open top thereof, and a lock ring in said groove providing an abutment for said upper plunger to retain the parts in the body.

6. A thrust valve type hydraulic tappet which comprises a tappet barrel having a closed bottom and on open top with a cylindrical bore between the open top and closed bottom, a light spring bottomed on the bottom of said barrel, a choke ring slidable in said bore and resting on said light spring, said choke ring coacting with said bore to provide a leakdown clearance therebetween, a stemmed thrust load transmitting valve having coaction with said choke ring to provide a valve passage through the ring, a movable end wall in said tappet barrel slidable on the stem of the valve, resilient means urging said end wall toward the bottom of the barrel to confine a body of hydraulic fluid in the barrel on opposite sides of the choke ring, a head on the stem of said valve and slidably mounted in said bore, and said head providing an abutment coacting with said movable end wall to retain the resilient means under load.

7. In a hydraulic tappet of the thrust load transmitting valve type the improvement of a valve assembly adapted to confine the hydraulic fluid and to control flow of the confined fluid which comprises a valve member having a stem and an enlarged head at one end thereof, valve seat means coacting with said head, a seal slidably mounted on said stem, an end wall slidably mounted on said stem for backing up said seal, said stem having an abutment coacting with said end wall to limit movement of the end wall toward the valve head, a head member on said stem in spaced relation from said end wall, and a return spring compressibly loaded between said end wall and head.

8. In a hydraulic tappet including a tappet barrel, a choke ring mounted in said barrel and a light spring urging said choke ring away from the bottom of the barrel, the improvement of the valve assembly insertable as a unit in said barrel, said assembly having a stemmed valve with a head portion coacting with said choke ring, a cup seal slidably mounted on said stem, a lower plunger slidably mounted on said stem and backing up said cup seal, said stem having a reduced diameter portion providing an abutment shoulder, said lower plunger having an inturned end portion surrounding said reduced diameter portion of the stem and abutted by said shoulder, an upper plunger on the end of the stem and adapted to be slidably mounted in the tappet barrel, said upper plunger having a recess, a ring seal in said recess coacting with said barrel, and a return spring between the upper and lower plungers effective to move the upper plunger for extending the length of the assembly while maintaining the cup seal tightly against a body of hydraulic fluid in the tappet barrel.

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