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VALVE CLEARANCE ELIMINATING DEVICE

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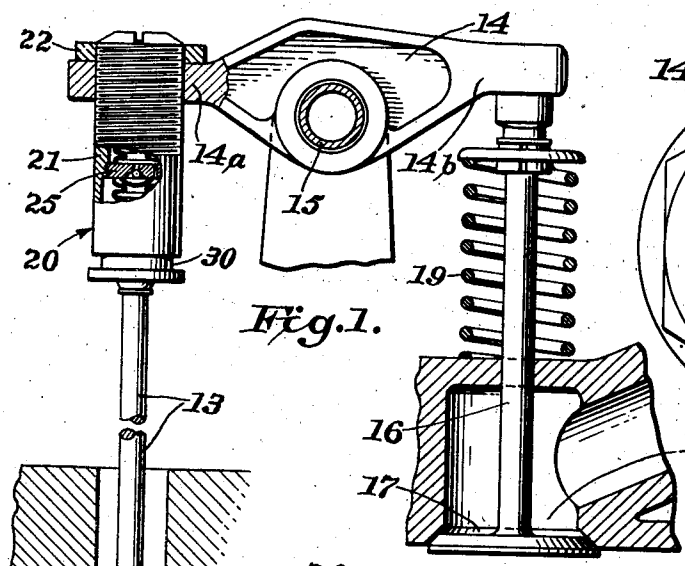


Fig. 1.

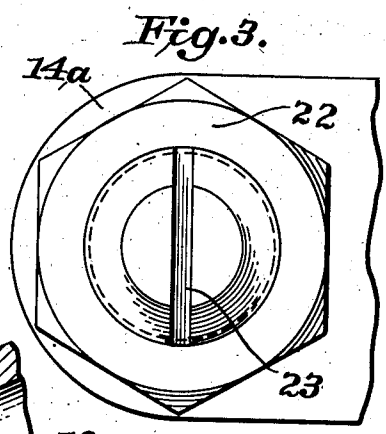


Fig. 3.

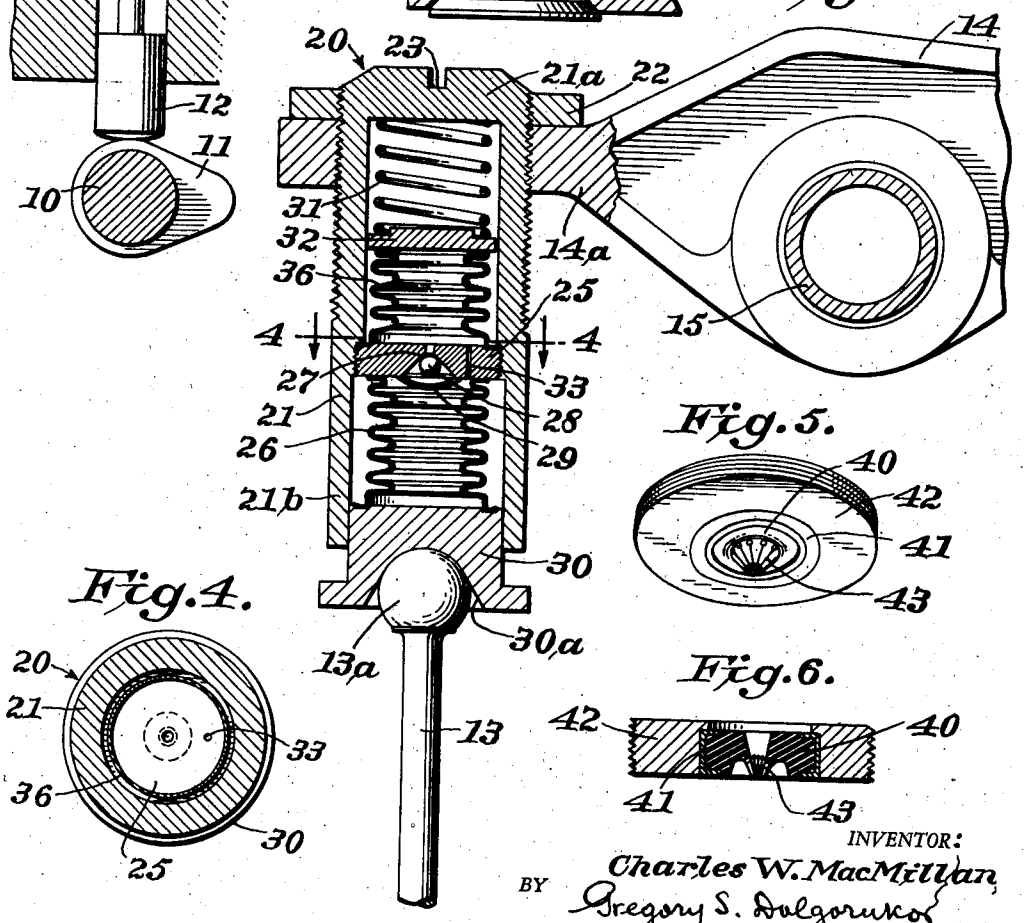


Fig. 2.

Fig. 4.

Fig. 5.

Fig. 6.

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VALVE CLEARANCE ELIMINATING DEVICE

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3 Claims. (Cl. 123—90)

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This invention relates to clearance eliminating devices, and more particularly, but not exclusively, to such devices as may be used to a great advantage in combination with valve mechanisms or valve operating trains, such for instance as those used in internal combustion engines.

The numerous advantages which may be attained with the aid of a device adapted to maintain substantially at zero the clearance between the parts of a valve operating train in an internal combustion engine, are now well appreciated in the art. It is also appreciated that additional advantages may be attained with the use of a device of this general character operated hydraulically and interposed in the valve operating train, said device being adapted to transmit the valve operating force through a column of oil, which column is automatically adjustable to take up any clearance that may occur in the valve operating train.

However, embodiment of the above principle into actual operative structures has presented many difficulties which greatly reduce and impair the usefulness and dependability of such devices. For instance, being dependent upon engine lubricating system for their oil supply, conventional devices of the above character suffer from gummy deposits, dirt, particles of metal and rust, acids and the like which are carried into and deposited in the restricted passages of the devices or between the closely machined and carefully adjusted mating surfaces of their mechanisms. In addition, such conventional devices require for their proper functioning precision machining and finishing of their mating surfaces and closely controlled clearances, which are difficult and expensive to provide and to maintain. Furthermore, the necessity of ensuring oil supply for such devices by connecting them to the lubricating system of an engine, necessitates providing long oil conduits usually drilled through walls, partitions, and other parts of the engine, which often is very difficult and, in general, is objectionable for a number of important reasons.

One of the objects of the present invention is to provide an improved clearance eliminating device of the hydraulic type, in which the above disadvantages are overcome and largely eliminated.

Another object of the invention is to provide an improved clearance eliminating device for valve operating trains of internal combustion engines, which device is completely sealed and self-sustained as far as its liquid supply is concerned, and in which relatively small quantity of specially selected and graded liquid, particularly adapted for its intended function, and not compromised by requirements presented to an engine lubricant, such as cheapness, is used for operating the device.

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A further object of the present invention is to provide an improved hydraulic clearance eliminating device for valve operating trains of internal combustion engines, which device does not depend upon the engine lubricating system for its operating liquid and, therefore, may be located anywhere in the engine as functionally required without the necessity of leading engine oil to it through a complicated system of conduits.

A still further object of the present invention is to provide a hydraulic clearance eliminating device which may be used in connection with structures having no liquid supply suitable for operating such a device, or in connection with structures where conducting to the device the necessary supply of operating liquid is difficult or impractical.

A still further object of the present invention is to provide a hydraulically operated clearance eliminating device in which precision machining and finishing operations, or closely controlled clearances are not necessary for proper functioning of the device.

It is an added object of the present invention to provide an improved structure of the foregoing character which is simple in construction, dependable in operation, and is relatively inexpensive to manufacture.

Other objects and advantages of the present invention will be apparent from the following description and the accompanying drawing forming a part of the present specification, in which drawing similar numerals refer to similar parts throughout the several views.

In the drawing,

Figure 1 is a view showing, partly in section, a valve operating mechanism of an internal combustion engine, said mechanism including a clearance eliminating device embodying the present invention;

Figure 2 illustrates separately on a larger scale and in longitudinal section the clearance eliminating device of Figure 1;

Figure 3 is a top view of the clearance eliminating device of Figures 1 and 2;

Figure 4 is a transverse sectional view of the clearance eliminating device, taken in the direction of the arrows on the section plane passing through the line 4—4 of Figure 3;

Figure 5 is a perspective view showing a modi-

fied form of a check valve for the clearance eliminating device of Figures 1–4; and

Figure 6 is a longitudinal sectional view of the check valve of Figure 5.

Before explaining in detail the present invention, it is to be understood that the invention is capable of other embodiments and modifications and that the terminology and phraseology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention beyond the requirements of the prior art.

In the drawing there is shown, by way of example, a clearance eliminating device embodying the present invention and adapted to be used in a valve operating train or mechanism of an internal combustion engine. It will be understood, however, that the illustrated use of the clearance eliminating device herein shown is not exclusive and that clearance eliminating devices embodying the present invention may be used successfully in combination with other mechanisms or machines where it is necessary or desirable to maintain the clearance between the contacting parts of a train of operative parts substantially at a zero value.

Referring particularly to Figure 1, the valve operating mechanism or train illustrated therein is of the type used in internal combustion engines of the overhead valve type. For the above reason only as much of the detail description thereof is given as is necessary for the proper understanding of the present invention. The valve operating train comprises, generally, a cam shaft 10 operably arranged in the engine structue and having a cam 11 of a suitable shape. The cam 11 cooperates with a follower or tappet 12 operated by the cam 11 and suitably guided in the engine structure along a straight reciprocating path. The tappet 12 has an open or hollow end receiving the lower end of a rod 13, the upper end 13*a* of said rod being received by a socket provided on one end of the clearance eliminating device, said device being generally designated by the numeral 20. The opposite end of the clearance eliminating device is adjustably connected to the end 14*a* of a rocker arm 14, said arm being hinged at the engine structure as shown at 15. The other end 14*b* of the rocker arm 14 bears upon the end of the valve stem of a valve 16 operatively arranged in the engine structure and adapted to seat in the valve seat 17 to close and to open a port 18. A main valve spring 19 is provided, which when unopposed by the force exerted by the cam 11 and transmitted to the valve 16 through the above described valve operating mechanism, forces the valve 16 into its seat 17 to close said port 18.

It will now be understood in view of the following, that the clearance controlling device 20 is a force transmitting member of the valve operating train, acting at times as a positive structural member thereof. It is well apreciated in the art, that considerable difficulties in operation of an internal combustion engine valve are produced by occurrences in the valve operating train of undesirable clearances, commonly called tappet clearances and usually produced by thermal contraction of the parts and of their wear, which clearances cause noisy operation of the valve operating mechanism. On the other hand, thermal expansion of the valve operating train parts prevents proper seating of the valve and causes faulty operation of the engine due to occurrence of objectionable "valve seat clearance." The

clearance eliminating or controlling device of the present invention operates to consume "tappet clearance," as the same occurs in the valve operating mechanism, and is also effective to prevent occurrence of "valve seat clearance," whereby quiet operation of the engine as well as proper and tight seating of its valve is ensured.

The device 20 comprises a hollow cylindrical body or cartridge 21 having a closed end 21*a* threaded at the outside and adapted to be screwed into or otherwise adjustably secured to the end 14*a* of the rocker arm 14, as mentioned. A nut 22 is provided to prevent undesirable rotation of the device. Controlled rotation of the device for its approximate adjustments may be effected with the aid of a screw driver or similar instrument engaging the device at a slot 23.

The interior of the cartridge 21 is divided into two parts by a partition 25 screwed into or otherwise rigidly secured in the cartridge 21 to transmit valve operating force thereto. On the partition 25 and underneath thereof there is mounted a member 26 adapted to hold a quantity of liquid. The member 26 is of such a construction that if the quantity of the liquid therein is increased, the size of the member 26 in its axial direction is increased. In other words, the member 26 may be longitudinally expanded by forcing liquid thereinto. Escape of the liquid from the member 26, except through passage 33 as for the purposes explained in detail below, is prevented by a check valve provided in the partition 25 and in the present embodiment of the invention comprising a valve seat 27, a ball 28 and a ball retainer 29. The valve permits the flow of liquid into the memebr 26 but checks the reverse flow. The opposite end of the member 26 is closed and it carries a plug 30 guided in the open end 21*b* at the cartridge body 21 by the walls thereof and provided with a socket 30*a* adapted to receive the ball end 13*a* of the rod 13.

The member 26 is substantially rigid transversely. Many important advantages are achieved by making the member 26 in the form of metal bellows which may be aproximately ¼" in diameter and ½"–¾" long. Such bellows member possesses the ability of being longitudinally expandable by the internal hydraulic pressure, but is sufficiently rigid transversely.

On the opposite side of the partition 25 there is mounted another liquid expandable member 36 preferably of the same metal bellows construction. The member 36 is also completely enclosed and carries a quantity of liquid similarly to the member 26. A compression coil spring 31 provided within the cartridge 21 is adapted to act on the member 36 through the washer 32 and to maintain the liquid within said member under pressure. The spring 31 is considerably weaker than the valve operating spring 19. A restricted passage 33 is provided in the partition 25 to permit predetermined rate of flow of liquid from the bellows member 26 into the bellows member 36.

With the structure as above described, the operation of the device is as follows: as the valve lifting force is applied by the cam 11 to the tappet 12, said force is received by the rod 13 and is transmitted by the ball end 13*a* thereof to the plug 30 of the operating bellows member 26. This will create an increased hydraulic pressure within the bellows member 26 and will induce a momentary flow of liquid through passage 33 from the bellows member 26 to the bellows member 36 thereby operating to seat the ball 28 and to check

such flow. The liquid entrapped in the operating bellows member 26 being substantially uncompressible will present a substantially rigid column for transmitting of the main operating force, which in the present application of the device is the valve lifting force, to the partition 25, and consequently to the cartridge body 21 of the device, to the rocker arm 14 and the valve 16, opening said valve against opposition of the spring 19. Thus, the entire valve operating mechanism will present a rigid force-transmitting train.

Should clearance occur in the above described force-transmitting train, which in the present embodiment will normally occur in the socket 30a or at the end of the stem of the valve 16, pressure on the plug 30 will cease and hydraulic pressure within the operating bellows member 26 will be reduced to a value less than the pressure in bellows 36. Since the hydraulic pressure in the supply bellows member 36 remains substantially unchanged, due to the action of the spring 31, substantially constant flow of liquid will immediately result from said supply bellows member 36 into the operating bellows member 26, due to unseating of ball 28. Bellows 26 thus becomes expanded, forcing the plug 30 outwardly until the clearance is consumed. Since passage 33 is relatively restricted or small as compared with the opening thru ball seat 27, the relative amount of flow thru passage 33 is small and would be insufficient by itself to provide rapid expansion of bellows 26 when clearance in the valve train occurs.

Should on the other hand expansion of the valve operative train-parts cause failure of the valve 16 to seat properly, such condition may be only of a very short duration when the present clearance controlling device is used. The predetermined flow of the liquid through the restricted passage 33 of the partition 25, which is taking place at every valve-opening stroke of the valve mechanism, will after a relatively short period of time gradually reduce the dimension of the bellows member 26 in the force-transmitting or longitudinal direction, which will first operate to consume the "valve seat clearance" and thereby to ensure proper seating of the valve, and thereupon will tend to create or will create "tappet clearance." Such a tendency or actual occurrence will be immediately counteracted by the action of the spring 31 forcing the liquid into the operating bellows member 26 and expanding said member to consume such "tappet clearance," as explained above.

It will now be understood in view of the foregoing that bellows members 26 and 36 hold a constant amount of operating liquid completely sealed therein. Thus, the device is self-sufficient as far as its liquid supply is concerned, and, therefore, it does not depend in any way on the engine lubrication system for its supply of operating liquid. A high grade liquid, such, for instance, as glycerine or the like may be used in the device embodying the present invention, thereby eliminating the difficulties produced by gummy deposits, dirt, rust, particles of metal and the like which are liable to be carried into the device with engine oil.

Bellows construction of the members, eliminates close machining and finishing operations necessary where cylinder and plunger mechanisms are employed. Moreover, the device of the present invention is completely liquid-tight, with all of its vital mechanisms completely enclosed,

thereby ensuring compact and easily interchangeable structure. Its operative self-sufficiency permits its installation in any desirable location of an internal combustion engine, without any reference to the available oil supply; in fact the device may be installed in machines where such supply is totally lacking and where conventional devices of this general character could not be used at all.

Figures 5 and 6 illustrate an improved check valve which may be used to a great advantage in the clearance eliminating devices embodying the present invention. Said valve comprises a body 40 of rubber or a rubber-like material, preferably having a retaining outside member, such as shown at 41, which may be pressed or screwed into a supporting member, such as a member 42 corresponding to the partition 25 of the device shown in Figures 1–4. The body 40 is provided with an opening 44 around which there is provided a plurality of tongues 43 preferably integral with the body 40 and forming in their free condition a hollow figure such as a cone. It will now be understood that should pressure within the cone rise above that on the opposite side thereof, the tongues 43 will be bent and the passage for the fluid opened, permitting the flow of fluid to said opposite side. Reverse flow, however, will be immediately checked by the fluid closing the tongue 43 and pressing them together. If desirable, the tongues may be so constructed as to permit in their closed positions a very slow flow which may serve the same purpose as the flow through the passage 33 of the device, as explained above. Construction of said tongues 43 to accomplish this purpose may be made by shortening them, thus providing a central opening at the apex of the cone formed by said tongues when in the closed position.

I claim:

1. A clearance eliminating device including a cartridge body, a partition within said body rigid therewith, two metal bellows enclosed within said body and mounted on both sides of said partition, respectively, one of said bellows being a force-transmitting bellows and having one end supported on said partition, its other end being movable and adapted to receive the main operating force and to transmit the same through the mass of liquid contained therein to said partition and said body, and the other of said bellows having one end supported on said partition and the other end free and a spring acting on said other end to maintain a predetermined liquid pressure within said other bellows which pressure is less than the liquid pressure created in said first bellows by the main operative force acting thereon, and a check valve in said partition opening into said first bellows and delivering liquid thereto from said other bellows when main operating force fails to act on said first bellows.

2. A clearance eliminating device including a cartridge body, a partition within said body rigid therewith, two metal bellows enclosed within said body and mounted on both sides of said partition, respectively, one of said bellows being a force-transmitting bellows and having one end supported on said partition, its other end being movable and adapted to receive the main operating force and to transmit the same through the mass of liquid contained therein to said partition and said body, and the other of said bellows having one end supported on said partition and the other end free and a spring acting on said other end to maintain a predetermined liquid pressure

within said other bellows, which pressure is less than the liquid pressure created in said first bellows by the main operative force acting thereon, and a check valve in said partition opening into said first bellows and delivering liquid thereto from said other bellows when main operating force fails to act on said first bellows, and means effecting flow at a predetermined rate from said first bellows into said other bellows.

3. A clearance eliminating device comprising a housing, a partition within said housing rigid therewith, two expandable and hollow containers inclosed within said housing and mounted on opposite sides of said partition, one of said containers being a force transmitting member having one

end supported on said partition and its other end being movable, the other container also having one end supported on said partition and its other end in contact with a spring tending to compress the latter said container, the complete assembly adapted to transmit operating force of a mechanism thru a hydraulic column and control of fluid within said containers, means of said control comprising a check valve in said partition for relatively large flow of liquid in one direction between said containers and a fixed passage for relatively small flow of liquid in the opposite direction.

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