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DAMPENING FLUID

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Fig. 1

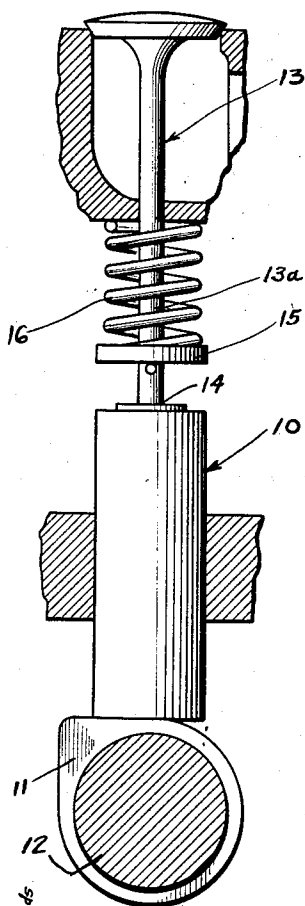


Fig. 2

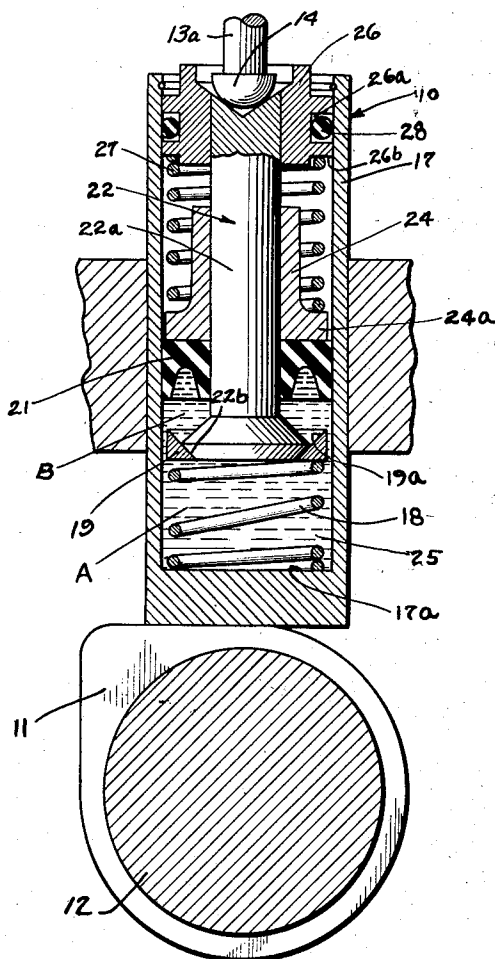
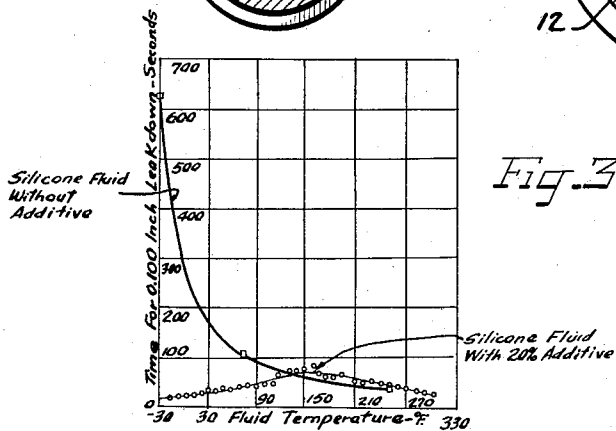


Fig. 3



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DAMPENING FLUID

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1 Claim. (Cl. 123—90)

The present invention deals with improved clearance regulators, lash adjusters, or the like and finds particular applicability to the field of hydraulically operated tappets of the type employed for opening and closing poppet valves in internal combustion engines. The invention is also directed to an improved hydraulic fluid composition particularly useful in such clearance regulators.

Automatic clearance regulators, of which valve tappets are the best example, are designed to counteract looseness or play in a mechanical linkage system whether these irregularities are caused by mechanical difficulties or due to the effects of thermal expansion and contraction. In the operation of the regulators, it is important not only that the clearance regulator be operative to compensate for looseness in the system, but they must not over control the linkage to produce an undesirable tightness, which, in the case of automatic tappets, would prevent full seating of the valve during operation.

In order to operate effectively, an automatic tappet must have substantially the same characteristics, regardless of the temperature at which it is employed. Thus the tappet must be readily operable under low temperature conditions encountered when starting the engine in cold weather and should operate effectively, without substantial change of characteristics, even under the high temperature conditions encountered after prolonged use in a high speed engine.

To a large extent, the response characteristics of a hydraulically operated tappet are dependent upon the type of hydraulic fluid contained within the unit. It is particularly important that the fluid employed have a reasonably constant viscosity characteristic along an extended range of temperatures. This characteristic is desirable in the hydraulic fluid, but is rarely achieved. For example, a typical hydraulic fluid presently being employed in tappets has a viscosity of about 950 centistokes at a temperature of about 40° F., but this viscosity falls to a value of less than 200 as the temperature is raised to 200° F. As a result, the operation in the hydraulic tappet may be sluggish at low temperatures or excessively fast at high temperatures.

We have now found that the viscosity characteristics of the hydraulic fluid can be stabilized, where the fluid is a polysiloxane polymer, by the addition thereto of certain ester type plasticizers and that when such mixtures are used in hydraulic tappets, the leak-down time of the tappet becomes practically constant, at constant load, irrespective of temperature.

Accordingly, an object of the present invention is to provide an improved hydraulically controlled clearance regulator whose operational characteristics are not varied substantially by extreme changes in temperature.

Another object of the invention is to provide a hydraulically operated, automatic tappet for internal combustion engines with an improved type of hydraulic fluid.

Still another object of the invention is to provide an improved hydraulic fluid having general utility in various fields of application.

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We have now found that substantially improved results are obtained in hydraulically operated clearance regulators by employing, as the hydraulic fluid, a mixture of a di-methyl polysiloxane polymer and an ester type plasticizer, specifically the compound di-2-ethylhexyl adipate. Specifically, the combination of a di-methyl polysiloxane polymer having a viscosity of at least 100,000 centistokes at 25° C. (77° F.) having added thereto at least 10% by weight, and preferably about 20% by weight of the compound di-2-ethylhexyl adipate produces a more nearly uniform viscosity characteristic in the temperature range from about minus 60° to about 300° F. This temperature range includes and indeed exceeds the normal operating temperature range of an internal combustion engine tappet assembly.

A further description of the present invention will be made in conjunction with a specific embodiment thereof as illustrated in the attached drawings.

In the drawings:

Figure 1 is a view in elevation of a complete tappet mechanism employed with an internal combustion engine poppet valve; and

Figure 2 is a longitudinal cross-sectional view of the tappet barrel assembly illustrated in Figure 1;

Figure 3 is a graph comparing leak-down rates with respect to temperature between a silicon fluid of the prior art and a dampening fluid according to the present invention.

As shown in the drawings:

Reference numeral 10 indicates generally the tappet assembly of the present invention whose movement is controlled by means of a cam 11, supported on a suitable cam shaft 12 of the internal combustion engine.

The vertical movement of the elements in the tappet assembly 10 is transmitted to a poppet valve 13 in the engine block by acting on the tip 14 of the valve stem 13a. A spring retainer 15 is locked on the valve stem 13a to bottom a valve spring 16 surrounding the valve stem and compressed between the retainer 15 and the engine block.

The tappet mechanism itself includes a cylindrical barrel 17 having an open top and the closed bottom indicated at 17a. A relatively light, cylindrical coiled spring 18 is disposed at the base of the hollow cylinder 17 and exerts a relatively light force on a choke ring 19 which has a smaller outer diameter than the inner diameter of the barrel 17. The choke ring 19 preferably has a generally triangular cross-section so that it provides an inner tapering valve seating face 19a along its inner surface.

Also included within the barrel 17 is an elastomeric synthetic rubber cup seal member 21 which engages the walls of the barrel 17. The rubber cup member 21 has a central bore therethrough which receives the shank 22a of a valve member 22. The valve member 22 also has an enlarged head portion formed with a valve seating surface 22b which is arranged to become seated in the valve seat surface 19a of the choke ring 19.

The shank 22a of the valve member 22 is also slidably received within a lower plunger member 24 having an enlarged annular flange portion 24a bottomed against the upper surface of the rubber cup member 21.

An upper plunger member 26 is press fitted or otherwise secured to the top end of the shank 22. The upper plunger member 26 has a relieved portion 26a which receives an elastomeric sealing ring such as a synthetic rubber circular seal 28 in sealing relation against the surfaces of the barrel 17 so as to prevent dirt and other contaminants from entering the interior of the tappet mechanism.

The upper plunger member 26 is also provided with a relieved shoulder portion 26b which serves to provide a means for containing a helical return spring 27 which

normally separates the upper plunger member 26 from the lower plunger member 24. The spring 27 is preferably heavier and stiffer than the spring 18.

In accordance with the present invention, the bottom portion of the tappet barrel 17, up to the upper cup member 21 is filled with a hydraulic fluid 25 comprising preferably a mixture of a methyl polysiloxane polymer having a viscosity in the range from about 100,000 to about 1,000,000 centistokes at 25° C., having dissolved therein from 10 to 50% by weight and preferably about 20% by weight of the compound di-2-ethylhexyl adipate.

The choke ring 19 and the valve head 22b divide the lower portion of the tappet assembly into a lower pressure compartment A and a storage compartment B about the level of the valve and its valve seat. The return spring 27 bottoms the cup member 21 against the fluid 25 in the compartment B.

In the operation of the tappet mechanism, when the cam 11 is in a position for moving the tappet 10, the load of the valve spring 16 is transmitted to the valve member 22 and through this valve member 22 to the choke ring 19. Since the choke ring rests on the body of hydraulic fluid 25 in the compartment A, the lifting pressure from the tappet barrel will be transmitted through the trapped oil in compartment A to the valve member 22 and finally to the engine valve 13. Some leak-down occurs between the outer periphery of the choke ring 19 and the inner wall of the barrel 17, thereby causing the hydraulic fluid to flow from compartment A to the storage compartment B. As this leak-down occurs, the tappet valve 22 drops in the barrel, thereby shortening the assembly.

When the cam 11 has moved to a position in which it no longer applies a valve opening load on the valve spring 16, the tappet return spring 27 takes over and expands to force the upper plunger 26 upwardly through the open end of the barrel 17. As this occurs, the valve seating face 22b of the valve element 22 becomes unseated with respect to the valve seating face 19a of the choke ring 19. As the valve element is opened, the compartment A is placed in full fluid communication with the storage compartment B. At the same time, the fluid in the compartment B is under the compressive force exerted by the expanding return spring 27 through the lower plunger member 24 and the cup member 21, thereby forcing fluid from compartment B to compartment A. A condition of pressure equilibrium is promptly reached between the two compartments, and the valve seating face 22b will be seated, or very nearly seated, upon the valve seating face 19a of the choke ring 19.

Tests have indicated that the use of the improved hydraulic fluid of the present invention provides a substantially constant leak-down rate, at constant load, over a wide range of temperatures. In this characteristic, the fluid differs very radically from the same siloxane polymer when employed in the absence of the diester additive. For example, it was found that at a temperature of about 0° F., a tappet assembly employing a polymer without the additive required a leak-down time of about 300 seconds at a given load. The same polysiloxane

fluid containing 20% by weight of di-2-ethylhexyl adipate required a leak-down rate of only about 15 seconds at 0° F. At increases in temperature, the siloxane polymer containing no additive exhibited a very rapid decrease in the leak-down time required, and at a temperature of about 250° F., the leak-down time had been reduced to about 20 seconds. In contrast, the leak-down time for the fluid containing the additive was fairly constant from a temperature of minus 30 to 300° F., and never exceeded about 75 seconds, nor fell below 10 seconds.

The results of the tests described above are depicted in graphical form in Figure 3 of the drawings, wherein the curve labelled "silicone fluid with 20% additive" demonstrates how the fluid of the present invention exhibits substantially constant leak-down characteristics throughout a normal operating range of temperature.

Additional tests also indicated clearly that the fluid containing the diester additive possesses a viscosity stability both statically and dynamically under load which is not present in the fluid without the additive.

The improved behaviour of the fluid under widely varying temperature conditions indicates that the fluid may be employed not only in clearance regulators, but also in other systems where such characteristics are desirable. Specifically the fluid may be employed in hydraulic systems of hydraulically operated brakes low temperature hydraulic systems, and damping or dash port type mechanisms.

It should be evident that various modifications can be made to the described embodiments without departing from the scope of the present invention.

We claim as our invention:

An automatic clearance regulator for an internal combustion engine comprising first and second relatively movable parts together forming a fluid reservoir and having a leak-down passage through which dampening fluid in said reservoir is forced upon relative movement of said first and second parts, and a dampening fluid in said reservoir comprising a di-methyl polysiloxane polymer having a viscosity of at least about 100,000 centistokes at 25° C. and having added thereto in amount of 10% to 50% by weight the compound di-2-ethylhexyl adipate and said dampening fluid exhibiting substantially constant leak-down characteristics in a temperature range in the order of from about -30° F. to +300° F.

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