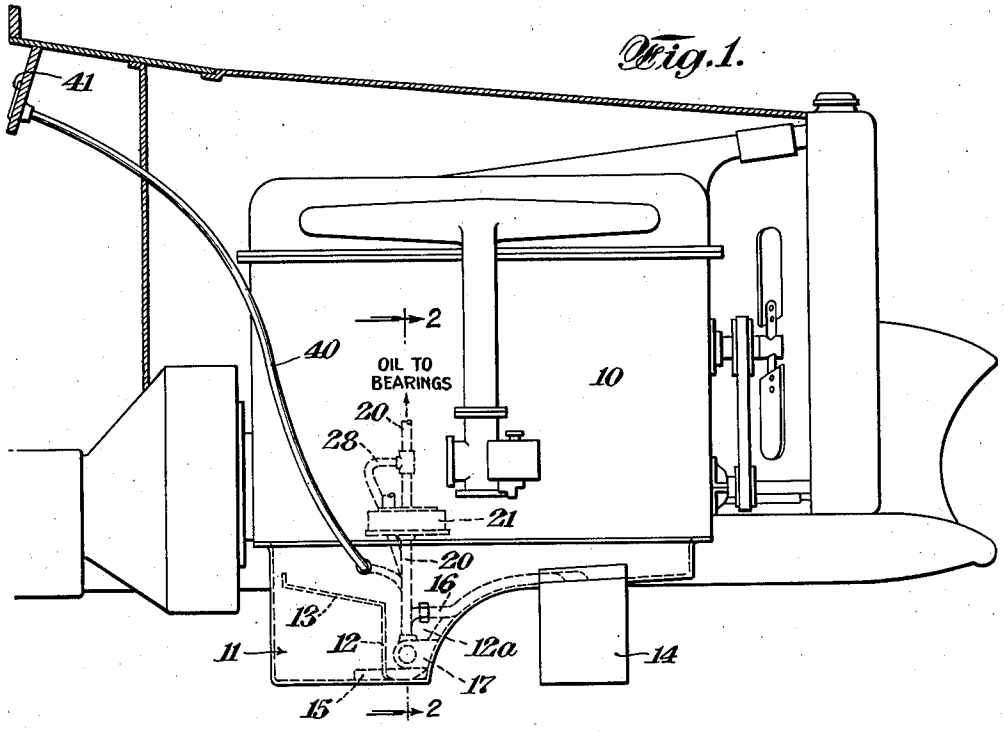
Jan. 21, 1936. H. T. BOOTH 2,028,187

VISCOSITY RESPONSIVE DEVICE

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Fig. 1.



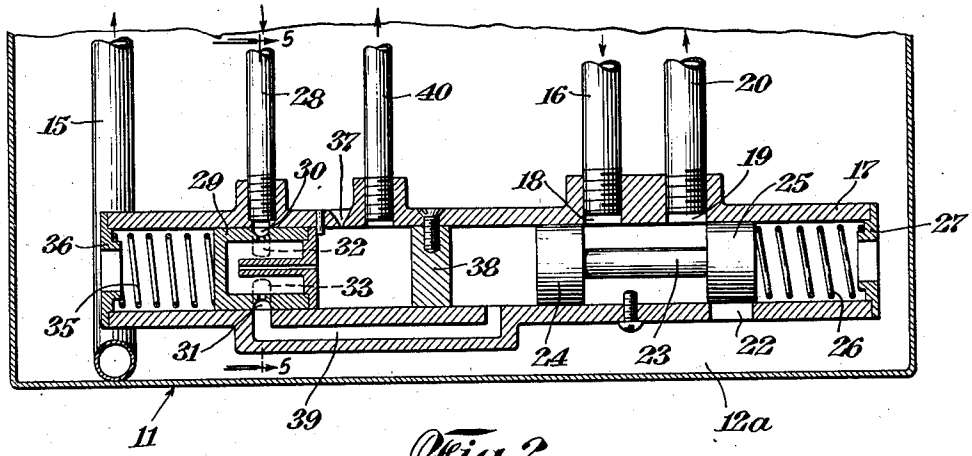


Fig. 2.

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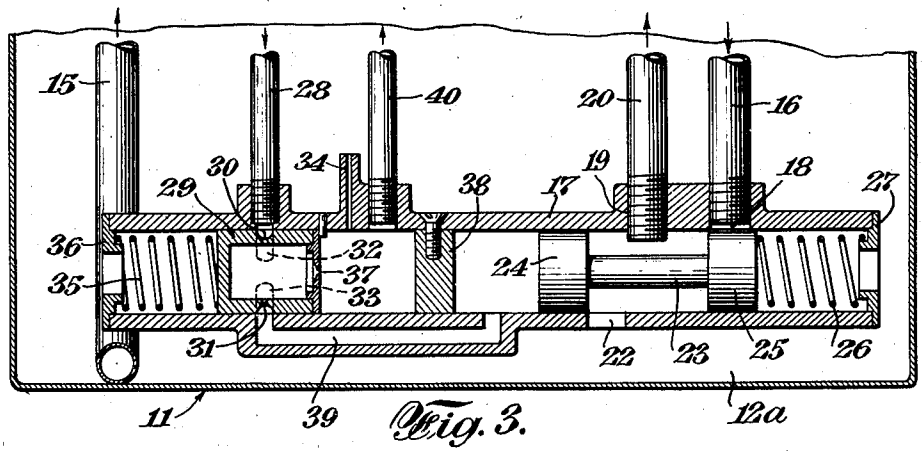


Fig. 3.

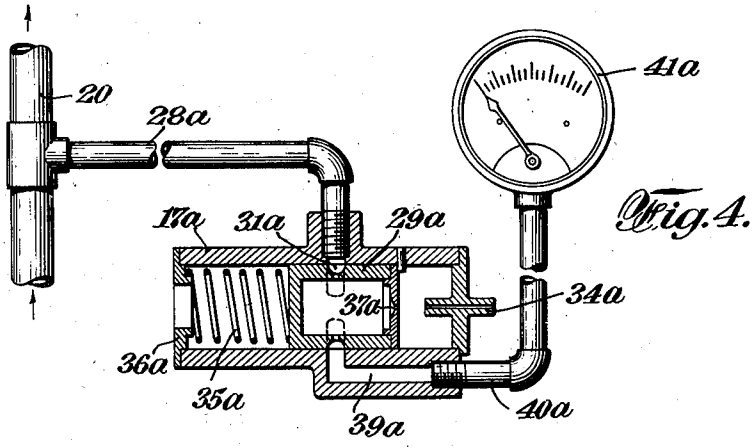


Fig. 4.

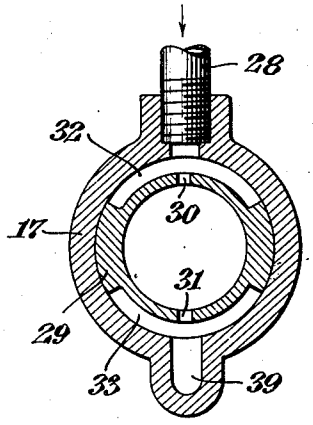


Fig. 5.

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UNITED STATES PATENT OFFICE

2,028,187

VISCOSITY-RESPONSIVE DEVICE

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Application February 7, 1933, Serial No. 655,576

7 Claims. (Cl. 137—165)

This invention relates to viscosity responsive devices and has for an object a simple and efficient device responsive to variations in viscosity of fluid flowing through the device.

In a device embodying the invention, the fluid is caused to pass successively through two ports, one comprising a friction tube, the resistance of which to flow varies with the viscosity of the fluid and the other comprising an orifice, the resistance of which to fluid flow is substantially independent of the viscosity of the fluid, these parts being arranged in either of two orders of succession. Means are provided for regulating the pressure of the fluid supplied to the first port to maintain constant pressure in the fluid between the two ports and the pressure of the fluid supplied to the inlet port is applied to pressure responsive means which may be a control member or an indicator. The pressure of the fluid supplied to the inlet port is a function of the viscosity of the fluid and the control member or indicator is operated in response to changes in viscosity of the fluid.

Such a viscosity responsive device is of utility in connection with any fluid system in which viscosity regulation is required and is of special utility in connection with the lubricating system of an internal combustion engine to control the viscosity of the lubricant as described and claimed in the co-pending application of Henry B. Clarke, Serial No. 644,287, filed Nov. 25, 1932, and is also of utility for directly measuring and indicating the viscosity of fluid flowing through the device.

Other objects, novel features and advantages of this invention will be apparent from the following specification and accompanying drawings, wherein:

Fig. 1 is a side elevation of an automobile engine having a lubricating system embodying the invention;

Fig. 2 is an enlarged fragmentary section on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 of a modified form of the invention;

Fig. 4 is a sectional view through a modified form of the viscosimeter, and

Fig. 5 is a section on the line 5—5 of Fig. 2.

The internal combustion engine 10 is provided with an oil pan 11, the forward portion of which is of less depth than the rear portion. A vertical partition 12 forms a well or pocket 12a with the curved bottom of the forward portion of the oil pan, this partition terminating in a sloping shelf 13 extending nearly to the rear wall of the pan. The bottom edge of the partition 12 engages the bottom of the oil pan, but does not make a fluid tight seal therewith. A heat exchange device or radiator 14 is suspended from the bottom of the oil pan adjacent the front end thereof. A pipe 15 leads from the chamber formed by the partition 12 and shelf 13 to the radiator 14 and a pipe 16 leads from the radiator to a casing 17 arranged in the well 12a.

The casing 17 is provided with a port 18 registering with the pipe 16 and a port 19 registering with a pipe 20 which leads to a pump 21 and a port 22 communicating with the interior of the well 12a. A piston 23 having heads 24 and 25 is slidably mounted in the casing 17 and controls the flow of oil into the casing through the pipe 16 and the port 22. The piston valve 23 is so designed that in one position thereof, the head 25 closes the port 22 with the head 25 out of register with the port 18 while in another position the head 24 closes the port 18 with the head 25 out of register with the port 22. A spring 26 interposed between the head 25 and the hollow plug 27 closing the right end of the casing 17 tends to hold the piston 23 in the position shown in Fig. 2.

A branch pipe 28 leads from the pipe 20 to the left end of the casing 17. A hollow piston 29 is slidably mounted in the casing 17 and is provided with radial ports 30 and 31 which communicate with peripheral grooves 32 and 33 in the outer surface of the piston (Fig. 5). The position of this piston with respect to the pipe 28 controls the flow of oil through said pipe into the interior of the piston. The piston is provided with a friction tube 34 which extends through the right end wall of the piston. A spring 35 is interposed between the piston 29 and a hollow plug 36 mounted in the left end of the casing. An orifice 37 provides a port for escape of oil from the space between the piston 29 and the partition 38 arranged between the piston and the head 24, the rate of flow through the orifice and the friction tube being the same. A conduit 39 has one end in communication with the groove 33 and the other end in communication with the space between the partition 38 and the head 24.

The friction tube 34 is of such dimensions that its resistance to fluid flow varies with the viscosity of the fluid while the orifice 37 is of such dimensions that its resistance to fluid flow is substantially independent of the viscosity of the fluid and, as will later be described, the pressure of the oil supplied to the friction tube is regulated to maintain substantially constant pressure in the oil between the friction tube 34 and orifice 37.

The resistance of the friction tube to flow and the pressure differential across it vary conjointly with viscosity and as the oil pressure between the friction tube and orifice is maintained constant and the resistance to flow of the orifice is dependent on the rate of flow and is independent of viscosity and as the rate of flow through the friction tube and orifice is the same, the pressure of the oil supplied to the friction tube is a measure of the rate of flow through the friction tube and is a function of the oil viscosity.

When the engine is at rest, the various elements are in the position shown in Fig. 2. The peripheral grooves **32** and **33** are in register with the port **30** and conduit **39** and the port **22** is closed while the port **19** is opened and all the chambers and spaces are filled with oil. On starting of the engine, oil is drawn in through the pipe **16** and delivered to the bearings and a part of the oil is delivered by way of the pipe **28** to the piston **29**, thence through the friction tube **34** and orifice **37** into the well **12***a*. The flow of oil through the device produces increase of pressure in the space between the partition **38** and piston **29** tending to move the latter to the left against action of the spring **35**. Such movement of the piston cuts down the flow of oil into the piston **29** and continues until the increased pressure in the space between the piston **29** and the partition **38** equals the strength of the spring **35** and such relationship is maintained throughout the entire operation by regulatory movement of the piston back and forth in its cylinder. The pressure in the oil flowing between the friction tube and orifice is thus maintained substantially constant.

When the oil is of high viscosity as is the case upon starting of the engine, the rate of flow through the friction tube **34** is low by reason of the high resistance of the friction tube to oil of high viscosity and consequently the pressure within the piston is high. This pressure is applied through the conduit **39** to the head **24** to move the piston **23** to the right against the action of the spring **26**, thereby closing the port **18** and opening the port **22**. With this arrangement of the piston, the by-pass through the radiator is closed and oil is drawn by the pump solely from the well **12***a*. After a period of operation, the oil becomes of higher temperature and consequently of lower viscosity. Therefore, the resistance to flow of the friction tube **34** decreases with a corresponding decrease in the pressure of the oil in the piston **29**. The piston **23** is thereupon moved to the left under the influence of the spring **26** to partially close the port **22** and partially open the port **18**. In this position of the piston, oil is drawn through the radiator **14** as well as from the well **12***a* and the mixture thus obtained is supplied by the pump to the bearings. The addition of cooled oil tends to retard further viscosity decrease. Movement of the piston to the left continues as long as the viscosity of the oil supplied to the bearings tends to decrease and the pressure in the piston tends to decrease, thereby increasing the ratio of cooled oil in the mixture supplied to the bearings. As soon as the oil reaches the desired viscosity, further movement of the piston valve to the left ceases and the ratio of oil drawn directly from the sump and through the radiator remains constant.

Any decrease in viscosity of the oil due to change of engine speed or other cause is immediately compensated for by movement of the valve **22** to the left to increase the flow of oil through the by-pass, thereby tending to increase the ratio of cooled oil in the mixture. Any increase in viscosity is compensated for by movement of the valve **21** to the left to decrease the flow of oil through the radiator, thereby tending to decrease the ratio of cooled oil in the mixture. Such regulatory movement of the piston valve maintains the oil at proper viscosity.

The viscosity at which the oil is maintained is dependent upon the spring **26**. This spring prevents any movement of the valve **23** until such time as the pressure exerted by the oil against the head **24** exceeds the strength of the spring and moves the piston to the left as soon as such pressure decreases below the strength of the spring and as the pressure exerted on the head **24** is a function of the viscosity of the oil, the spring **26** is designed to be of proper strength to insure maintenance of the oil at the desired viscosity.

If desired, there may be provided a pipe **40** leading from the space between the piston **29** and partition **28** to a pressure responsive indicator **41** suitably calibrated to give direct viscosity readings. The pressure of the oil in the space between the piston **29** and the partition **38** is directly applied to the indicator and as the pressure in this space is a function of the oil viscosity, readings of the oil viscosity may be obtained from the indicator.

The modification disclosed in Fig. 3 differs from the modification disclosed in Fig. 2 in that the piston **29** is provided in its right end wall with an orifice **37** and a friction tube **34** is provided for discharging oil from the space between the piston **29** and the partition **38**. Also, the positions of the pipes **16** and **21** are interchanged and the head **25** is in register with the port **18** when the engine is at rest. In this modification, the pressure of oil in the space between the piston **29** and the partition **38** is maintained substantially constant by reason of the regulatory action of the piston **29**.

As the resistance of the friction tube **34** to flow varies with the viscosity and as the oil pressure between the orifice and the friction tube is maintained constant, the rate of flow through the friction tube varies with viscosity. As the resistance to flow of the orifice is independent of viscosity and is dependent upon rate of flow, and as the rate of flow through the orifice is the same as through the friction tube, the pressure of the oil supplied to the friction tube is a measure of the rate of flow and is a function of the oil viscosity. With high oil viscosity as at the starting of the engine, the rate of flow through the friction tube **34** will be low and therefore the pressure in the piston **29** will be low, and the valve **23** will remain in the position shown in Fig. 3 so that oil is drawn by the pump solely from the well **12***a*. As the viscosity decreases, the rate of flow through the friction tube **34** increases with corresponding increase of pressure in the piston **29**, thereby causing movement of the piston **23** to the right to partially open the port **18** and partially close the port **22**, thus regulating the flow of warm and cooled oil to the bearings and maintaining constant the viscosity of the oil supplied to the bearings.

The viscosimeter disclosed in Fig. 4 is based on the same principle as just discussed. The piston **29***a* is slidably mounted in the casing **17***a* and oil is supplied to the piston from the pipe **20** through the branch pipe **28** and port **31***a*. From the interior of the piston **29***a*, the oil flows through the orifice **37***a* and escapes from the casing through the friction tube **34***a*. The spring

35a cooperates with the piston to maintain constant pressure in the space between the orifice 37 and the friction tube 34a. The pressure in the piston 29a is applied to the indicator 41a through the conduit 39a and pipe 40a. As the oil pressure in the piston 29a is a function of its viscosity, the indicator 41a gives direct readings of viscosity of the oil flowing through the device.

In each of the devices above described, the space between the friction tube and orifice constitutes a chamber having an inlet port comprising either the friction tube or orifice and an outlet port comprising either the orifice or friction tube. The pressure of the oil in this chamber is maintained constant and the pressure of the oil supplied to the inlet port is utilized either to actuate a valve for controlling flow of cool and warm oil to the pump to make up the mixture to be supplied to the bearings or to actuate an indicator which registers the viscosity of the oil or to operate both the valve and indicator. One wall of the chamber is movable in response to pressure changes in the chamber to control the flow of oil to the inlet port to maintain constant the pressure in the chamber. In Figs. 2 and 4, a viscosity indicator is shown as combined with the valve controlling means, but it is to be understood that the indicator is not in any way essential to the proper functioning of the valve control means and may be eliminated. In fact, it is probable that in most installations of the device shown in these two figures, the indicator will be eliminated as the control means maintains the oil at a predetermined viscosity.

It is to be understood that various modifications may be made in the structure above described, without in any way departing from the spirit of the invention as defined in the appended claims.

I claim:

1. In a fluid system, two fluid paths, a conduit with which said paths communicate, a heat exchange device in one path, a chamber having a port comprising a friction tube and another port comprising an orifice, means for supplying fluid from said conduit to one of said ports, means for regulating the pressure of the supplied fluid to maintain constant pressure within said chamber, and valve means responsive to the pressure of the fluid supplied to the inlet port of said chamber for controlling flow through said paths.

2. In a fluid system, two fluid paths, a conduit with which said paths communicate, a heat exchange device in one path, a chamber having an inlet port comprising a friction tube and an outlet port comprising an orifice, means for supplying fluid from said conduit to said inlet port under pressure, means for regulating the pressure of the supplied fluid to maintain constant pressure within said chamber, and valve means responsive to the pressure of the fluid supplied to the inlet port of said chamber for controlling flow through said paths.

3. In a fluid system, two fluid paths, a conduit with which said paths communicate, a heat exchange device in one path, a chamber having an inlet orifice and a friction tube outlet, means for supplying fluid from said conduit to said orifice under pressure, means for regulating the pressure of the supplied fluid to maintain constant pressure within said chamber, and valve means responsive to the pressure of the fluid supplied to the inlet port of said chamber for controlling flow through said paths.

4. In a fluid system, two fluid paths, a heat exchange device in one path, a casing with which said paths communicate, a conduit with which said casing communicates, a hollow piston mounted in one end of the casing, a valve piston slidably mounted in the other end of the casing to control flow through said paths, a spring opposing movement of each piston in one direction, a partition between said piston and valve piston, co-operating ports in said casing and hollow piston to control fluid flow into the piston, means for flowing fluid from said conduit to said casing port a friction tube extending through the end of said hollow piston adjacent said partition, an outlet orifice for the space between said hollow piston and partition, and a conduit leading from the interior of said hollow piston to the space between said partition and valve piston.

5. In a fluid system, two fluid paths, a heat exchange device in one path, a casing with which said paths communicate, a conduit with which said casing communicates, a hollow piston mounted in one end of the casing, a valve piston slidably mounted in the other end of the casing to control flow through said paths, a spring opposing movement of each piston in one direction, a partition between said piston and valve piston, co-operating ports in said casing and hollow piston to control fluid flow into the piston, means for flowing fluid from said conduit to said casing port said hollow piston having an orifice in the end thereof adjacent said partition, a friction tube outlet for the space between said hollow piston and partition, and a conduit leading from the interior of the hollow piston to the space between said partition and valve piston.

6. In a fluid system, a pair of fluid paths, a heat exchange device in one of said paths, a casing communicating with said paths, a conduit with which said casing communicates, a valve piston in said casing for controlling flow through said paths, a hollow piston in said casing, a partition between said hollow piston and said valve piston, a spring in each piston opposing movement thereof in one direction, co-operating ports in said casing and hollow piston to control flow into said piston, said hollow piston having a passage extending through the end thereof adjacent said partition, said casing having an outlet passage for the space between said hollow piston and partition, one of said passages comprising a friction tube and the other passage comprising an orifice, and a conduit leading from the interior of said hollow piston to the space between said partition and valve piston.

7. In a fluid system, a fluid path divided over a portion of its length into two channels, a heat exchange device in one channel, a chamber having inlet and outlet ports of which one comprises a friction tube and the other comprises an orifice, a branch path for by-passing fluid from said system through said chamber, means for regulating the pressure of the fluid supplied to said inlet port to maintain constant pressure within said chamber, and valve means responsive to the pressure of the fluid supplied to said inlet for controlling flow through said heat exchange device.

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