

Jan. 26, 1937.

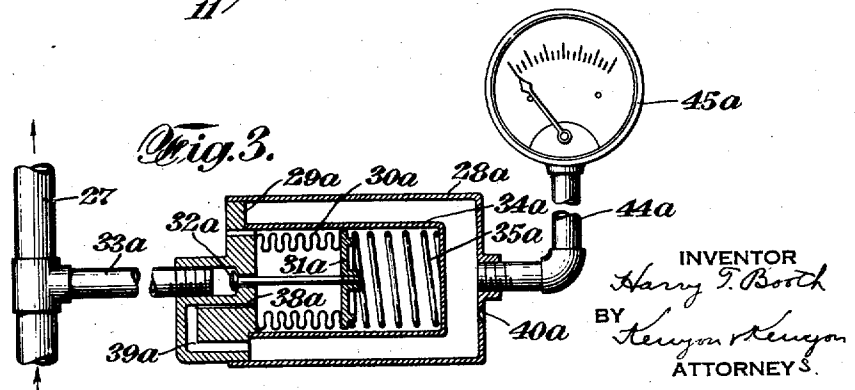
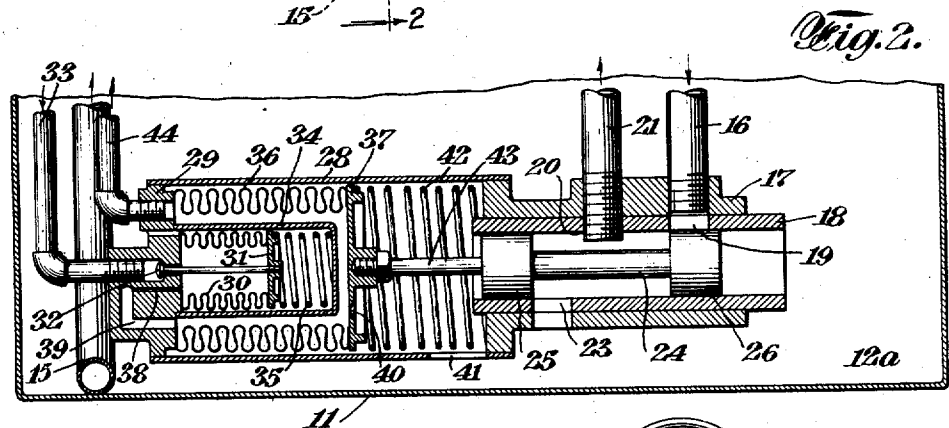
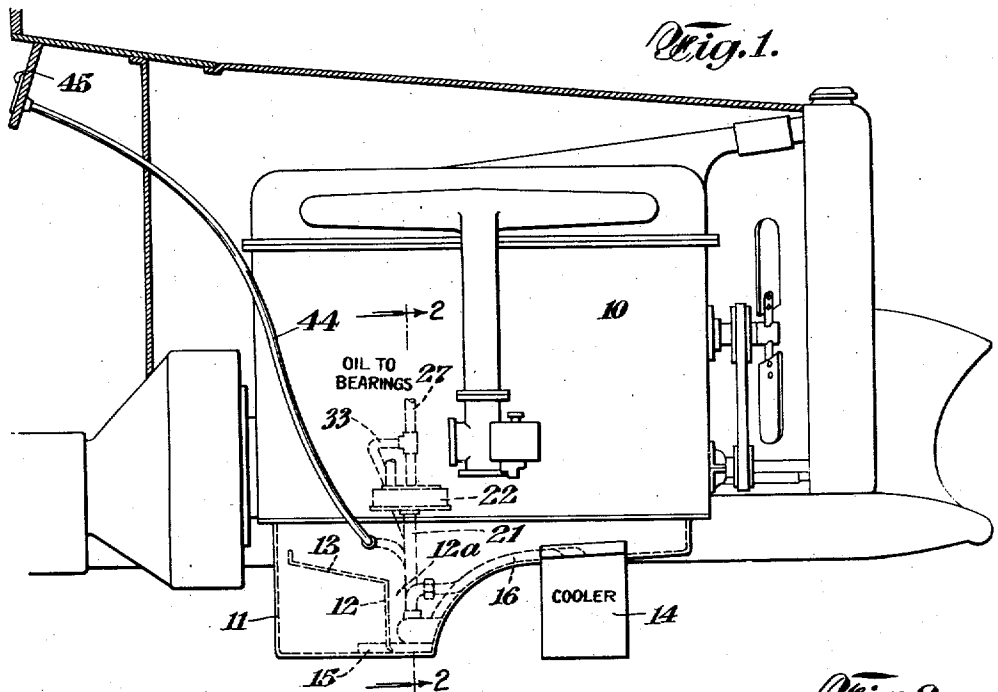
H. T. BOOTH

2,068,973

VISCOSITY RESPONSIVE DEVICE

Original Filed Feb. 7, 1933

2 Sheets-Sheet 1



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Fig. 4.

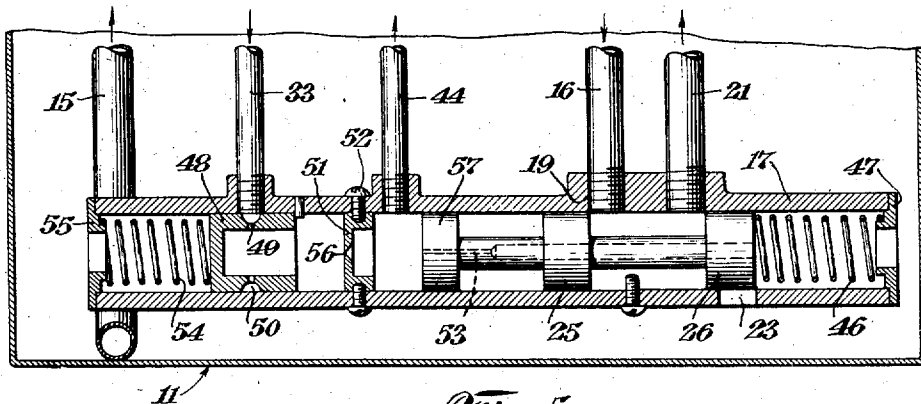
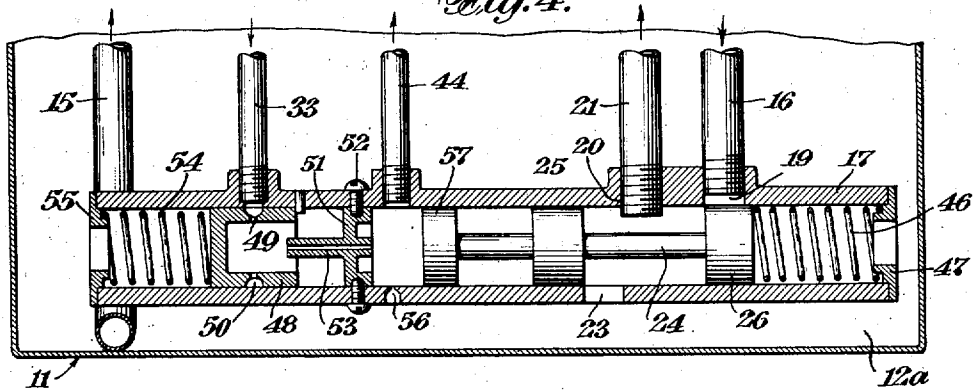


Fig. 5.

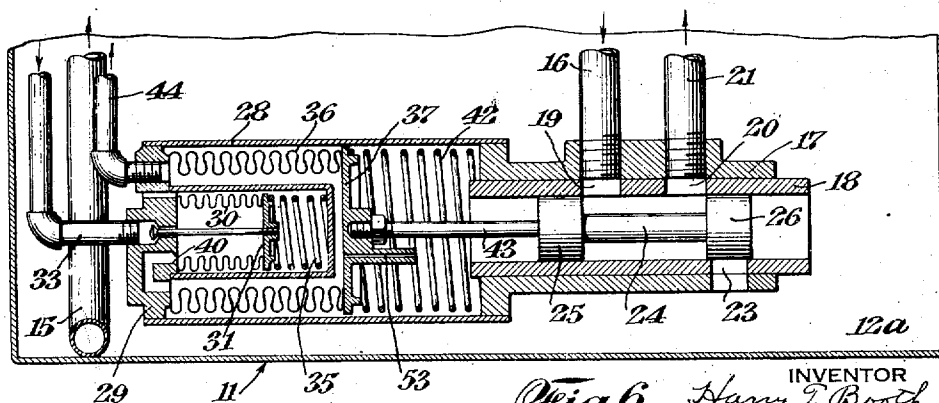


Fig. 6.

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VISCOSITY-RESPONSIVE DEVICE

Harry T. Booth, Glencoe, Ill., assignor to Lubrication Control Corporation, Chicago, Ill., a corporation of Delaware

Application February 7, 1933, Serial No. 655,575
Renewed June 20, 1936

14 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.

5 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 fluid flow varies with the viscosity of the fluid and the other comprising an orifice, 10 the resistance of which to fluid flow is substantially independent of the viscosity of the fluid, these ports being arranged in either of two orders of succession. Means are provided for supplying fluid to the first port at constant pressure and the pressure of the fluid between the 15 two ports is applied to pressure responsive means which may be a control member or an indicator. The pressure of the fluid between the two ports 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 especial 25 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 November 25, 1932 and is 30 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;

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

Fig. 3 is a sectional view through a viscosimeter embodying the invention; and

45 Figs. 4, 5 and 6 are views similar to Fig. 2 of modified forms of the invention.

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 50 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 de-

vice 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 5 arranged in the well 12a.

In the casing 17 there is provided a cylindrical liner 18 having a port 19 registering with the pipe 16, a port 20 registering with a pipe 21 which leads to a pump 22 and a port 23 communicating 10 with the interior of the well 12a. In the liner 18 there is slidably mounted a piston 24 having heads 25 and 26, the piston controlling the flow of oil into the liner 18 through the pipe 16 and port 23. The piston valve 24 is so designed that 15 in one position thereof, the head 26 closes the port 19 with the head 25 out of register with the port 23 while in another position the head 25 closes the port 23 with the head 26 out of register with the port 19. A pipe 27 leads from the pump 20 22 to the bearings for supplying oil thereto.

A casing 28 extends from the left end of the casing 17 and is closed at its left end by a plug 29. A bellows member 30 is attached at one 25 end to the inner face of the plug 29 and at its other end is closed by a head 31. The plug 29 is provided with an inlet port controlled by a valve 32, the stem of which is carried by the head 31. A branch pipe 33 leads from the pipe 27 to the port in the plug 29 controlled by the valve 32. 30 A casing 34 surrounds the bellows member 30 and is supported by the plug 29 and a spring 35 is interposed between the frame and the head 31, this spring exerting pressure on the head 31 tending to maintain the valve 32 in open position. 35 A second bellows member 36 is attached at one end to the plug 29 and at its other end is closed by a plate 37. A friction tube 38 formed in the plug 29 leads from the interior of the bellows member 30 to a conduit 39 communicating with 40 the interior of the bellows member 36. In the plate 37 there is provided an orifice 40 and an aperture 41 is provided in the housing 28. A spring 42 is interposed between the plate 37 and the left end of the casing 17, and the piston 45 valve 24 is connected to the plate 37 by a link 43, the spring 42 tending to maintain the parts in the position shown in Fig. 2.

When the engine is at rest, the various elements are in the position shown in Fig. 2. The 50 inlet port through the plug 29 is open and the port 23 is opened, while the port 19 is closed and all chambers and spaces are filled with oil. On starting the engine, oil is drawn through the port 23 and delivered to the bearings. Also, oil is 55

forced by way of the pipe 33 into the bellows member 30 thence through the friction tube 38 and conduit 39 into the bellows member 36 from which it flows through the orifice 40 and aperture 41 into the well 12a, the rate of flow through the friction tube and orifice being the same. The increased pressure thus produced in the bellows member tends to move the head 31 to the right against the action of the spring 35. Such movement of the head 31 moves the valve 23 to partially close the inlet port and continues until the pressure within the bellows member equals the strength of the spring 35 and such pressure is maintained throughout the entire operation by regulatory movement of the valve 32 against or by the spring 35. The pressure in the bellows member 30 is thus maintained constant.

The friction tube 38 is of such dimensions that its resistance to fluid flow varies with the viscosity of the fluid while the orifice 40 is of such dimensions that its resistance to fluid flow is substantially independent of the viscosity of the fluid and, as has been described, the pressure of the oil supplied to the friction tube is maintained substantially constant. As the oil is supplied to the friction tube at constant pressure, change of viscosity of the oil effects conjoint variation of the resistance to flow of the friction tube and the pressure differential across the friction tube with resulting change of pressure of the oil between the friction tube and the orifice. As the resistance to flow of the orifice is dependent upon rate of flow and is substantially independent of viscosity and as the rate of flow through the orifice is the same as through the friction tube, the pressure of the oil between the friction tube and orifice is a measure of the rate of flow through the friction tube and is a function of the oil viscosity.

When the oil is of high viscosity as is the case upon starting of the engine, the rate of flow through the friction tube 38 is low by reason of the high resistance of the friction tube to oil of high viscosity, and consequently the pressure in the outer bellows member 36 is low and is insufficient to expand the bellows member against the action of the spring 42. Therefore, the piston 24 remains in the position shown in Fig. 2 with the port 23 open and the port 19 closed. With this arrangement of the piston, the by-pass through the radiator 14 is closed and oil is drawn by the pump solely from the well 12a. After a period of operation, the oil becomes of higher temperature and consequently of lower viscosity. Therefore, with constant pressure on the oil in the bellows member 30, the rate of flow through the friction tube 38 increases as the viscosity decreases. Such increase in flow results in an increased back pressure in the bellows member 36 and the latter is expanded against the action of the spring 42 so that the head 31 moves the piston 24 to the right, thereby partially closing the port 23 and partially opening the port 19. In this position of the piston 24, oil is drawn through the radiator 14 as well as directly from the well 12a and the mixture thus obtained is supplied by the pump to the bearings. The addition of cool oil tends to retard further viscosity decrease. Movement of the piston 24 to the right continues as long as the viscosity of the oil supplied to the bearings tends to decrease and the increased pressure in the bellows member 36 tends to expand the same, thereby increasing the ratio of cool oil in the mixture supplied to the bearings. When the oil reaches the desired

viscosity further movement of the valve to the right ceases and the ratio of oil drawn directly from the sump and through the radiator remains constant. Any decrease in viscosity of the lubricant due to change in engine speed or other cause results in increase of pressure in the bellows member 36 which causes further movement of the valve 24 to the right, thus increasing the ratio of cooled oil in the mixture. Any increase in viscosity results in decrease of pressure in the bellows member 36 resulting in movement of the piston 24 to the left under the influence of the spring 42, thereby decreasing the ratio of cooled oil in the mixture. Such regulatory movement of the valve maintains the oil at proper viscosity.

The viscosity at which the oil is maintained is dependent upon the spring 42. This spring prevents movement of the valve to the right from the position shown in Fig. 2 until such time as the pressure in the bellows member 36 is sufficient to expand the bellows member against the action of the spring 42 and moves the piston to the left when the pressure in the bellows member 36 tends to decrease and as the pressure in the bellows member 36 is a function of the viscosity of the oil, the spring 42 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 44 leading from the bellows member 36 to a pressure responsive indicator 45 suitably calibrated to give direct viscosity readings. The pressure of the oil in the bellows member 36 is thus directly supplied to the indicator and as the pressure in the bellows member is a function of the oil viscosity, the viscosity of the oil at any given time may be read directly from the indicator.

The viscosimeter shown in Fig. 3 embodies the same principle of construction as above described. The pipe 33a leads from the pipe 27 to the bellows member 30a. The inlet port to the bellows member is controlled by a valve 32a the stem of which is connected to the movable head 31a of the bellows member 30a. A casing 34a surrounds the bellows member and is carried by the plug 29a closing the left end of the housing 28a. A spring 35a is interposed between the frame and the head 31a. A friction tube 38a in the plug 29a leads from the interior of the bellows member 30a to a conduit 39a communicating with the interior of the housing 28a. The housing 28a is provided with an orifice 40a and a pipe 44a leads from the housing to a pressure responsive indicator 45a suitably calibrated to give direct viscosity readings. Constant pressure is maintained within the bellows member 30a as previously described and the pressure of the oil in the housing 28a is a function of the viscosity of the oil, and as the pressure responsive device 45a is acted upon by the pressure in the housing 28a, it will directly indicate the viscosity of the oil flowing through the device.

In the modification disclosed in Fig. 4, the pipes 16 and 21 lead to and from the casing 17 provided with an inlet port 19 communicating with the pipe 16, an outlet port 20 communicating with the pipe 21 and an inlet port 23 communicating with the well 12a. A piston valve 24 is slidably mounted in the casing and is provided with heads 25 and 26 for controlling flow into the casing through the ports 19 and 23. A spring 46 is interposed between the head 26 and a tubular plug 47 closing the right end of the casing 17.

The branch pipe 33 leads from the pipe 27 to 75

the left end of the casing 17. A skirted piston 48 is slidably mounted in the casing and the skirt is provided with radial ports 49 which communicate with a peripheral groove 50 in the outer face of the skirt. The position of the piston with respect to the pipe 33 controls the flow of oil through said pipe into the interior of the piston. A plug 51 is held in the casing 17 by screws 52 and carries a friction tube 53 which extends through the plug. A spring 54 is interposed between the piston 48 and the tubular plug 55 closing the left end of the casing 17. An orifice 56 is provided in the casing wall to the right of the plug 51 and the piston 24 is provided with an additional head 57 at the left of the head 25.

In operation, oil is supplied to the friction tube 53 at constant pressure by operation of the piston 48 against or by the spring 54. The pressure of the oil in the chamber between the plug 51 and the head 57 regulates the flow of oil through the pipe 16 and port 23, through movement of the valve 24 to the right as the pressure in this chamber increases and movement of the valve to the left under the influence of the spring 46 as the pressure decreases. The pressure of the oil in this chamber is a function of its viscosity as previously pointed out and therefore the oil supplied to the bearings is maintained at uniform viscosity by the regulatory movement of the piston 24 in response to variation of pressure acting on the head 57. If desired, the device may be provided with means for registering the viscosity, such means comprising a pressure responsive indicator connected to the casing by the pipe 44.

The modification disclosed in Fig. 5 differs from the modification disclosed in Fig. 4 in that the plug 51 contains the orifice 56 and the friction tube 53 is carried by the head 57 and discharges into a conduit 58 extending through the piston 24. Also the positions of the pipes 16 and 21 are interchanged and the head 26 is in register with the port 23 when the engine is at rest. In this modification, the oil is supplied to the orifice 56 at constant pressure by reason of the regulatory action of the piston 50.

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

When the oil is of high viscosity as at the starting of the engine, the rate of flow through the friction tube 53 is low because of its high resistance to high viscosity oil and therefore the piston 24 is immediately moved to the right by reason of the high pressure acting on the head 57 to open the port 23 and close the port 16 so that the pump draws oil only from the well 12a. As the viscosity of the oil begins to decrease after a period of engine operation, the pressure acting on the head 57 correspondingly decreases and the piston 24 is moved to the left under the influence of the spring 46 to partially close the port 23 and partially open the port 16 and regulatory movement of the valve 23 is thus effected to maintain constant oil viscosity.

The modification disclosed in Fig. 6 differs from

the modification disclosed in Fig. 2 in that the plug 29 is provided with an orifice 40 establishing communication between the interior of the bellows member 30 and the conduit 29 while the plate 37 carries a friction tube 33 discharging into the housing 28. Also, the positions of the pipes 16 and 21 are interchanged and the head 26 is in register with the port 23 when the engine is at rest. At the starting of the engine, the rate of flow through the friction tube 33 is low and, therefore, pressure in the bellows member 36 is high and the piston 24 is moved to the right to open the port 23 and close the port 16. As the viscosity decreases after a period of engine operation, the pressure in the bellows member 36 likewise decreases and the piston 24 is moved to the left under the action of the spring 42, thereby partially closing the port 23 and partially opening the port 20 to regulate the flow there-through to maintain the oil at uniform viscosity.

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 supplied to the inlet port is maintained constant and the pressure of the oil in the chamber is a function of the viscosity of the oil and 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 applied to the bearings or to actuate an indicator which registers the viscosity of the oil or to operate both the valve and the indicator.

In Figs. 2, 4 and 6, one wall of the chamber is movable in response to pressure changes within the chamber and is conjunctively related to the valve for actuating the same. In Figs. 2, 4 and 6, a viscosity indicator is shown as combined with the valve controlling means, but it is to be understood that the indicator is in no way essential to the proper function of the valve control means and may be eliminated. In fact, it is probable that in most installations of the devices shown in these figures, the indicator will be eliminated as the control means maintains the oil at 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 device of the character described, a chamber having a movable wall and having a port comprising a friction tube, a port comprising an orifice, means for supplying fluid to one of said ports at constant pressure, the other port being in said movable wall, means opposing movement of said movable wall in one direction, and means actuated by said movable wall.

2. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths comprising a casing containing a valve piston, a chamber in said casing having a port comprising a friction tube and a second port comprising an orifice, said chamber having a movable wall, means for flowing fluid from said conduit to one of said ports at constant pressure, and means for opposing movement of said movable wall in one direction, said movable wall and valve piston being conjunctively related.

3. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths compris-

ing a casing containing a valve piston, a chamber in said casing having a port comprising a friction tube and a second port comprising an orifice, said chamber having a movable wall, means for flowing fluid from said conduit to one of said ports at constant pressure, the other port being in said movable wall, and means for opposing movement of said movable wall in one direction, said movable wall and valve piston being conjunctively related.

4. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths comprising a casing containing a valve piston, a chamber in said casing having an inlet port comprising a friction tube and an outlet port comprising an orifice, means for flowing fluid from said conduit to said inlet port at constant pressure, and means for actuating said valve piston in response to pressure variations in the fluid in said chamber.

5. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths comprising a casing containing a valve piston, a chamber in said casing having an inlet port comprising a friction tube and an outlet port comprising an orifice, said chamber having a movable wall, means for flowing fluid mixture from said two paths to said inlet port at constant pressure, and means opposing movement of said movable wall in one direction, said movable wall and said valve piston being conjunctively related.

6. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths comprising a casing containing a valve piston, a chamber in said casing having an inlet port comprising an orifice and an outlet port comprising a friction tube, means for flowing fluid mixture from said two paths to said inlet port at constant pressure, and means for actuating said valve piston in response to pressure variations in the fluid in said chamber.

7. In a fluid system, two fluid paths, a conduit with which said paths communicate, valve means for controlling flow through said paths comprising a casing containing a valve piston, a chamber in said casing having an inlet port comprising an orifice and an outlet port comprising a friction tube, said chamber having a movable wall, means for flowing fluid from said conduit to said inlet port at constant pressure, and means opposing movement of said movable wall in one direction, said movable wall and valve piston being conjunctively related.

8. In a device of the character described, a bellows member having one fixed wall and one movable wall, an inlet port in said stationary wall, a valve controlling said inlet port, said valve being connected to and operated by said movable wall, a casing enclosing said bellows member, a spring interposed between said casing and the movable wall of said bellows member, a second bellows member enclosing said casing having a fixed and a movable wall, a passage leading from said first bellows member to said second bellows member, and an outlet passage in the movable wall of said second bellows member, one of said passages being a friction tube and the other passage being an orifice.

9. In a device of the character described, a bellows member having one fixed wall and one movable wall, an inlet port in said stationary

wall, a valve controlling said inlet port, said valve being connected to and operated by said movable wall, a casing enclosing said bellows member, a spring interposed between said casing and the movable wall of said bellows member, a second bellows member enclosing said casing having a fixed and a movable wall, a passage leading from said first bellows member to said second bellows member, an outlet passage in the movable wall of said second bellows member, one of said passages being a friction tube and the other passage being an orifice, and means actuated by said last named movable wall.

10. In a device of the character described, a casing having an inlet port, a piston reciprocal in said casing to control fluid flow through said port into said casing, a spring tending to oppose movement of the piston in one direction, a partition in said casing, a passage extending through said partition, a piston valve in said casing on the opposite side of the partition from said piston, a passage through which fluid discharges from the space between said partition and said piston valve, one of said passages being a friction tube and the other passage being an orifice, said piston valve being adapted to be acted upon by fluid flowing from one passage to the other, a spring tending to oppose movement of said piston valve in one direction, two fluid paths communicating with said casing, said piston valve being movable to control flow through said paths, a conduit with which said casing communicates, and a heat exchange device in one path, said casing port being in communication with said conduit.

11. In a fluid system, two fluid paths, a heat exchange device in one path, a tubular casing communicating with said paths, a conduit with which said casing communicates, a piston slidably mounted in said casing to control flow through said paths, a portion of said casing constituting a chamber of which one wall comprises one end of said piston, said chamber having an inlet port communicating with said conduit and an outlet port, one of said ports comprising a friction tube and the other port comprising an orifice, means for maintaining at constant pressure fluid supplied to said inlet port, and means for opposing movement of said piston in one direction.

12. In a fluid system, two fluid paths, a heat exchange device in one path, a casing communicating with said paths, a piston slidable in said casing to control flow through said paths, a conduit with which said casing communicates, a bellows member having one fixed wall and one movable wall, an inlet port in said fixed wall communicating with said conduits, a valve controlling said inlet port, said valve being connected to and operated by said movable wall, a casing enclosing said bellows member, a spring interposed between said casing and the movable wall of said bellows member, a second bellows member enclosing said casing having a fixed and a movable wall, said movable wall being conjunctively related to said piston, a passage leading from the first bellows member to the second bellows member, and an outlet passage in the movable wall of said bellows member, one of said passages being an orifice and the other being a friction tube.

13. In a fluid system, two fluid paths, a heat exchange device in one path, a conduit into which said paths discharge, a casing communicating with said paths, a valve piston in said casing

for controlling flow through said paths, a second piston in said casing, said casing having an inlet port controlled by said second piston, means for supplying fluid from said conduit to said inlet port, a spring tending to oppose movement of the second piston in one direction, a partition in said casing having a passage therethrough, said valve piston being arranged in said casing on the opposite side of the partition from said second piston, a passage through which fluid discharges from the space between said partition and said valve piston, one of said passages being an orifice and the other passage being a friction tube, said valve piston being adapted to be acted upon by fluid flowing from the first passage to the second passage, and a spring tending to oppose movement of said valve piston in one direction.

14. In a fluid system, two fluid paths, a heat exchange device in one path, a conduit into which

said paths discharge, a casing communicating with said paths, a valve piston in said casing for controlling flow through said paths, a second piston in said casing, said casing having an inlet port controlled by said second piston, means for supplying fluid from said conduit to said inlet port, a spring tending to oppose movement of the second piston in one direction, a partition in said casing between said pistons and having a passage, a passage through which fluid is discharged from the space between said partition and said valve piston, said valve piston being adapted to be acted upon by fluid flowing from the first passage to the second passage, one of said passages being an orifice and the other passage being a friction tube, and a spring tending to oppose movement of said valve piston in one direction.

HARRY T. BOOTH. 20

CERTIFICATE OF CORRECTION.

Patent No. 2,068,973.

January 26, 1937.

HARRY T. BOOTH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, lines 29 and 30 and lines 41 and 42, claims 5 and 6 respectively, for the words "mixture from said two paths" read from said conduit; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of March. A. D. 1937.

(Seal)

Henry Van Arsdale
Acting Commissioner of Patents.

for controlling flow through said paths, a second piston in said casing, said casing having an inlet port controlled by said second piston, means for supplying fluid from said conduit to said inlet port, a spring tending to oppose movement of the second piston in one direction, a partition in said casing having a passage therethrough, said valve piston being arranged in said casing on the opposite side of the partition from said second piston, a passage through which fluid discharges from the space between said partition and said valve piston, one of said passages being an orifice and the other passage being a friction tube, said valve piston being adapted to be acted upon by fluid flowing from the first passage to the second passage, and a spring tending to oppose movement of said valve piston in one direction.

14. In a fluid system, two fluid paths, a heat exchange device in one path, a conduit into which

said paths discharge, a casing communicating with said paths, a valve piston in said casing for controlling flow through said paths, a second piston in said casing, said casing having an inlet port controlled by said second piston, means for supplying fluid from said conduit to said inlet port, a spring tending to oppose movement of the second piston in one direction, a partition in said casing between said pistons and having a passage, a passage through which fluid is discharged from the space between said partition and said valve piston, said valve piston being adapted to be acted upon by fluid flowing from the first passage to the second passage, one of said passages being an orifice and the other passage being a friction tube, and a spring tending to oppose movement of said valve piston in one direction.

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