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FLUID VISCOSITY CONTROL

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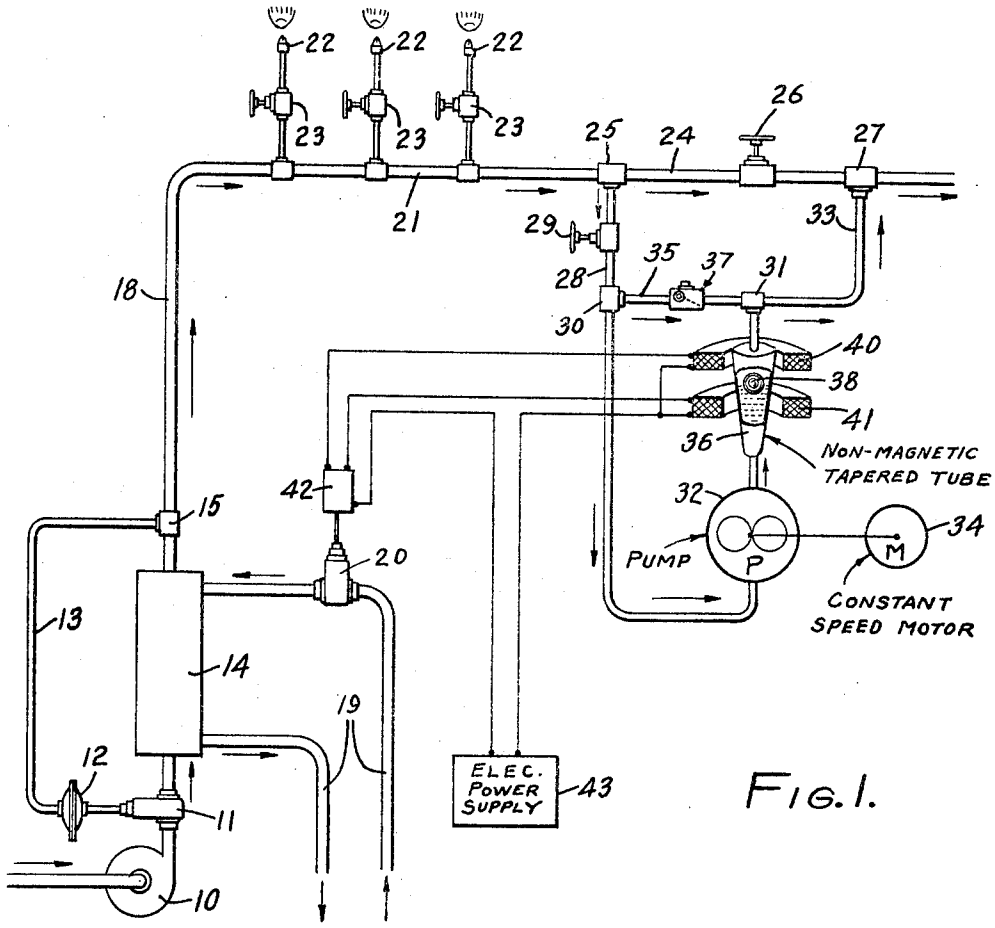


FIG. 1.

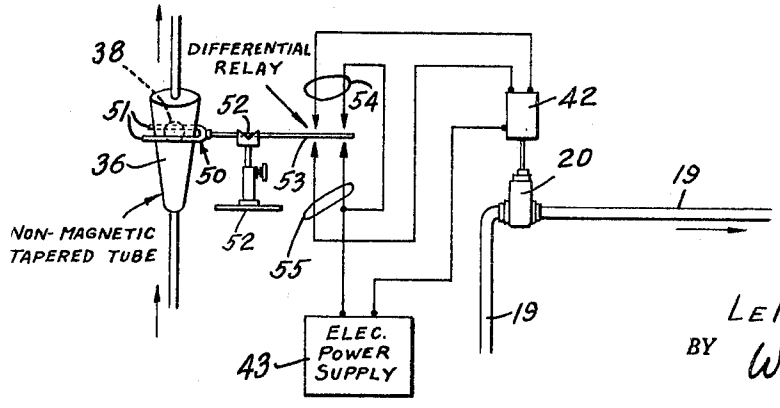


FIG. 2.

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FLUID VISCOSITY CONTROL

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to viscosity controls for liquids and particularly to regulators for controlling the quantity of heat energy supplied to a fluid system whereby the viscosity thereof may be maintained at a predetermined quantity or level.

Optimum performance of pressure atomizing oil burners and optimum conditions of combustion in diesel engine cylinders is dependent upon uniform atomization of the fuel oil. The extent of atomization (size of the globules) of the fuel oil is determined by the viscosity of the fuel oil and the pressure difference between the supply side of the atomizing orifice and the combustion chamber. For refined petroleum products, the viscosity does not vary widely, particularly while a single grade of fuel oil is supplied. For residual fuels, however, there is a wide variation in the viscosity. Seldom do two successive deliveries have identical viscosities and, in some instances, settlement of heavier fractions results in viscosity variations between the time the supply tank is well filled and the time it approaches an empty condition.

The viscosity of residual hydrocarbons and even of most refined hydrocarbons is a function of temperature which temperature, in modern high rate fuel burning installations, must be closely and continuously controlled and monitored to produce a constant viscosity of the fuel oil. Any variation is viscosity at the burner or diesel cylinder injectors induces a loss in efficiency.

Surprisingly few such controls, i.e., viscosity monitored, continuous temperature controls, are found in the prior art. That shown by Smith in Patent No. 1,654,614 is based on a pressure-operated electromechanical control of the heating medium. There, the pressure-operated sensor is located directly in the burner feed line and the electromagnetic valve is regulated either full on or full off. These features would seem to possess certain disadvantages leading to a possible cyclic variation in the viscosity of the fuel oil which, in itself, would result in a reduced efficiency.

The principal object of my invention, therefore, is to provide a fluid viscosity control which has none of the disadvantages of those in the prior art and will maintain the operation of those devices served by the fluid at maximum efficiency.

Another object of my invention is to provide a fluid viscosity control that will operate purely as a function of the viscosity of the fluid being used.

A further object of my invention is to provide a fluid viscosity control wherein the fluid viscosity sensor is ancillary to the main flow of fluid in the operating system and does not impede the flow of fluid to the operating devices.

A still further object of my invention is to provide a fluid viscosity control such that when the control means or sensor has been adjusted or set for a predetermined fluid viscosity, that viscosity will be maintained within close limits.

Other and further objects and advantages of my invention will be appreciated in the study of the following detailed description and accompanying drawings wherein:

FIGURE 1 is a schematic layout of a fluid system employing my viscosity control; and

FIG. 2 is a schematic diagram illustrating a modified form of viscosity control.

With reference to FIG. 1, fuel oil service pump **10** draws fuel oil from a tank or other source of supply (not shown) and pumps it into a fuel oil heater **14** through a pressure controlled by-pass valve **11**. The pressure-control **12** is installed in by-pass line **13** which taps into the main line **18** beyond the oil heater at fitting **15**. As in the usual installation, when the pressure drops off at the fitting **15** due to a stoppage in the heater, the differential pressures developed in the pressure-control **12** opens the by-pass valve **11** and allows the fluid to flow around the defective oil heater.

The fuel oil heater **14** is provided with the usual heating fluid supply and return lines **19** which deliver the heating fluid from a supply source (not shown) to the oil heater. An electric motorized control valve **20** is installed in the heating fluid delivery line which valve and its functioning will be described later.

The heated fuel oil passes from line **18** into a header **21** from which a supply of fuel oil is fed to a plurality of burners **22** which are provided with the usual valves **23**. From header **21**, line **24** leads back into the fuel oil tank or fuel oil pump suction to return the unused oil thereto. Line **24** is provided with control line tap fitting **25**, fuel oil return control valve **26** and control line return fitting **27**.

Control line **28** leads from tap fitting **25** through a control line valve **29**, and a bypass fitting **30** to a positive displacement type metering pump **32** which is driven by a constant speed motor **34** which is activated from a constant source of electrical power supply (not shown). The constant metered quantity of oil is then fed to a closed non-magnetic tapered tube **36**. A freely movable, magnetic restriction element **38** is located within the tapered tube **36** for purposes hereinafter described. The oil then passes through the tap fitting **31** into return line **33**, through fitting **27** into the return line **24**. The usual by-pass line **35** with its check valve **37** are provided to by-pass the control line fluid in event of the malfunctioning of the pump **32** or stoppage in the tapered tube **36**.

Magnetic induction coils **40** and **41** are positioned around and adjacent the tapered tube **36** so as to be influenced by the rise and fall of the magnetic restriction element. These coils are connected as shown to the motor control portion **42** of the motorized control valve **20** in the heating fluid line and to a source of suitable electrical power supply **43**.

With reference to FIG. 2, the modification here shown consists principally in employing a permanent magnetic fork **50** whose tines **51** extend on each side of the non-magnetic tapered tube **36**. The fork **50** is balanced on a knife edge or other suitable pivot arrangement **52** and its extending arm **53** is arranged to open and close the relay contacts **54** and **55**. These relay contacts **54** and **55** are connected, as shown, to the motorized control **42** of the valve **20** and the source of electrical power supply **43**.

In the operation of the control device shown in FIG. 1, a small quantity of fuel oil is bled from the main line **24** and is passed to the positive displacement type pump **32** from which it is delivered to the non-magnetic tapered tube **36** at a constant rate. This tapered tube **36** is so positioned that the metallic and freely movable restriction element **38** of magnetic qualities located therein is responsive to the force of gravity and the internal friction or viscosity of the fluid moving through the tube. The magnetic restriction element in the tapered tube, with a constant rate of fluid flow, positions itself at that point at which the internal friction or viscosity of the oil is balanced by the weight of the element. An increase

in viscosity causes the element to rise while a decrease in the viscosity will permit it to fall. The induction type relay **40**, **41**, **42**, the magnetic field of which is conditioned by the position of the magnetic restriction element with relation to the coils **40** and **41**, will respond to the assumed position of the element to actuate a control **42** which in turn monitors the supply of energy to the fuel heater **14** through the motorized control valve **20**. If the magnetic element rises in the tapered tube because of an increase in viscosity, the magnetic field of the relay is changed and the relay and its control operates to increase the energy flow to the oil heater which increases the temperature of its contents. This increase in temperature acts to reduce the viscosity of the oil discharging from the heater, thus allowing the magnetic element to return to its initial predetermined position. Conversely, if the magnetic element drops below its initial position because of reduced viscosity, the relay operates to reduce the energy flow to the oil heater, thus reducing the temperature and increasing the viscosity of the oil. The median position of the magnetic restriction element **38** in the tapered tube **36** is adjustable to that corresponding to the desired viscosity of the fluid passing through the system.

The principle of operation of the circuitry in FIG. 2 is identical to that described above except that here we have a mechano-magnetic system instead of the electro-magnetic system of FIG. 1. As the magnetic restriction element **38** rises and falls under the variable viscosity conditions outlined above, the permanent magnetic fork **50** follows the element **38** and its arm **53** makes contact with relay contacts **54** and **55**, depending on the motion of the element **38**. Obviously, as the element **38** falls due to reduced viscosity, the fork **50** follows it and the arm contacts and closes the relay points **54**. This results in reducing the energy flow to the fluid heater and the viscosity thereof is increased. The converse follows. As before, the median position of the element **38** may be adjusted by controlling the flow of fluid of the desired viscosity through the tapered tube **36**. A further finer adjustment is here provided which consists of the movable pivot **52** being adjustable to either center the arm **53** between the relay contacts **54**, **55**, or to assume such position with relation thereto as may be desired.

While the preferred embodiment of the invention, and an important modification thereof, have been described, it is to be understood that the description is illustrative only and there is no intention of being limited thereto. While my invention has been described, mainly, as being applicable to fuel oil systems, it is equally applicable to any system wherein the viscosity of a fluid is a function of a controllable temperature. Obviously, many modifications of my system may be suggested by those skilled in the art. It is contemplated that all such may well fall within the spirit of the disclosed invention and the scope of the appended claims, wherein I claim:

1. In a fluid system having a main fluid conduit, variable heating means connected in said main conduit for heating said fluid and pump means connected in the main conduit for forcing the fluid therethrough, a fluid viscosity control comprising:

a bypass fluid conduit connected to said main fluid conduit so as to bypass a portion of the fluid around a portion of the main fluid conduit;

a constant flow pump connected in said bypass conduit for maintaining a constant flow of said fluid through said bypass conduit; and

means operatively connected to said bypass conduit for magnetically sensing the viscosity of the fluid flowing therethrough and for controlling the heat of the variable heating means as a function of said viscosity.

2. A fluid viscosity control as claimed in claim **1** wherein:

the magnetic sensing means includes a tapered non-magnetic tube connected in said bypass conduit;

a freely movable magnetic restriction element within the tapered tube and capable of moving longitudinally therein in response to the viscosity of the fluid flowing therethrough; and

means associated with the tapered tube and located exterior thereof for sensing the movement of the magnetic restriction element.

3. In a fluid system including a first conduit leading from a source of fluid supply to a point of consumption, pump means interposed in the first conduit for forcing the fluid therethrough, a heating means interposed in the first conduit for regulating the temperature of the fluid passing therethrough, an infinitely variable source of energy for said heating means and control means associated with the source of energy for variably controlling the amount of energy supplied to the heating means, a fluid viscosity control comprising:

a second conduit leading from said point of consumption back to said source of supply;

pump means interposed in the second conduit for forcing fluid therethrough at a constant rate; and

sensing means associated with said second conduit for electromagnetically sensing the viscosity of said fluid, said sensing means capable of being connected with said control means for regulating the temperature of said fluid passing through said heating means as a function of said viscosity.

4. A fluid viscosity control as claimed in claim **3** further characterized by said sensing means comprising:

a tapered non-magnetic tube connected in the fluid circuit associated with said second conduit;

a magnetic restriction element suspended in the fluid within said tapered tube, said element being free to move with respect to the longitudinal axis of said tube and said element having a median position in said tube established by the predetermined fluid viscosity acting against said element to counteract its weight;

means associated with said tube for creating a magnetic field coaxial with respect to the longitudinal axis thereof;

a source of electrical power associated with said means; and

connection means for connecting said means with said source of electrical power and said variable control means for said source of energy for said heating means.

5. A fluid viscosity control as claimed in claim **4** wherein said means for creating said magnetic field consists of a pair of solenoid coils surrounding said tapered tube, said coils being positioned on either side of said median position of said magnetic restriction element.

6. A fluid system as claimed in claim **3** further characterized by said sensing means comprising:

a tapered non-magnetic tube connected in the fluid circuit associated with said second conduit;

a magnetic restriction element suspended in the fluid within said tapered tube, said element being free to move with respect to the longitudinal axis of said tube and said element having a median position in said tube established by the predetermined fluid viscosity acting against said element to counteract its weight;

magnetic means partially surrounding said tapered tube, said magnetic means being adapted for following said element in its motion along the longitudinal axis of said tube;

electrical contact means carried by and associated with said magnetic means;

a source of electrical power associated with said contact means; and

electrical circuit means for connecting said source of electrical power, said electrical contacts and said variable control means for said source of energy for said heating means.

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