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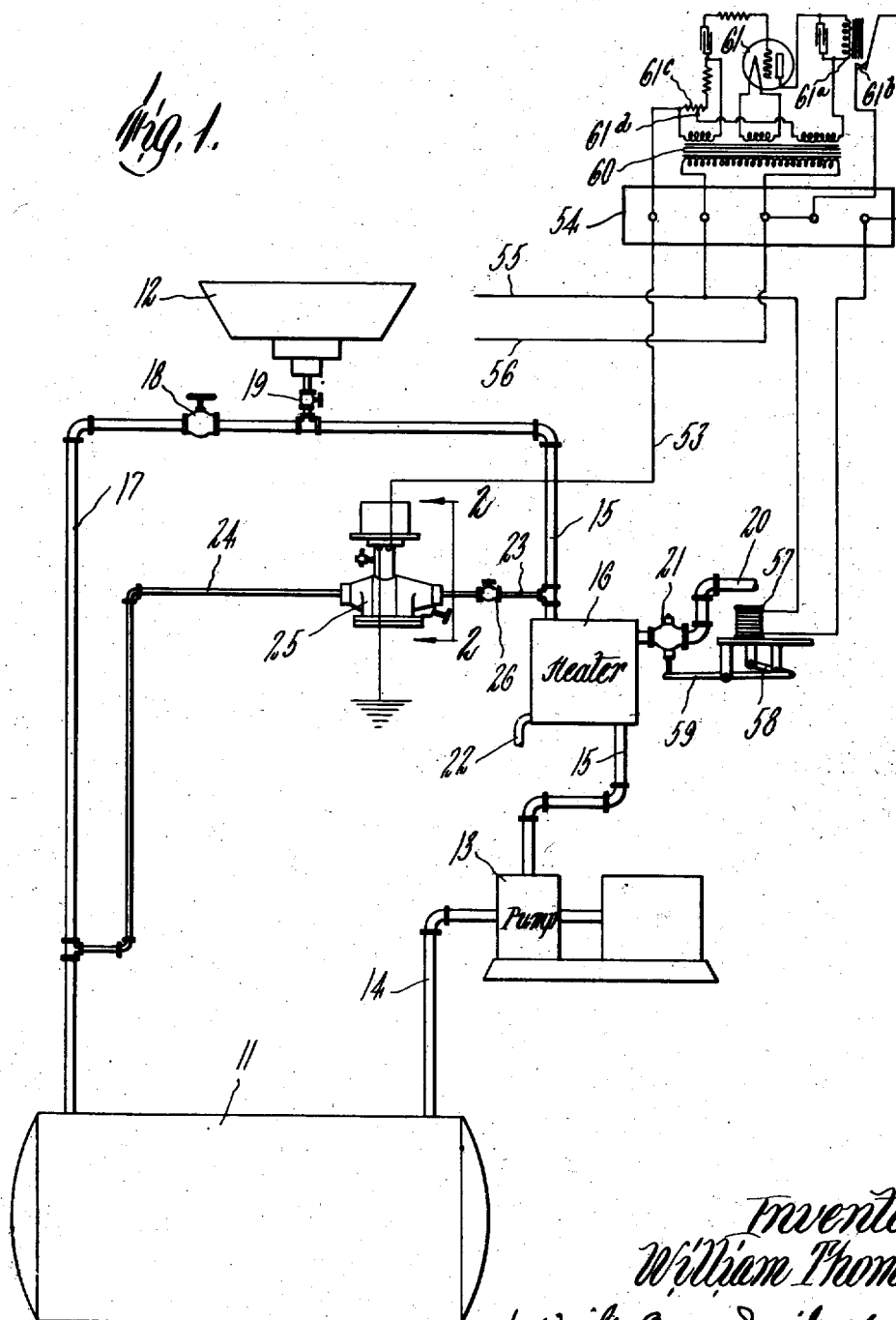
W. THOMAS

2,031,018

VISCOSITY REGULATOR

Filed May 15, 1933

4 Sheets-Sheet 1



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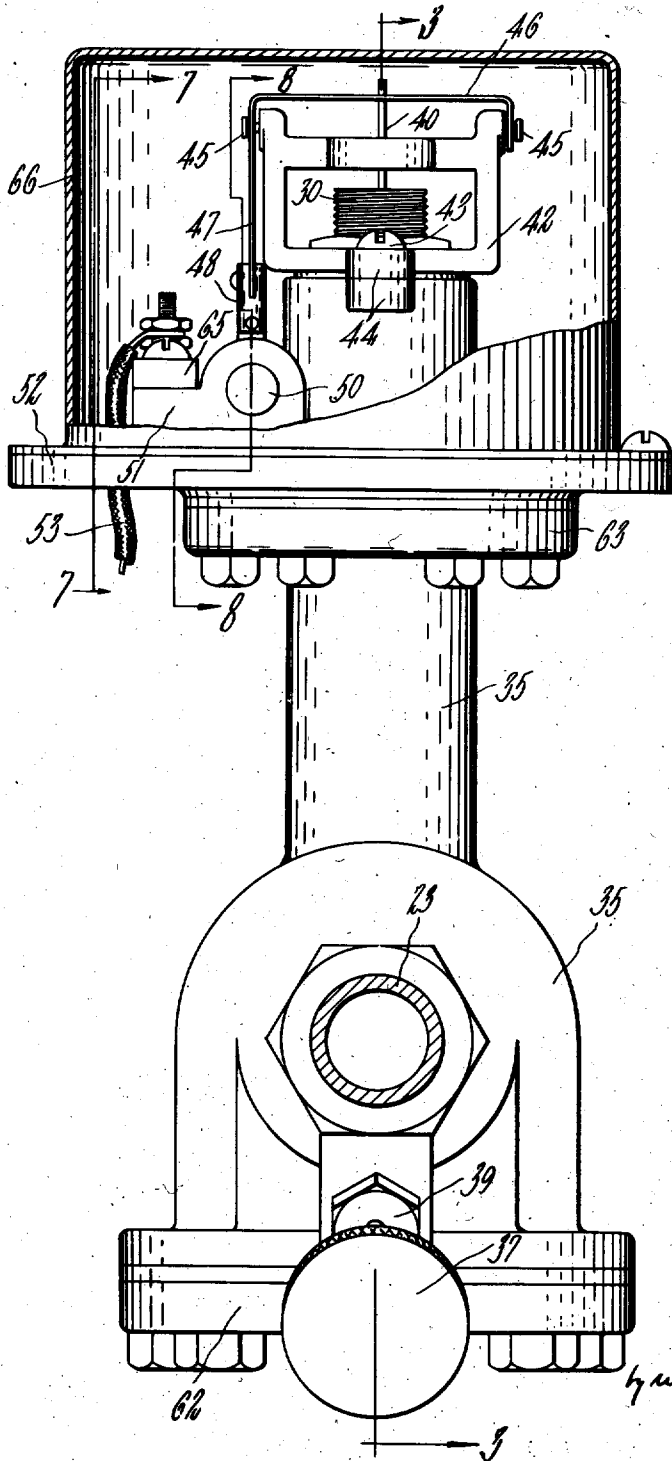


Fig. 2.

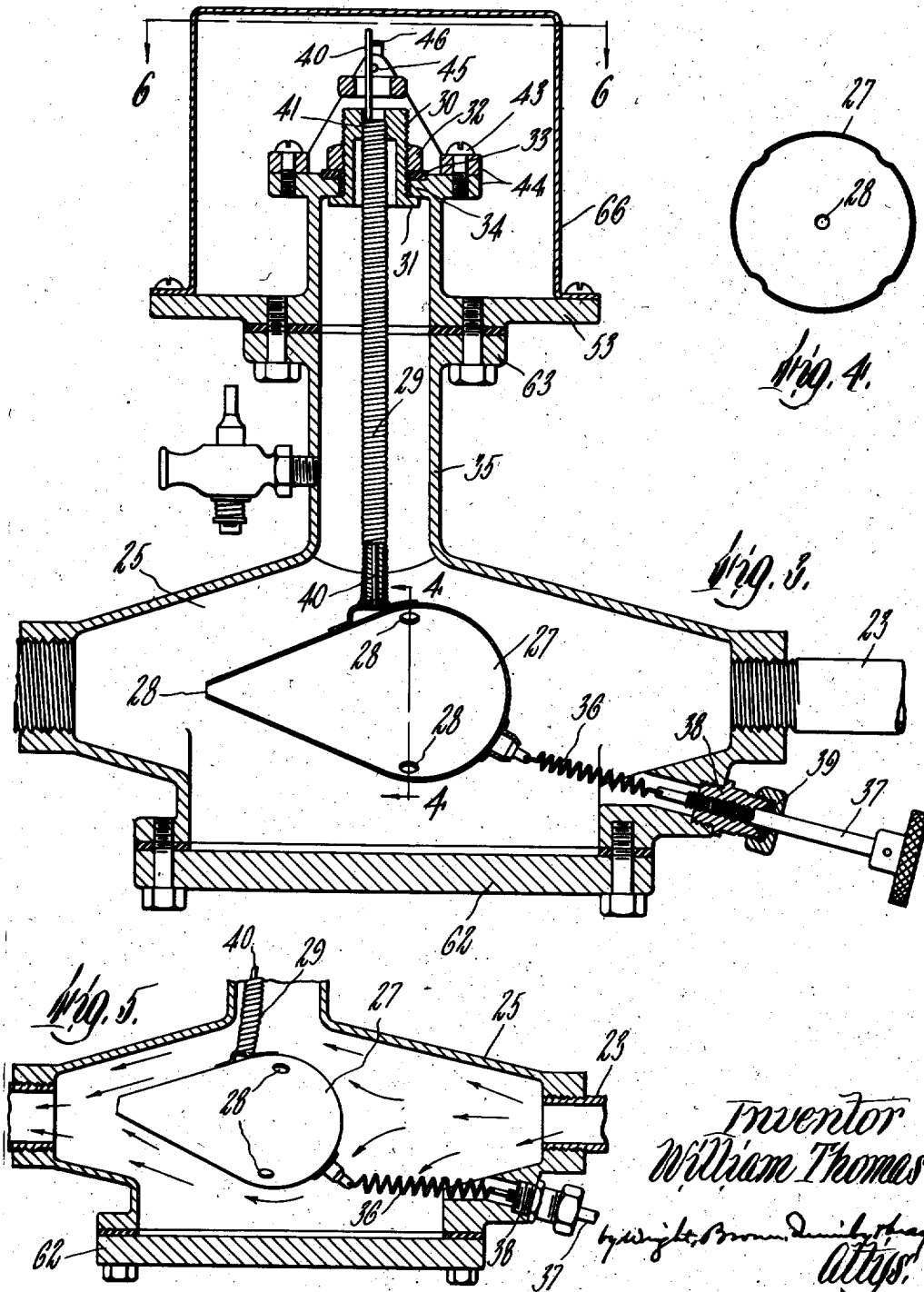
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4 Sheets-Sheet 3



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Fig. 6.

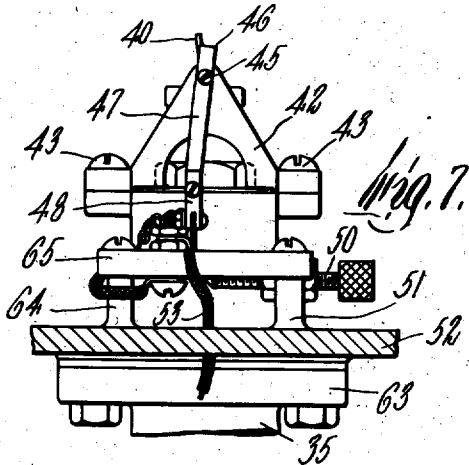
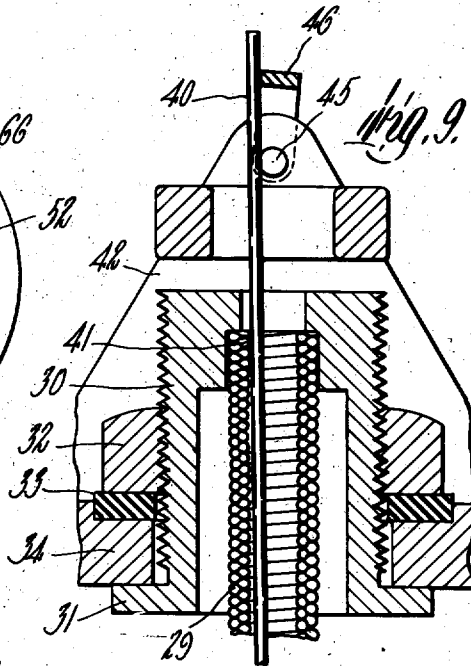
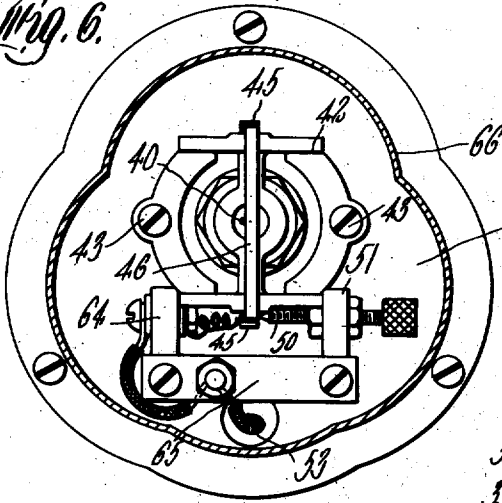
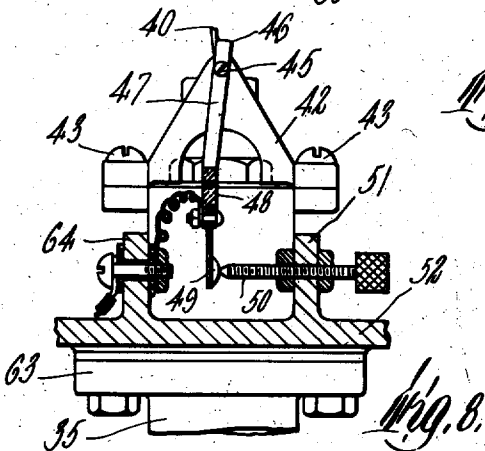
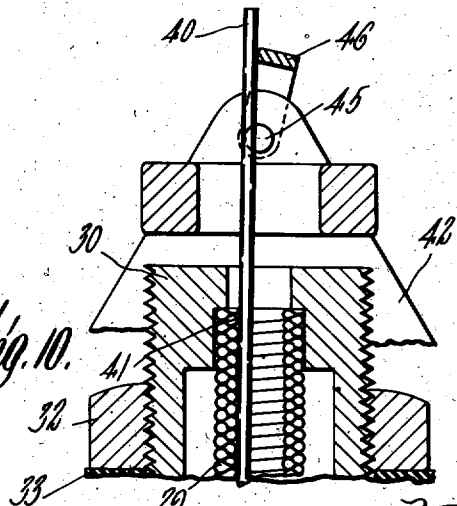


Fig. 10.



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UNITED STATES PATENT OFFICE

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VISCOSITY REGULATOR

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Application May 15, 1933, Serial No. 671,193

9 Claims. (Cl. 137-78)

The present invention relates to means for controlling, altering and regulating the viscosity of liquids; such liquids, for example, as fuel oils of the grades which are burned under the steam boilers of power plants. While the invention is not limited as to its field of use, it has special utility, and was developed with primary reference, to the purpose of maintaining a definite prescribed viscosity in oils of the heavier grades which are burned to generate industrial power. The invention will now be described in terms of its adaptability for that purpose, in the understanding that such description does not imply any limitation of protection to less than that to which the invention is entitled by virtue of its place in the art.

It is well known that in burning the heavier grades of oil for industrial purposes, the most effective combustion is secured by maintaining a constant viscosity and pressure for each particular grade of oil and each orifice of burner tip, regardless of the load on the boiler. In most installations, the proper pressure at the burner is maintained by operating a valve in the oil return line to the storage tank, this valve being opened or closed, according to the load or the number of burners.

Viscosity may be varied either by mixing oil of different viscosity with that taken from the main supply, or by varying the temperature of the oil at some point in its course from the supply tank to the burner. In practice the only variation made in viscosity is to thin the sluggish oil by heating or by dilution with a lighter oil.

The object of this invention is to provide a simple control apparatus which is sensitive to the viscosity of oil and is adapted to operate through electrical or other suitable control means to open and close a valve for admitting steam to a steam heater through which the oil passes, or admitting dilution oil to the stream flowing to the burner, or alternatively, to operate other heat controlling means of any suitable character, such as the switch of an electric heater, etc. In utilizing the viscosity of the oil as the primary control factor, I am able to avoid the difficulties and objections incident to the use of thermostatic and damper control means, to obtain an extremely high degree of sensitivity in control, and to effect adjustments in a most simple and efficient manner. The primary controlling element of the invention is a movable body immersed in a flowing stream of the oil and which is affected by friction of the oil on its surface and is restrained by yielding means from traveling with the oil.

Its movements in opposite directions due to changing viscosity of the oil are utilized to operate an electric relay or the like, which in turn causes a regulating valve to be opened and closed. An embodiment of the invention in connection with an oil burning system which uses steam to heat the viscous sluggish oil is shown in the drawings herewith and described in the following specification.

In the drawings,—

Fig. 1 is a diagrammatic view of the entire apparatus;

Fig. 2 is an elevation partly in section of the controller in which the invention is particularly embodied, viewed from the line 2—2 of Fig. 1;

Fig. 3 is a section of the control apparatus taken on line 3—3 of Fig. 2;

Fig. 4 is a detail cross section of the primary control element taken on line 4—4 of Fig. 3;

Fig. 5 is a sectional view of the lower part of the regulator showing the primary control element as displaced by the frictional drag of flowing oil;

Fig. 6 is a plan view of the controller and horizontal section on line 6—6 of Fig. 3;

Fig. 7 is a side elevation and vertical section on line 7—7 of Fig. 2;

Fig. 8 is a vertical section on line 8—8 of Fig. 2;

Figs. 9 and 10 are detail sectional views on an enlarged scale showing the packing and fulcrum mounting by which the primary control element is supported and through which it operates the electric circuit closer which constitutes a second element of the control means.

Like reference characters designate the same parts wherever they occur in all the figures.

Referring to Fig. 1 which shows diagrammatically the principles of an oil burning plant in which the invention is embodied, 11 represents a storage tank in which a supply of oil is contained, and 12 represents an oil burner, typifying any type or character of burner by which oil of the heavier grades may be burned. Oil is withdrawn from the tank by a pump 13 through a pipe 14, and forwarded to the burner through a pipe line 15 and a heater 16 interposed in this pipe line. A return pipe 17 leads back to the tank from the burner. In fact the supply and return lines form a closed circulating system with the tank, from which branches lead to the burner 12, and other burners. The desired pressure is maintained in the supply side of this circuit by a valve 18 in the return line, and each burner has its own independent regulating valve 19.

The heater 16 may be assumed to be a steam

heater to which steam is admitted by a pipe 20 under control of a regulating valve 21, and in which there are suitable provisions for making intimate thermal contact between steam and oil. 22 represents a waste pipe for the condensed water. However, this heater may be considered as typifying a heater of any other character in which other heating agents than steam may be used, as a flame, an electric heat generator, etc., controlled by a valve or switch; and it may also typify a mixing chamber into which lighter oil may be delivered by pipe 20 under control of a valve. In the generic sense therefore the heater is a modifier of the viscosity of the oil, and may be so called.

A by-pass 23, 24 leads from the supply pipe at the delivery side of the viscosity modifier to the return line. This by-pass is composed in part by the casing 25 of my new viscosity regulator. The part 23 of the by-pass between the supply pipe and the regulator is of small capacity compared with the supply pipe, so as to permit only a small proportion of the oil to pass the regulator; and it is provided with a valve 26 which may be adjusted to throttle this flow, as well as to be closed entirely. Thus oil with the same viscosity as that supplied to the burner is caused to traverse the regulator with a continuous flow at low velocity and pressure, and without substantially reducing the supply available for the burners. However, if desired, and provided the regulator is designed to withstand the high pressure of oil in the burner supply line, the return side of the by-pass may also be connected to the supply pipe, rather than to the return pipe; or the regulator could be interposed directly in the main supply line.

Referring to Figs. 3 and 4, the casing 25 of the regulator is shown as forming an enlarged chamber in the by-pass, being in effect a part of the same conduit with the pipes 23 and 24. In this chamber is located the primary control element 27 which for convenience of description I have called a movable baffle. It is preferably located in the axis of the flowing oil stream, and is made with stream-line contours in order to utilize to the fullest practicable degree the effects of surface friction, and to minimize the effect of direct pressure and impact for deriving motion from the stream. Thus the friction of the oil on the sides of the baffle tends to carry the baffle with the oil stream against the resistance of the yieldable restraining means, presently described. By its stream lined form, the baffle cancels out to a great extent the impact or pressure factor which causes flow and velocity, and is made extremely sensitive to friction drag and to the variations of friction due to variations in viscosity of the liquid. A commercially practicable and economical approximation to the most efficient stream-lined form is obtained by making the baffle as a hemisphere at the end which faces against the direction of flow, and giving it a reducing conical taper from the large end in the direction of flow.

The baffle is preferably made of thin sheet metal, hollow, with ports 28 in its sides and small end so as to admit the oil freely to its interior. This reduces its buoyancy to the lowest possible terms and eliminates errors and aberrations due to buoyancy; still further limiting the effects of the oil upon it to those due to friction alone.

The baffle is flexibly suspended by a metallic hose or tube 29 of bellows construction, which is secured rigidly at its lower end to the upper side of the baffle, and is anchored at its upper end in

a thimble 30 which is secured by its flange 31 and a clamp nut 32 and packing washer 33 in the end wall 34 of a tubular extension or stand-pipe 35 which rises from the upper side of casing 25. The flexible hose is located centrally within this stand-pipe and the thimble, the walls of which, except where the hose is sealed in the thimble, are separated far enough to permit free and unimpeded flexing of the hose with movements of the baffle back and forth under varying conditions of oil viscosity. A spring 36 is connected at one end to the baffle and at its other end to a regulating spindle 37 which passes to the exterior of the casing in screw threaded connection with a nipple 38 and is rotatable for adjustment. A stuffing box 39 prevents leakage of oil past the spindle 37; and the hose 29 prevents escape of oil through the thimble 30, being itself of impervious bellows construction and being sealed liquid tight at its ends to the baffle and in the thimble, respectively, by solder or suitably otherwise.

A rod 40 which passes through the whole length of the flexible hose 29 and protrudes from the end of the latter, is rigidly fastened to the baffle at its lower end centrally in the hose, and is bent or curved between its ends so that it bears against the inner wall of the hose at the outer end of the latter approximately at the location indicated by the numeral 41 in Fig. 9. This bearing point is in the diameter of the hose parallel to the direction of stream flow and is the fulcrum point about which the rod 40 swings when the baffle moves with, or oppositely to, the oil stream. The protruding end of the rod operates an electric switch or circuit breaker which is the secondary element of the viscosity control, and will now be described.

A bracket 42 is secured to the upper end of the stand-pipe by means of screws 43 in lugs 44, and supports pivots 45 at opposite sides of the axis of the stand-pipe. A yoke 46 is mounted to oscillate on these pivots and crosses the stand-pipe beside the rod 40. One arm 47 of the yoke carries an insulating holder 48 in which is mounted a switch contact button 49 cooperating with an adjustable stationary contact 50 made as a screw which is threaded through a lug 51 on base 52. The contact 49 is normally held by gravity against the contact 50, due to the arrangement and disposition of these parts, as shown by the drawings. But equivalent means, such as a spring, may be obviously substituted for gravity in other arrangements embodying the principles of this invention.

The most sensitive position of the baffle is that which it naturally assumes by gravity when no oil is flowing through the regulator. Hence the rod 41 and the yoke or rocker 46 are mutually so disposed as to allow the contact 49 to rest against contact 50 when the baffle is in that position. This is the position shown in all the figures except Figs. 5 and 10. But when the baffle is displaced by flowing oil of too great viscosity, as indicated in Fig. 5, it causes rod 40 to swing about the fulcrum point 41, as shown by Fig. 10, thereby displacing the rocker yoke and separating contact 49 from 50.

One of these contacts, preferably the screw contact 50, is grounded on the frame, and the other one is connected by conductor 53 with a relay 54 to which electric current is supplied by the line wires 55 and 56, which controls a solenoid 57 operating valve 21 through levers 58 and 59. The relay is one of the type in which

a vacuum tube controls current output, but involves novel features and principles for which I claim protection. The alternating current in the line induces, by means of a transformer 60, alternating currents in the filament, grid and plate of a vacuum tube 61. The grid potential is positive when the circuit of the regulator is open. When this condition exists, current flows to the plate element of the tube, the contactor coil 61a is energized and contactor 61b is closed, which completes the circuit of solenoid 57 with the line, and causes valve 21 to be opened. But when the circuit of the regulator is closed, the grid circuit is grounded, its potential is negative, flow of current to the plate is instantly stopped and the contactor coil 61a becomes dead, contactor 61b opens the solenoid circuit, and the valve 21 closes. Gravity, a spring or other force or force applying means may be employed for opening the valve.

In order to prevent the solenoid valve from chattering and the system as a whole from hunting, means are provided for delaying the closing of the solenoid circuit. This time delay is accomplished by adjusting a variable resistance 61c in the grid circuit. The adjustable connection 61d of this resistance is in one side of the plate circuit. The less resistance there is in this path to the grid element, the more positive becomes the grid; hence the more rapid the return to positive from negative. The larger the resistance in this circuit, the slower is the change from negative to positive. The range of adjustment provided in the apparatus which I have made for commercial use allows a variation in time lag from zero to four seconds.

A wide range of viscosity regulation is obtainable by adjustment of the spindle 37 which varies the resistance offered by spring 36 to displacement of the baffle by oil friction. Thus this adjustment alone suffices to adapt the regulator instantly and accurately to oils of different grades, and to enable the switch 49, 50 to be alternately opened and closed with minute variations from any specific degree of viscosity which is determined as suitable for flow through the burner. It will be seen from Fig. 3 that the distance from fulcrum point 41 to the point where rod 40 bears on rocker 46 is a small fraction of the distance from this fulcrum point to the baffle, wherefore the baffle acts on the rocker with multiplied leverage through this rod. This, as well as the length and flexibility of the hose 20, assures that minute differences in the friction effect of oil on the baffle will be transposed into useful units of force and transmitted without loss to the control switch.

Desirable structural features which, however, are not fundamental essentials of the invention, are the following. The casing 25 is made with an opening in the bottom large enough to receive the baffle, which is closed after assembly by a plate 62 bolted in place with an interposed packing washer.

The stand-pipe 35 is made in two parts, of which the lower part is integral with the casing 25 and the upper part is in one piece with the base 52 which is bolted to a flange 63 with an interposed washer and carries the lug 51 previously mentioned and also a lug 64 in which a binding post for the wire leading to the movable switch contact 49 is mounted. A bridge 65 is secured across the lugs 51 and 64, containing a binding post to which the conductor 53 from the relay 54 is connected and from which a

wire leads to the binding post for the contact 49, as plainly shown by the drawings. A cover 66 is bolted detachably to the base 53 and encloses the upper end of the stand-pipe, the circuit closer or relay switch, and associated parts.

It is to be understood that this invention embraces not only the specific embodiment herein illustrated, but also the generic principles thereof and all equivalent forms of such principles, for all purposes to which they are applicable; whether the liquid to be regulated is oil or other viscous liquid and whether the destination of the liquid is a burner or other receiver, and whether the viscosity is altered by heating, cooling, mixing, or otherwise.

What I claim and desire to secure by Letters Patent is:

1. A viscosity regulator comprising a chamber having an inlet and an outlet for conduction of a flowing stream of liquid, a flexible liquid tight hose suspended from and opening through the top of said chamber in liquid tight connection therewith, a body secured in liquid tight connection with the lower end of said hose and suspended thereby in the midst of the chamber for frictional contact with the flowing liquid, a rod passing through the flexible hose into rigid connection with the friction body at the lower end of the hose and having a fulcrum bearing at one side of the upper end of the hose, and protruding therefrom to provide an external lever arm adapted to transmit motion for useful purposes.

2. A viscosity regulator comprising a chamber having aligned inlet and outlet and an extension at one side between said inlet and outlet, a flexible hose sealed liquid tight in the outer end of said extension and projecting thence into said chamber, clear of the walls of the extension whereby it is free to flex toward either the inlet or the outlet, a movable baffle secured liquid tight to the inner end of said hose in the midst of the flow passage between the inlet and outlet, adapted to be displaced with, or against, the flow of liquid through the chamber, a spring acting on said baffle in opposition to the liquid flow to make the displacements of the baffle proportional to the surface friction effect of the liquid due to its viscosity, and means operable by such displacements of the baffle for effecting a viscosity modification of the liquid.

3. A viscosity regulator comprising a chamber having aligned inlet and outlet and an extension at one side between said inlet and outlet, a flexible hose sealed liquid tight in the outer end of said extension and projecting thence into said chamber, clear of the walls of the extension whereby it is free to flex toward either the inlet or the outlet, a movable streamlined baffle secured to the inner end of said hose and located in the midst of the chamber for displacement due to the friction of liquid flowing therethrough, an adjustable spring connected with the baffle to act thereon oppositely to the liquid, and means actuated by such displacement of the baffle for effecting a modification in the viscosity of the liquid.

4. A viscosity regulator comprising a chamber having aligned inlet and outlet and an extension at one side between said inlet and outlet, a flexible hose sealed liquid tight in the outer end of said extension and projecting thence into said chamber, clear of the walls of the extension whereby it is free to flex toward either the inlet or the outlet, and a stream-lined hollow baffle having ports opening to its interior, secured to the inner end of said hose and located thereby in

the midst of a stream flowing through the chamber.

5 5. A viscosity regulator comprising a chamber having an inlet, an outlet, and a lateral extension intermediate the inlet and outlet and transverse to the line joining them, a stream-lined baffle located in the chamber in the line of flow between the inlet and outlet adapted to be displaced by surface friction with the liquid, yielding means
10 acting on said baffle in opposition to the frictional drag of the liquid, a rod secured to the baffle projecting through and out of said extension, a flexible liquid impervious hose surrounding said rod and fastened in liquid excluding connection at one end with the baffle and in liquid
15 excluding connection at its other end with the outer part of said casing extension, the rod protruding from said sleeve and having a fulcrum bearing in the outer end thereof.

20 6. A viscosity regulator comprising a chamber having an inlet, an outlet, and a lateral extension intermediate the inlet and outlet and transverse to the line joining them, a stream-lined baffle located in the chamber in the line of flow between the inlet and outlet adapted to be displaced by surface friction with the liquid, yielding means acting on said baffle in opposition to the frictional drag of the liquid, a rod secured to the baffle projecting through and out of said
25 extension, a flexible liquid impervious hose surrounding said rod and fastened in liquid excluding connection at one end with the baffle and in liquid excluding connection at its other end with the outer part of said casing extension, the rod
30 protruding from said sleeve and having a fulcrum bearing in the outer end thereof, a rocker pivotally mounted on said extension and arranged for engagement by the protruding end of said rod to be moved thereby in consequence of displacements of the baffle, and an electric circuit closer
35 operable by said rocker.

40 7. A viscosity regulator comprising a chamber having a hollow extension in one side and an inlet and outlet in a line transverse to said extension, a hollow stream-lined baffle having an opening into its interior located in the chamber in the line of stream flow between the inlet and the outlet, an impervious flexible hose secured at one end to the baffle and projecting thence through

the extension into liquid tight union with the outer end part of the latter, said hose forming both a support for the baffle and a means to prevent leakage of outflow of liquid through the extension, a spring connected with the baffle and
5 arranged to exert yielding force thereon oppositely to the direction of liquid flow through the chamber, means external to the chamber for adjusting the force application of said spring, and a lever connected with the baffle adapted to
10 operate viscosity moderating means in consequence of displacements of the baffle.

8. A viscosity regulator comprising a chamber having a hollow extension in one side and an inlet and outlet in a line transverse to said extension, 15 a hollow stream-lined baffle having an opening into its interior located in the chamber in the line of stream flow between the inlet and the outlet, an impervious flexible hose secured at one end to the baffle and projecting thence through 20 the extension into liquid tight union with the outer end part of the latter, said hose forming both a support for the baffle and a means to prevent leakage of outflow of liquid through the extension, a spring connected with the baffle and
25 arranged to exert yielding force thereon oppositely to the direction of liquid flow through the chamber, means external to the chamber for adjusting the force application of said spring, a lever connected with the baffle for movement in
30 consequence of displacement by the latter, and an electric circuit closer mounted on the chamber extension and shiftable by said lever for opening and closing an electric circuit.

9. A viscosity regulator comprising a conduit, 3 an element supported yieldingly in said conduit so as to be movable against yielding resistance by the frictional drag of fluid passing through the conduit, a means in connection with the conduit for changing the viscosity of the liquid therein, 4 an electromagnetic appliance for actuating said viscosity changing means, an electric relay controlling the circuit of said electromagnetic appliance, including a vacuum tube, and a circuit closer operable by said frictional drag element, 4 one contact of the circuit closer being in circuit with the grid element of the vacuum tube and the complemental contact being grounded.

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