Sept. 9, 1941. J. R. HAWLEY 2,255,318

CONTROL APPARATUS FOR OIL BURNERS

Filed Aug. 21, 1939 2 Sheets-Sheet 1

Fig 1

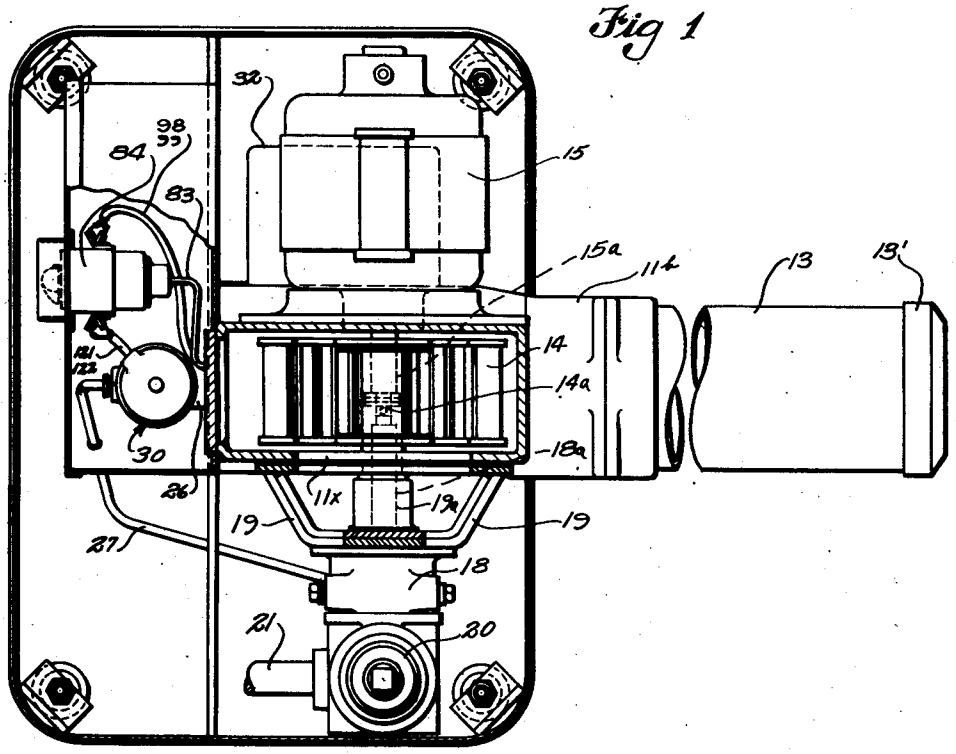
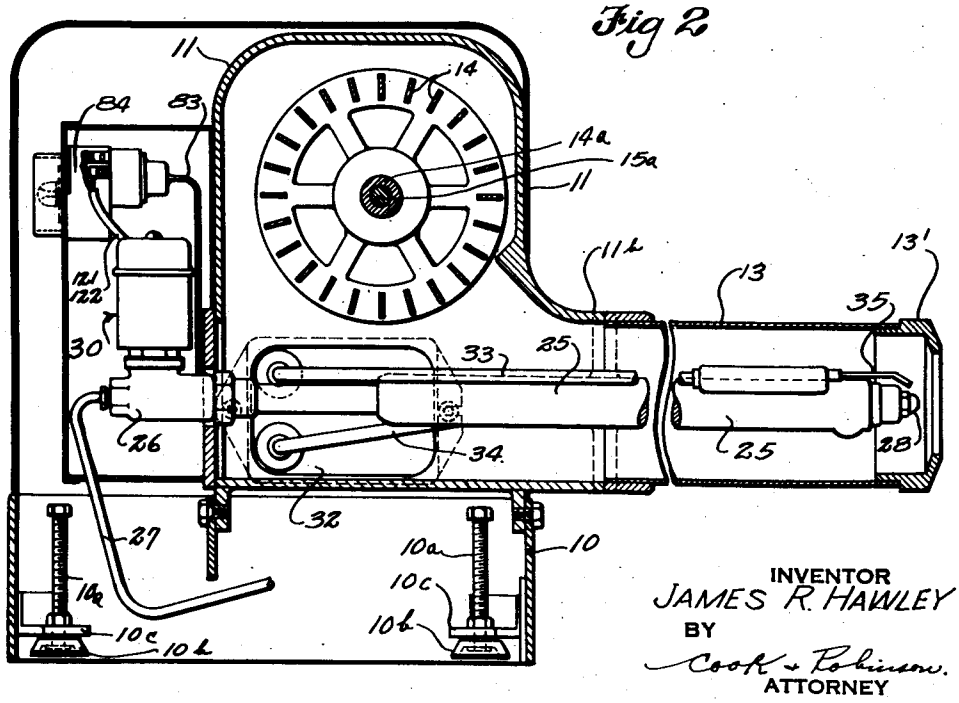


Fig 2



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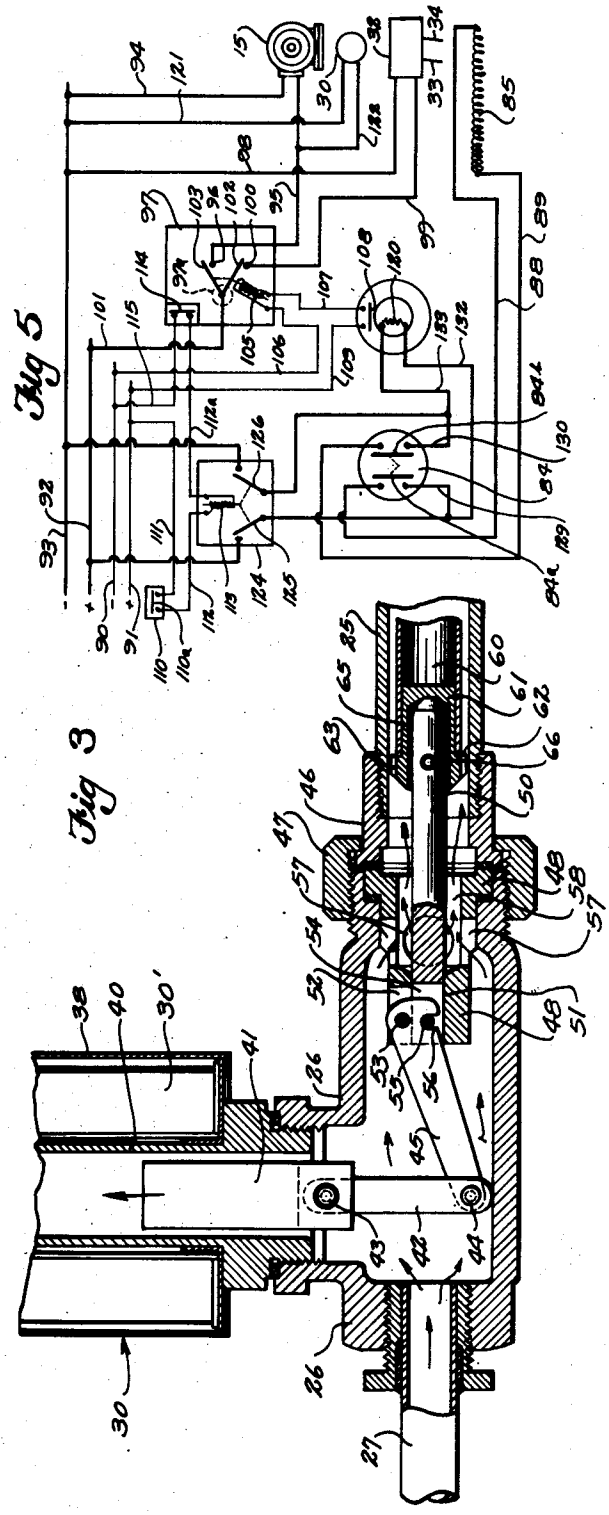


Fig 5

Fig 3

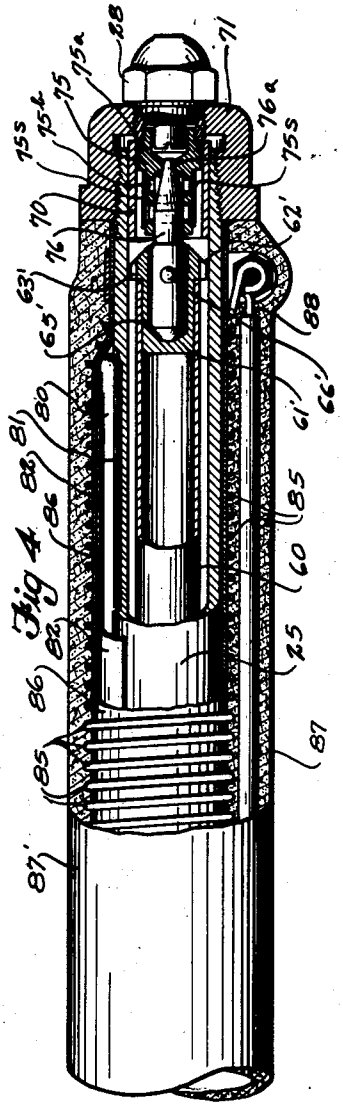


Fig 4

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CONTROL APPARATUS FOR OIL BURNERS

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Application August 21, 1939, Serial No. 291,148

9 Claims. (Cl. 158—28)

This invention relates to heating systems and more particularly to improvements in oil burners designed for the heating of homes, for commercial plants and various other uses, and adapted to burn what is generally referred to as "heavy" fuel oil; it being the principal object of this invention to adapt the principle of atomization of heavy fuel oils, by applying heat and mechanical pressure to small capacity nozzles, thereby to render their operation satisfactory and free from coking or other fouling.

Explanatory to the invention, it will be here stated that it has been recognized in the use of heavy fuel oils that a greater heating efficiency can be obtained in the burning operation if the temperature of the fuel oil is raised to a degree near the temperature of combustion before it is atomized for ignition in the combustion chamber. In some burners, provision has been made for such heating of the oil, but usually at some point remote from the actual point of atomization and burning.

There have been some disadvantages observed in such preheating of the oil at a point distant from the point of combustion; for example, in the resultant heat loss from the oil as it flows from the point of heating to the point of combustion, and the corresponding loss of burning efficiency. It has been particularly noted, however, that should the pre-heating be carried to a high degree sufficient to compensate for this drop in efficiency due to heat loss, there will then be the objectionable feature of coking of the oil in the preheating coils and apparatus, requiring that they be periodically cleaned of such coke or carbon, or that the apparatus ultimately be replaced because of resultant deterioration.

Furthermore, small particles of this coke will be dislodged from the inside walls of the heater pipes, and will be carried to the atomizing nozzle, either partially or completely closing the orifice therein, rendering the burner inoperable and also presenting a serious hazard to safety. It is also possible that such particles of carbon or coke would clog or foul the valve plunger in its valve seat, holding it partially open, and allowing a slow drip or leaking of the oil, also creating a serious hazard to safety.

Another disadvantage incident to the preheating of the oil at a point remote from the point of ignition, is due to the long period of time required to bring the oil to a temperature for ignition.

In view of the above mentioned, and other disadvantages in systems as generally manufactured, it has been an object to provide an oil burner wherein the oil, delivered from a point remote from the burner, is preheated within the burner itself to a degree reasonably close to its vaporization temperature, and at a point substantially adjacent that where it is delivered in an atomized condition into the combustion chamber to avoid the previously mentioned heat loss, nozzle fouling and coking of the pipes.

It is also an object of this invention to provide a burner that will bring about a reduction in the cost of operation by reducing the amount of heat required to effect proper atomization of the oil and by preventing overheating of the oil supply.

Still another object of the invention is to provide an oil burner wherein the time required for the preheating operation prior to starting the burner is reduced to a minimum.

Another object of the invention is to provide a substantially accurate means of controlling the temperature of the oil in the pre-heating tube or chamber adjacent to the point of atomization so as to prevent overheating of the oil.

A further object of the invention is to provide that, upon shutting off the burner, the oil temperature in the heating tube or chamber be reduced, thereby dissipating the heat in the coils and eliminating the undesirable results that are incident to allowing over-heated oil to stand in the heating coils.

A still further object of the invention is to provide an oil burner of the kind stated, that is relatively simple in construction and relatively inexpensive to manufacture, that is durable in use, reliable and efficient in its operation, and otherwise well adapted for its intended uses.

Other objects of the invention reside in the details of construction of parts, in their combination and mode of operation as will hereinafter be fully described.

In accomplishing these objects, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein—

Fig. 1 is a horizontal, sectional view, taken centrally of a burner embodied by the present invention.

Fig. 2 is a vertical sectional view taken substantially axially of the blast tube of the burner.

Fig. 3 is an enlarged, sectional detail, showing the solenoid actuated valve mechanism for controlling oil delivery to the burner nozzle.

Fig. 4 is an enlarged, sectional detail of the burner nozzle and valve mechanism.

Fig. 5 is a wiring diagram, illustrating one way

in which the burner may be wired with electrical controls for automatic operation.

Briefly described, the present burner comprises a housing that contains a fan which is driven by an electric motor for the forcible delivery of air through a blast tube into the combustion chamber of the stove or furnace. Located coaxially within the blast tube is an electrically heated oil delivery tube which, at its outer end is connected to a source of oil supply and at its inner end is equipped with an atomizing nozzle for the derivery of the oil, in an atomized condition with the air blast, into the combustion chamber.

Automatic devices control the energizing of the electrical heating element, and also the delivery of oil to the atomizer in accordance with the objects of the invention as previously stated. The automatic means includes the usual room thermostat, that may be set to operate at a selected room temperature, a time delay switch for setting the pump and motor in operation after a predetermined time interval necessary for the oil heating and various relays later to be explained in detail.

Referring more in detail to the drawings—

The present device, in a preferred form of construction, comprises a rectangular base section 10 which mounts thereon a fan housing or casing 11. The base member may be made in various sizes, and of various heights, to best adapt it for use with stoves, furnaces or boilers of different kinds, and it is equipped within its four corner portions with vertical legs 10*a*, with feet 10*b*, and these legs are threaded through mounting brackets 10*c* fixed in the base, and they may be vertically adjusted therein to level the burner and maintain it at a set position.

The fan housing 11 rests upon and is rigidly fixed to the base member 10. It is substantially rectangular in cross section and within its upper portion containing an air delivery fan 14. The fan 14 is of the squirrel cage type and has a hollow hub portion 14*a* whereby it is mounted upon the end of the drive shaft 15*a* of an electric motor 15 which, in turn, is fixedly mounted upon a side wall of the housing 11. Air enters the fan housing through a side wall opening 11*x* opposite the motor.

Mounted on the side wall of the housing 11, about the wall opening 11*x*, is a bracket 19, and supported by the bracket 19 is a fuel oil pump equipped with a drive shaft 18*a* having a driving connection with the drive shaft of the electric motor 15.

Fixed to the pump housing is an oil filtering device, designated in its entirety by numeral 20, and this is connected by a pipe 21 with a source of supply of fuel oil, not shown. Upon operation of the pump, oil will be drawn through pipe 21 to the filter, and then delivered therefrom under pressure, to the oil heating tube, later to be described.

The lower portion of the fan housing 11 is rectangular in cross section, and is slightly larger than the upper portion, converging at its forward side to a cylindrical neck 11*b* from which a cylindrical air blast tube 13 extends for directing the air supplied by the fan 14 to the combustion chamber of the furnace with which the burner is used. At its delivery end, the tube is fitted with a nozzle member 13' for concentrating the blast and this may, if desired, be equipped with fins or deflectors, not shown, for causing a whirling or swirling delivery of the mixture into the combustion chamber.

Disposed horizontally within the housing 11 and coaxially of the blast tube 13 is the oil heating tube 25. The rearward end of this tube extends through the rearward wall of the housing 11 and is there provided with a tubular fitting 26 to which an oil delivery tube 27 from the pump 18 connects for supplying oil to the heating tube. At its forward end, the tube 25 is equipped with an atomizing tip 28 and this is disposed, as noted in Fig. 2, just within and centrally of the delivery end of the blast tube.

Mounted on a side wall of the housing 11, below the motor 15, is a transformer 32, and extending from this are circuit wires 33 and 34 leading into the housing and along the tube 25, terminating in ignition points 35 and 36 located adjacent the atomizing nozzle and between which points a spark may be caused to jump for igniting the combustible mixture as is the usual procedure.

Mounted upon the fitting 26 and disposed vertically thereon, is a solenoid 30 designed for control and operation of an oil delivery valve within the delivery end of tube 25, as presently will be explained.

As seen in Fig. 3, the solenoid 30 comprises a coil 30' that is enclosed within a housing 38, and is disposed about a cylindrical, liquid-tight, tubular dome 40, which is threaded into the fitting 26. The dome 40 contains a steel block 41 which operates as a solenoid core, and, as here shown, will be drawn upwardly upon energization of the coil.

A link 42 is pivotally connected to the lower end of the core, as at 43, and at its lower end, the link is pivotally attached, as at 44, to a lever 45 used in control of the oil valve in the tube, as presently will be explained.

The tube 25, as noted in Fig. 3, is threaded into a nipple 46 which is fixed to the fitting 26 by a coupling union 47. A tubular fitting 48, is inserted in the fitting 46 and is held in place by the nipple 46 and the union 47. This fitting 48 is shouldered to limit its insertion in part 26 and forms a leak-tight connection with the nipple 46 and it coaxially contains a rod 50, slidable therein within a coaxial bore 51. It will be noted that the fitting 48 is slotted at its inner end within part 26, as at 52, to receive the end of the lever 45, and this lever 45 is pivotally mounted in the slot 52 by a pin 53. Also, it will be noted that the rearward end of the rod 50 is slotted as at 54, and receives the pivoted end portion of the lever 45. Also, it is seen that a pin 55 is fixed in the rod 50 and extends through the slot, and that a notch or recess 56 in the lower edge of the lever receives the pin 55 therein. Ports 57 in the fitting 48 open into an enlarged central bore 58 for an unrestricted passage of oil therethrough to tube 25.

With this arrangement of parts, energization of the solenoid 30 causes an actuation of the lever 45 whereby the rod 50 will be pulled outwardly.

Disposed lengthwise within the tube 25 is a filler or spacer tube 60, provided at opposite ends with closure fittings 61—61' which seal the tube liquid-tight. These closure fittings 61 are provided with outer end portions 62—62' of a diameter slightly greater than that of tube 60, and they have an easy sliding fit within the tube 25. These enlarged portions 62—62' are provided with a plurality of notches or grooves 63—63' to allow a free and unrestricted passage

of oil therethrough and about the tube 60. Furthermore, the closures at the outer end of the tube 60 are counterbored, as at 65—65' from the outer end, to a diameter and depth suitable to loosely receive an end portion of the rod 50, and the valve plunger, as will presently be explained, which are fixed therein by pins 66—66' in a free or flexible connection.

The narrow passage between this filler or spacer tube 60 and the outer tube 25 provides for quicker and easier application of heat to the oil flowing therebetween, and these tubes, due to their construction, preferably copper, conduct the heat to the oil very readily. It is obvious that the oil may be heated quicker, more economically, and more uniformly in this manner.

Referring to Fig. 4, it will be seen that there is a sleeve 70 tightly pressed into the outer end of tube 25, and the tube is threaded into a cap 71, into which cap an atomizer spray tip or nozzle 28 is threaded. Flow of oil to the atomizer or nozzle 28 is under control of a valve device that is located in the forward end of the tube 25, within the cap 71 and adjacent to the spray tip 28.

The valve device comprises a valve seat member 75 which is threaded in a liquid-tight joint, into an inner end opening provided in the spray tip 28. A valve stem or plunger 76 has an outer end portion slidably contained in a counterbore within an inwardly extending portion of the valve seat member and has its other end portion loosely contained within the counterbore 65' within the closure fitting 61' at that end of the spacer tube 60. A pivot pin 66' connects the parts 76 and 61' in a free or flexible manner. The valve stem or plunger 76 has a tapered forward end portion 76a adapted to close against a valve seat formed by a tapered bore 75a in the valve seat 76 to cut off the oil flow through the part 76 to the atomizing nozzle. It will be understood that upon energization of the solenoid, the core 41 will be lifted, and the lever 45 will be actuated to pull the tube 60 outwardly, thus to unseat the valve plug from seat 75'. Also, upon de-energization of the solenoid, the core 41 will drop, and this action will move the valve to its closed position. Flow of oil to the nozzle through fitting 75 is permitted by reason of a plurality of ports 75b in the inner end portion inside the valve seat, as noted in Fig. 4. A screen 75s is wrapped about the member to catch any foreign matter that might be apt to clog the valve or nozzle, or prevent the valve from seating.

A thermostat bulb, designated by reference numeral 80, is disposed against the tube 25 near its forward end, and within a shallow, longitudinal groove 81. This bulb is covered by thin, formed shell 82. A small tube 83 leads from the bulb 80 to transmit pressure of expandable medium used in the bulb to a cut-out switch 84 to provide for control of the latter, as will be explained in connection with the wiring diagram illustrated in Fig. 5.

A heating coil or element 85 of resistance wire is formed about the tube 25, being electrically insulated therefrom by a sheet of suitable material, such as sheet mica, or the like, as indicated at 86, and a substantially thick covering 87, such as plastic asbestos or the like, is applied to the tube 25 and over the element 85, functioning both as an insulation for the said element and as a means of confining the heat of the element to the tube 25, thereby obtaining the maximum efficiency from the heating element in heating the oil within the tube.

It will be noted that there is a circuit wire 88 leading to the forward end of the heating coil, and this is embedded in the asbestos cover 87; the other circuit wire 89 connects to the rearward end of the coil; current being supplied, as presently described.

It will be stated that a much lower voltage is here desirable to operate the relay switch through the room thermostat, and to close the relay in the stack switch, than is necessary to operate the motor, ignition, heater and valve solenoid; therefore, two sources of current or circuits are utilized in the present instance.

In the wiring diagram shown in Fig. 5, 90 and 91 designate power lines leading from a source of low voltage current, while 92 and 93 designate power lines supplying high voltage current. The electric motor 15 has one side connected by a line 94 with line 93 and its other side connected by a line 95 with a contact 96 on the stack switch 97. The transformer 32 has one side connected by a wire 98 with the circuit line 93 and its other side connected by a wire 99 with a contact 100 of the stack switch 97. The switch 97 has a switch arm connected by a line 101 with line 92, and this arm comprises parts 102 and 103 adapted to open or close as a unit, and on closing to engage the contacts 96 and 100, and simultaneously close the high voltage circuit through motor 15 and the transformer 32. The switch members 102 and 103 are operable to closed position under control of a solenoid 105 having a circuit connection 106 with line 90 and a connection 107 through a time delay switch 108 and wire 109 from the switch to the line 91. The solenoid 105 is energized upon closing of switch 108 which will electrically connect wires 107 and 109.

The room thermostat, which is generally the instrument under which automatic control of the burner is placed, is designated at 110 and this has one side connected by a line 111 with circuit line 91 and its other side connected through a wire 42 to a solenoid coil 113, and then through a wire 112a to a lockout switch 114 and has a wire 115 connecting with the line 90.

The time delay switch 108 includes a heating element 120 which functions when current is passed therethrough, to heat a bi-metal strip to effect the closing of switch 108 and thus connect the lines 107 and 109, and energize the solenoid coil 105 in the stack switch 97. This solenoid coil 105 upon being energized closes the switch elements 102 and 103 in the stack switch, to energize the ignition transformer 32, and simultaneously operate the valve solenoid 30, and start the motor 15. It is shown in Fig. 5 that the valve solenoid 30 has a connection 121 with line 93 and a connection 122 with line 95. It is contemplated that the ignition transformer 32 and its circuit may be of the intermittent operation type as well as the continuous operation type; it being understood that the operation of the stack switch 97 is to open the circuit to the ignition transformer upon the establishment of combustion of the fuel oil through the expansion of a spiral bimetal coil 97a by the heat of combustion. Furthermore, in case of flame failure, for any reason, the lockout switch 114 will be opened and the entire system will close down automatically. In such cases the stack switch is manually rest, by closing the lockout switch 114. This is the conventional operation of most standard stack switches now on the market, as is well known in the art, but for a

better understanding of the operation of the system, it might be well to state here that the opening of the lockout switch 114 is accomplished by a bi-metal strip which is heated by a heating element connected in the stack switch which will open the lockout switch 114 a short predetermined interval of time after the closing of the switches 102 and 103 if the spiral bi-metal element 97a is not affected by the heat of combustion.

In heating a home, when the room temperature falls below that for which the room thermostat 110 is set, the switch 110a therein is closed, thereby energizing the solenoid coil 113 in the relay 124, which causes the closing of the switches 125 and 126. These latter switches close the circuit to the burner thermostatic switch 84 through the lines 129 and 130, and to the time delay relay switch through the lines 132 and 133.

The oil heating element 85 has its ends connected to the burner thermostatic switch 84 by the wires 88 and 89, and the circuit is completed through the normally closed switches 84a and 84b, to energize the heating element. Upon the heating element 85, the heater tube 25 and the oil contained therein reaching a certain predetermined temperature, the thermostat bulb 80 operates through the tube 83 to open the switches 84a and 84b in the thermostatic switch 84, and when these parts fall below a certain predetermined temperature, the thermostat bulb 80 operates to close the switches 84a and 84b, thereby maintaining the oil at a substantially constant temperature.

Simultaneously with the energization of the oil heater element 85, the time delay relay heater element 120 is energized, and after a predetermined period of time, which has been found to be approximately two minutes for most moderate climates, the switch 108 is actuated to a closed position, thereby closing the circuit to the solenoid coil 105 in the stack switch. During this period of time, the heater element 85 is heating the oil in the tube 25 to the point where atomization for combustion is most readily established and maintained most efficiently and economically. This period of time, of course, may vary in some cases and then it is necessary to make adjustments in the operation of the time delay relay, and also in the adjustable burner thermostatic switch 84.

When the solenoid 105 in the stack switch 97 is energized, it operates to close the switches 102 and 103. Upon these switches 102 and 103 being closed, the circuits are closed both to the valve operating solenoid 30, thereby opening the valve, and to the motor 15, starting the motor which drives the fan 11 and the pump 20, thereby delivering fuel oil under pressure through pipe 25 and a blast of air through tube 13 to support combustion, and also at the same time furnishing current to the ignition transformer 32, for effecting ignition of the fuel mixture.

If, for any reason, the ignition should fail, and there occurs what is termed a "flame failure," the lock-out switch will operate to close down the entire electrical circuit, as previously stated.

Upon combustion being established, it will continue, the burner operating until one of the controls automatically calls for a shut-down. The heating element 85 will remain energized to heat the oil to a predetermined temperature, or will be turned off and on intermittently to maintain a substantially constant heat under control of the thermostat bulb 80 and the switch 84.

In a normal operation, when the room thermostat 110 is satisfied, the switch 110a is opened, thereby de-energizing the solenoid coil 113 for opening the switches 125 and 126 in the relay 124. This opens the circuit to the heater 85, and the time delay relay element 120. However, a feature of this construction resides in the fact that the time delay relay switch 108 will not open for a predetermined interval of time, thereby maintaining the operation of the motor 15, the pump 20, and holding the valve solenoid 30 energized until the circuit is opened. This allows the burner to scavenge itself of hot oil in the heater tube 25, and dissipate the heat of the tube itself, in that the burner will continue to operate until the time delay relay switch 108 is opened. This provides that the oil temperature in tube 25 be reduced, and that the tube itself will be cooled to a safe temperature below which coking of the oil therein will not take place.

The primary control switch has been described as a room thermostat 110, operated by air temperature, but it may be replaced by a switch operated by water temperature or steam pressure, such as in commercial applications of the oil burner, or in a plurality of them, rather than in a home installation, as herein described. It is thought obvious that with an oil burner in accordance with the invention as herein disclosed and described, all of the faults of previously used burners are eliminated.

It is not intended that the claims be limited to the details of construction of parts, but that they be given an interpretation commensurate with the spirit and scope of the invention disclosed.

Having thus described my invention what I claim as new therein and desire to secure by Letters Patent is:

1. In an oil burner an oil delivery tube equipped with an atomizing nozzle at its delivery end, a valve in the tube for controlling the flow of oil therefrom to the nozzle, an electric heating element associated with the tube for heating the oil contained therein, an electric circuit for the heating element including a cut-out switch, a device adapted to be electrically energized to open the control valve, an electrically energized time delay switch operable to energize said device after a predetermined time interval with reference to energization of the time delay switch, and a control switch common to the circuits of the heating element and the time delay switch.

2. In an oil burner, an oil delivery tube, a valve in the tube for control of the discharge of oil therefrom, an electric heating element associated with the tube for heating the oil delivered therethrough, a circuit for the heating element, a time delay switch, a circuit for the time delay switch, a thermostatic switch common to the heating element circuit and time delay switch circuit, and means under control of the time delay switch for actuating the said control valve to open and closed positions respectively, at predetermined time intervals following the energizing and de-energizing of the heating element by the actions of the thermostatic switch.

3. In an oil burner, an oil delivery tube equipped at its discharge end with a control valve, a solenoid operatively connected with the valve and adapted, upon being energized, to open the valve and when de-energized, to close it, a circuit

for the solenoid, an electrical element for heating the oil in the delivery tube, a circuit for the said element including a cut-out switch, a time delay switch controlling the energization and de-energization of the solenoid circuit, a circuit for the time delay switch, a thermostatic switch operable to control both the heating element and time delay switch circuits and a thermostatic control for said cut-out switch operable under influence of temperatures of oil in the tube.

4. In an oil burner, an oil delivery tube equipped at its discharge end with a control valve, a solenoid operatively connected with and adapted, upon being energized, to open the valve, a circuit for the solenoid, an electrical element for heating the oil in the delivery tube, a circuit for said element, a time delay switch, a circuit for the time delay switch, a thermostatic switch for the joint control of the circuit of the heating element and of the time delay switch; said time delay switch being operable for effecting a delayed energization and delayed de-energization of the solenoid circuit, and a temperature responsive means associated with the delivery tube and oil contained therein for opening the heating element circuit independently of the action of the thermostatic switch.

5. In an oil burner, a tube for delivery of oil into a combustion chamber, an atomizing nozzle at the delivery end of said tube, a control valve in the tube adjacent the nozzle, a solenoid having operative connection with the valve to move it between open and closed positions, a circuit for the solenoid, an electrical element for heating oil in the tube, a circuit for the element, a time delay switch for control of the solenoid circuit, a circuit for the time delay switch, a thermostatic switch operable to control the circuits for the heating element and time delay switch; said time delay switch being arranged to control the solenoid circuit for opening and closing the valve at predetermined time intervals after the energization and de-energization of the heating element by the action of the thermostatic switch, and a temperature responsive element associated with the tube and operable in accordance with temperature of the oil therein for controlling the heating element circuit independently of other circuits while the control valve is open.

6. In an oil burner, the combination with an air blast tube and means for delivering a blast of air therethrough into a combustion chamber, of an oil delivery tube equipped at one end for delivering oil therefrom in an atomized condition into the air from the blast tube, to form a combustible mixture, a valve in the oil delivery tube at its discharge end, a heating circuit for the oil tube, a pump for delivering oil under pressure into the tube, an electric motor for operating the pump, a motor circuit, a solenoid for actuating the valve, a circuit for the solenoid, a time delay switch operable to control the solenoid circuit, a thermostatic switch for control of the time delay switch circuit and the heating circuit, and means under control of the time delay switch to open the motor circuit.

7. In an oil burner, an air blast tube, a fan operable to supply air under pressure to the tube for discharge into a combustion chamber, an oil delivery tube disposed within the air blast tube and equipped at its discharge end with means for discharge of oil from the tube in an atomized condition for mixture with the delivered air, a control valve in the tube adjacent the atomizing means, a pump operable to supply oil under pressure to the oil delivery tube, an element for heating oil in the tube, a circuit for the heating element a motor for operating the fan and pump an electric circuit for the motor, a solenoid for actuating the control valve between open and closed positions, a circuit for the solenoid, a cut-out switch in the circuit of the heating element, a time delay switch, a circuit therefor, a thermostatic switch for control of the circuit of the time delay switch and heating element, and a relay operated by the time delay switch, and controlling the motor and solenoid circuits.

8. In an oil burner, an electric power circuit, an oil delivery tube, a valve for controlling the discharge of oil therefrom to a combustion chamber, electrically operated mechanism for actuating the valve, a heating element associated with the tube, for heating the oil therein, a time delay switch for control of the valve actuating mechanism, a control switch controlling the energization of the heating element and time delay switch from the power circuit, an electrically operable pump for delivery of oil to the chamber, a second power circuit for said pump, and a switch in the latter circuit operable under control of the time delay switch to delay the de-energization of the pump for a predetermined interval after the heating means has been de-energized by the opening of the said control switch.

9. In an oil burner of the character described, an oil delivery passage, an atomizing nozzle at the discharge end of the passage, a control valve adjacent the nozzle, electrically energized means for actuating the valve, a source of electrical power, an electrical heating element for the passage, a time delay switch for controlling the valve actuating means for the opening and closing action of the valve in time delay to the energizing and de-energizing of said switch, and a thermostatic control switch and means electrically connecting said heating element and said time delay switch to the power circuit through the said thermostatic control switch.

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