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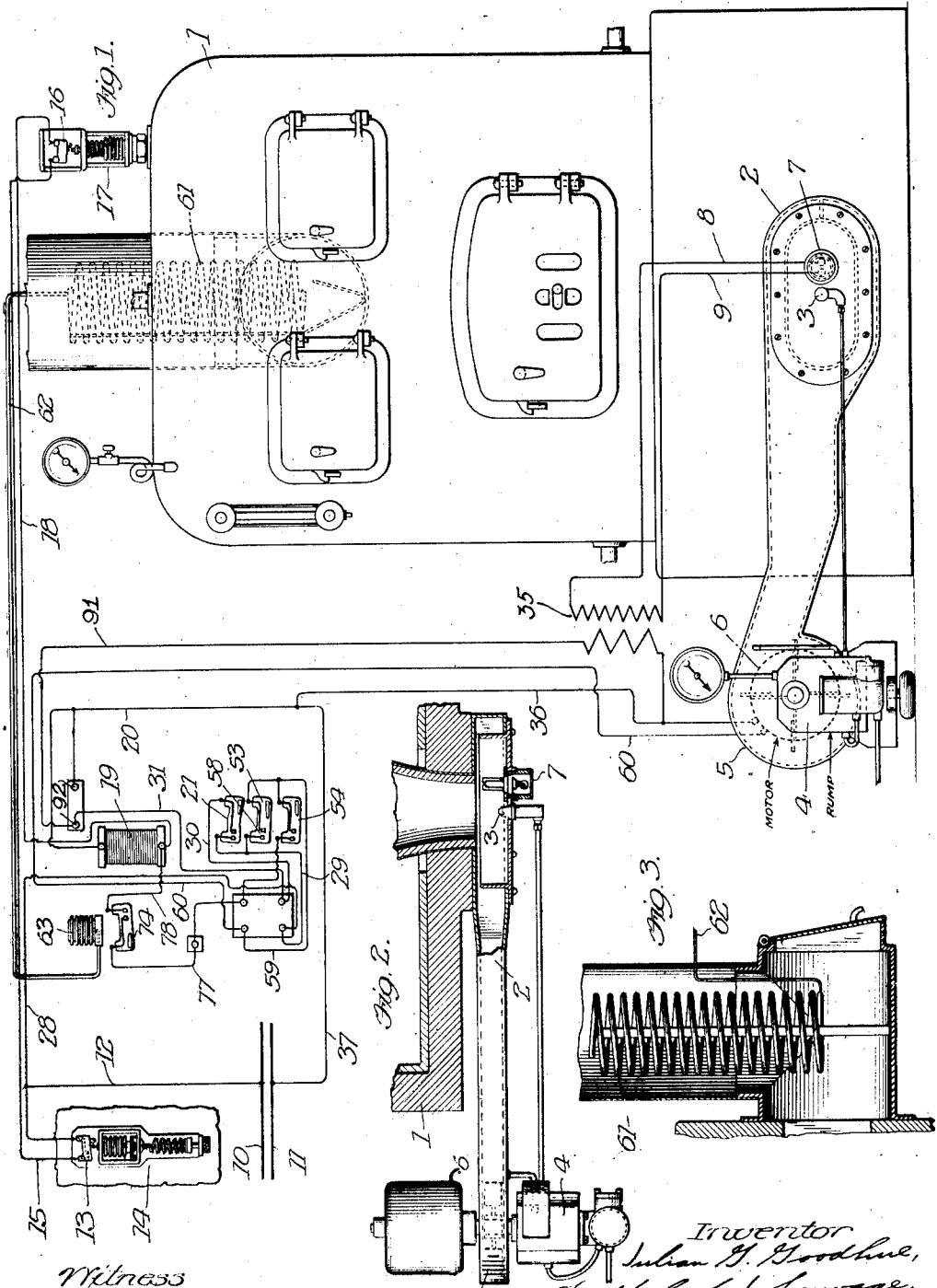
J. G. GOODHUE ET AL

1,660,959

OIL BURNER CONTROL

Filed May 11, 1925

4 Sheets-Sheet 1



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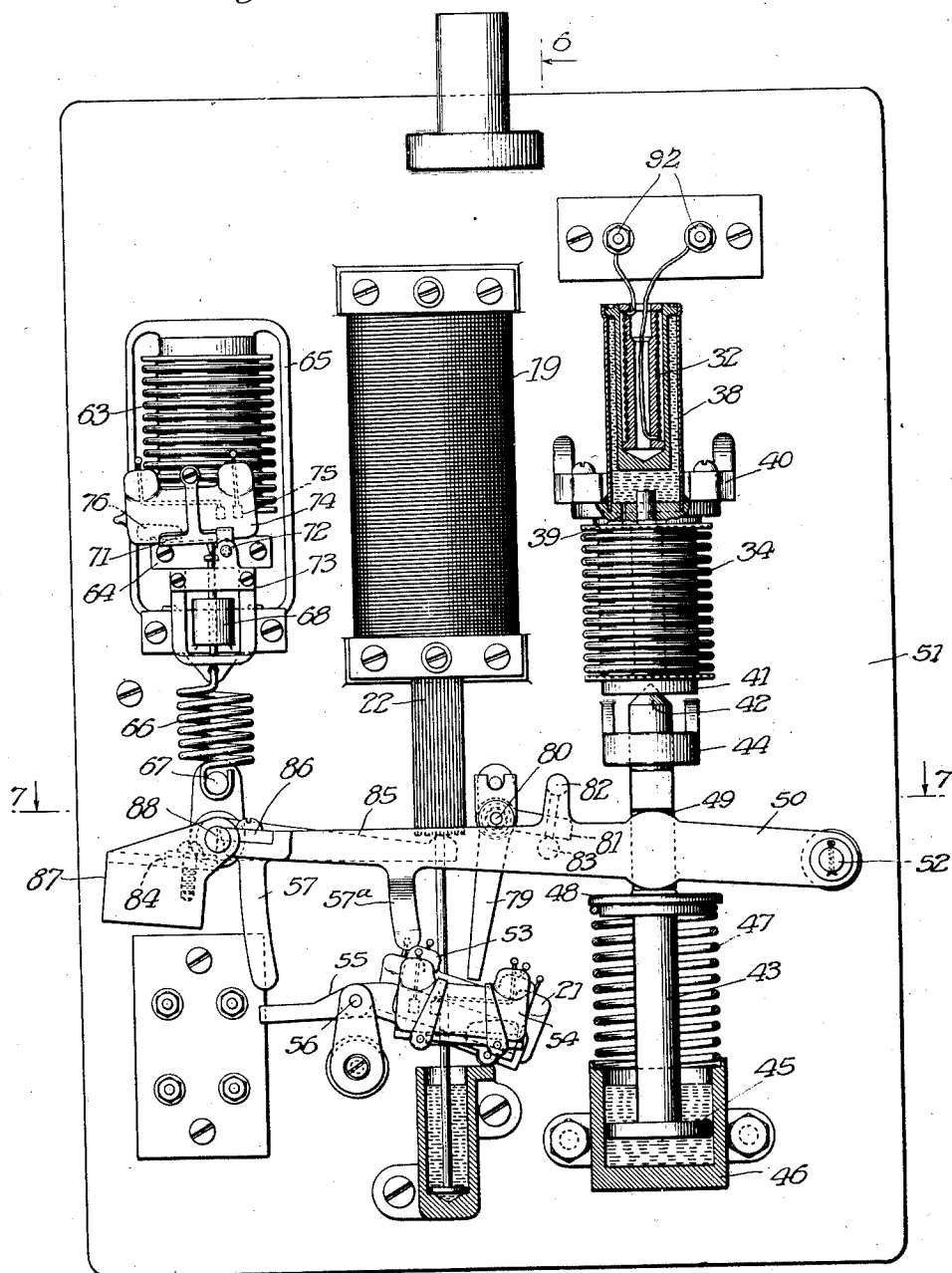
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Fig. 4.



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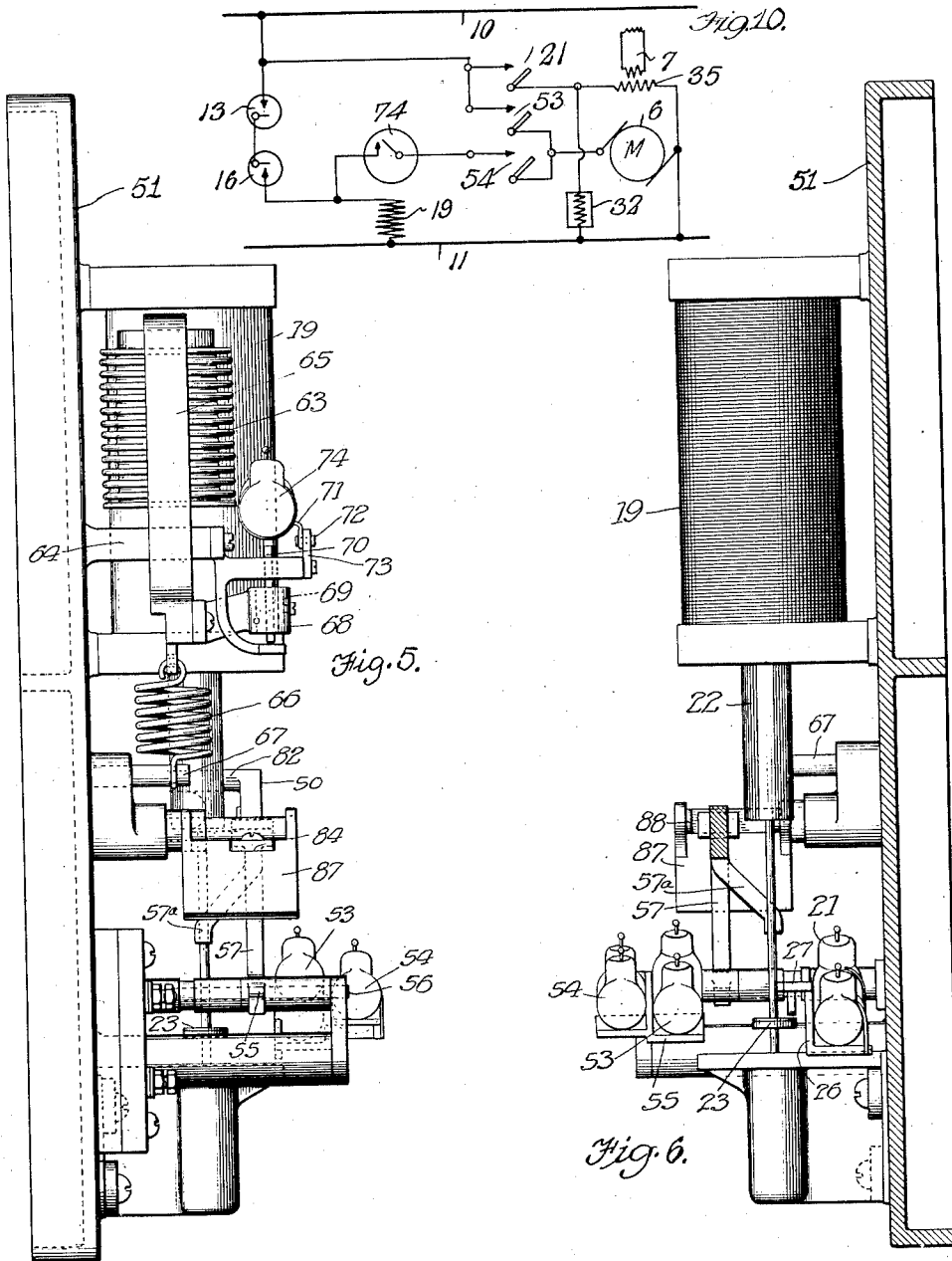
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Fig. 7.

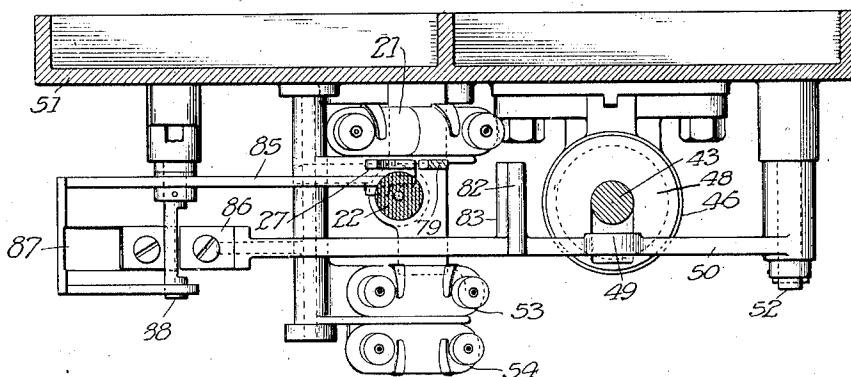


Fig. 8.

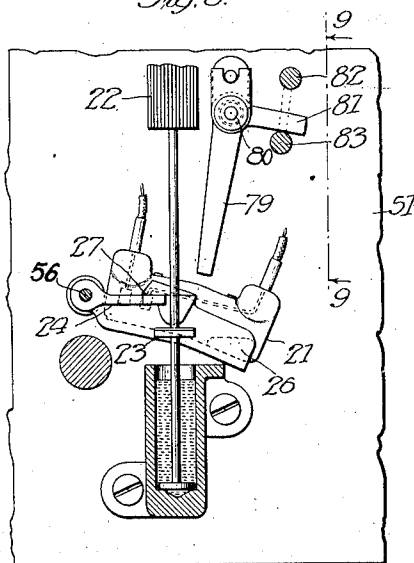
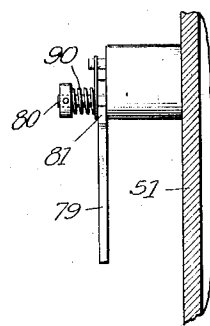


Fig. 9.



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UNITED STATES PATENT OFFICE.

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OIL-BURNER CONTROL.

Application filed May 11, 1925. Serial No. 29,640.

The purpose of this invention is to provide a reliable and safe means for controlling the operation of oil burning or other fluid fuel furnaces. It is mainly the purpose of the invention to insure that injection of fuel into the furnace will be stopped, unless all parts of the apparatus are in proper condition for functioning in the intended manner. In carrying out this purpose, there is provided a plurality of mercury switches for controlling the circuit of the ignition means and operating motor, all of said switches being normally open when the apparatus is at rest. These switches also control means for insuring the correct successive operation thereof, and means are provided rendering the switch operating mechanism ineffective in case of a drop in voltage in the line, sufficient to endanger the proper functioning of the ignition means of the oil burner or the motor for operating the oil pump and air delivery means. Other features of the invention are directed to preventing operation of the motor in case the ignition means is burned out or otherwise fails to function; and to provide a temperature controlled device, for instance, in the stack or outlet flue of the furnace, having the function of controlling the electric motor circuit so that in case an operation is started and the proper heat fails to develop within a predetermined time, the motor circuit will be opened and the entire apparatus permanently locked against operation until manually readjusted, as required for successful operation.

The objects of the invention are accomplished by a control system, as illustrated in the drawings, wherein—

Fig. 1 is a front view of a furnace showing the oil burning apparatus, and in diagram the various electrical and thermostatic control devices therefor.

Fig. 2 is a plan view of the oil burning apparatus, partly in section, to show the location of electrical ignition means therefor.

Fig. 3 is a side view of a temperature responsive element preferably located in the outlet flue of the furnace, and showing this flue in section.

Fig. 4 is a face view of a circuit controlling and timing unit, partly in section, and with the cover removed.

Fig. 5 is a side view of the mechanism shown in Fig. 4.

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 4.

Fig. 7 is a horizontal sectional view taken on the line 7—7 of Fig. 4.

Fig. 8 is a separate detail view of the ignition switch part of the mechanism shown in Fig. 4.

Fig. 9 is a detail taken on the line 9—9 of Fig. 8.

Fig. 10 is a simplified diagram of the circuits shown in Fig. 1.

The control apparatus illustrated comprises thermostatically controlled circuit operating devices, a plurality of thermostats being arranged in series, one in the place where the heat is to be delivered, another in the boiler of the furnace. A third dependable thermostat has its heat responsive element in the stack or outlet flue of the furnace. The thermostat in the place to be heated, or what may be termed a room thermostat, is in series with the boiler thermostat, so that it is necessary for both of these thermostats, upon a reduction in the temperature controlling the same, to move their respective switches to closed position in order to start the operation of the oil burner and controlling devices therefor. Upon a rise in temperature sufficient to cause either the room thermostat or the boiler thermostat to open its respective switch, the operation of the oil burner is discontinued.

The invention to which this application for patent is directed is not so much in the specific construction of the individual devices employed in the system as in the co-action brought about between these various devices, in order to safely and reliably control the operation of the oil burner. In the following description, the general arrangement of the control apparatus will first be pointed out and then more particular attention will be given to the details of the construction.

Referring to Fig. 1, a front view of a furnace and boiler 1 is indicated, the oil burner being shown at 2 and comprising means for injecting into the furnace atomized liquid fuel through the nozzle 3. The oil pump is indicated at 4 and air blower at 5, and a mo-

tor at 6 for operating the pump and air blower. Electrical ignition means 7 receives current from the wires 8 and 9, leading to transformer 35. The circuit of the transformer 35 is controlled by a switch 21 operated by solenoid 19. The solenoid is in a branch circuit from a source of current indicated by the line wires 10 and 11, and which follows the conductor 12 leading to switch 13 of room thermostat 14, wire 15 leading to the switch 16 of the boiler thermostat 17, wire 18 to solenoid coil 19 and from the solenoid coil through conductor 20, returning to the line wire 11. The function of solenoid 19 is that of a relay for controlling the circuit of the ignition device 7 through a switch 21. This switch is indicated more in detail in Fig. 8. When both switches 13 and 16 are moved to closed position, due to the cooling and contraction of their respective thermostats 14 and 17, coil 19, becoming energized, lifts its movable core 22 which carries a rod provided with a collar 23 for engaging the pivoted switch support 24.

Rocking this switch support upwardly around its pivot 56, results in a globule of mercury 26 rolling from the right hand end of the containing tube to position for closing the contacts 27. These contacts, when closed, serve to permit current to flow through the transformer 35 for the ignition device 7, the circuit of which may be traced in Fig. 1 from the line wire 10 through conductors 12, 28 and 29, through the switch 21, conductors 30 and 31, conductor 91 through the transformer 35 (Fig. 2), and conductors 36 and 37 to the line wire 11.

At the same time that the ignition transformer 35 is made operative, the heater coil 32 (Fig. 4) is energized. This coil is connected at posts 92 (Fig. 1) between conductors 31 and 20, the circuit of the coil, like that of the ignition device 7, being closed by switch 21. The coil 32 warms the liquid within the container 38, which, at the bottom through an aperture 39, communicates with the interior of an expansible bellows motor 34. The volatilization of the liquid in container 38 results in extending the bellows 34 downwardly, the support 40 therefor being located at the upper end of the motor. The disk 41 at the lower end of the motor is provided with a seat for engaging the conical end 42 of a plunger 43, guided in bearing 44 and carrying a dash pot piston 45 at its lower end. The function of the dash pot 46 is merely to slow up and steady the motion of the plunger, either under the action of the expansion motor 34 or a restoring spring 47, bearing between the upper end of the dash pot and a collar 48, an integral part of the plunger. This plunger is also provided with a recess 49 through which passes a switch operating lever 50 pivoted to support-

ing frame 51 by a pin 52. The heat motor 34 has a slow steady action as provided for by the effectiveness of the heating element 32 and the nature of the liquid within the motor, and the resistance of spring 47 and the dash pot.

Thus a definite time is required after the closing of the ignition switch to cause the switch operating lever 50 to move downwardly far enough to operate the motor control switches 53 and 54, shown in Figs. 4 to 7, and diagrammatically in Fig. 1. It may be seen in Fig. 4 that the switches 53 and 54 are supported at different inclinations on lever 55 pivoted upon pin 56, and therefore when the switch operating lever 50, which carries a depending finger 57 for engaging the left hand end of switch support arm 55 (Fig. 4), is in its extreme lower position, both of the switches 53 and 54 will be closed, but upon a rise of lever 50 toward its normal position, the switches 53 and 54 will open in succession. The purpose of this arrangement is to maintain the motor circuit closed under proper conditions, even though the switch 53 may be opened.

When the switch operating arm 50 is lowered by the heat motor 34, the circuit of the motor 6 is closed, due to the position of switch 53, the mercury therein then closing the circuit through the contacts 58 (Fig. 1).

The motor circuit through the switch 53 may be traced, as follows, from line conductor 10 to conductors 12, 28 and 29, switch 53, conductors 59 and 60, motor 6, conductors 36 and 37 to line wire 11. Thus only after a predetermined interval, after closing the circuit of the ignition means, is the motor started, resulting in the injection of atomized fuel into the furnace, its ignition and the delivery of air required for combustion.

A stack thermostat 61 (Figs. 1 and 3) is provided in order to control the motor circuit particularly to open it in case the ignition device fails, or for other causes combustion does not occur, after the motor circuit is closed. This stack thermostat is in the form of a coiled tube, one end of which is closed and the other end of which communicates through a conduit 62 with an expansion motor 63. The coil 61, tube 62 and expansion motor 63 are preferably filled with nitrogen gas, the change of pressure of which results in expansion and contraction of the motor 63. This motor is supported at its base on a bracket 64, Figs. 4 and 5. Upon expanding, it pushes upwardly upon a yoke 65, the lower end of which yoke is attached to one end of a spring 66. The other end of the spring 66 is wrapped around post 67. Thus, the expansion of the motor is against the action of spring 66. The movable yoke 65 carries a forwardly extending arm 68. This arm is vertically drilled to receive a bushing 69, the function

of which is to frictionally engage a switch operating rod 70, and is an important feature of the apparatus. When the motor expands, rod 70 is carried upward rocking a switch supporting member 71 to the right, Fig. 4, around its pivotal support 72, on an extension 73 of the fixed bracket 64.

The contacts 75 of the mercury switch 74 are at the right end of the same. Therefore, when the switch is rocked to the right, the mercury 76 therein, which is normally at the left end of the switch, rolls down to the right end, closing a circuit controlled by the switch. This circuit, as may be seen from Fig. 1, passes from the line wire 11, conductors 37 and 36, through the motor, then along conductor 60, conductor 59, switch 54, along conductor 77, through the expansion motor switch 74, conductors 78, and 18, boiler switch 16, and back through conductor 15 and switch 13 of room thermostat 14, conductor 12 to line wire 10. The purpose of this arrangement is to permit the motor to continue to operate after its circuit is first closed, only in case some predetermined minimum rise in temperature is effected at the outlet stack of the furnace. Accordingly, if for any reason whatever combustion should fail to take place, the outlet stack of the furnace would remain cold and consequently the expansion motor 63 would fail to function, leaving the motor circuit open. The switch 53, which is in parallel with switch 54, as previously described, originally serves to close the motor circuit, but this switch is again opened by a timing mechanism, and therefore, if in the meantime the expansion motor switch 74 is not closed, the motor cannot continue to function.

The timing mechanism includes a heat motor 34 (Fig. 4), the lower end of which, as previously described, bears upon the plunger 43 for operating the switch lever 50. This lever in its downward movement around the pivot 52 first serves to rock both of the motor switches 53 and 54 to closed positions by arm 57 thereof engaging the pivoted switch supporting lever 55, and arm 57^a, upon further downward movement of the lever 50, engages ignition switch support 24 rocking this switch to the "off" position. The downward motion of switch support 24 by engaging disc 23 forces the armature 22 down, although solenoid 19 is still energized.

At the same time lever 50 serves to rock a bell crank lever 79 downwardly around the pivotal support 80 therefor. The small arm 81 of bell crank lever 79 extends between a pair of pins 82 and 83 carried by arm 50, and spaced apart so as to provide lost motion between the arm 50 and the bell crank lever. Thus, after the lever 50 is forced downwardly part way by the heat motor 34,

pin 82 engages the bell crank lever, rocking it into position, as shown in Fig. 8, to prevent the ignition switch 21 from being drawn back to its closed position by solenoid 19.

When the arm 57 of lever 50 engages the supporting arm 55 of the switches 53 and 54, rocking both of the switches to closed position, the motor starts because of the closing of switch 53, the stack thermostat switch 74 being still open. The switches 53 and 54 are mounted upon the arm 55 at different inclinations, as shown in Figs. 4 to 6, so that upon the return of arm 50 the switch 53 will open before the switch 54. The rate of downward movement of arm 50 is regulated by the time it requires to heat up the expansible medium in heat motor 34 sufficiently to overcome the resistance of spring 47, Fig. 4. The ignition switch, as previously described, is first rocked to its closed position by the action of the armature 22 of solenoid 19. Then the next thing that happens upon the downward motion of arm 50 is to start the motor and then open the ignition switch, which includes in its circuit the heating element 32 of heat motor 34. Accordingly, after the opening of the ignition switch the heat motor 34 gradually contracts, and arm 50 slowly returns upwardly, but is stopped after the upward motion is sufficient to open switch 53, but not sufficient to open switch 54. Means for stopping the switch operating arm 50 at the desired position is the latching element 84 carried by the weighted lever 85, and coacting with another latch element 86 on the switch operating arm 50. The weight 87 of lever 85 is to the left of its pivot 88. The switch operating lever 50 is held in this position, and the oil burner continues to function until the circuit of solenoid 19 is opened either at the room thermostat 14 or the boiler thermostat 17. The switches for these thermostats open when the predetermined temperature is reached for which the thermostats are set for operation. Upon the opening of the circuit of solenoid 19, its armature 22 is released, and by its weight depresses the right hand end of the latch-supporting lever 85, releasing lever 50 and permitting all switches to return to open position, and the rise of lever 50 also results in pin 83 thereof rocking the bell crank lever 79 back to its normal position.

The lever 79, because of the tension of spring 90 (Fig. 9), always remains in the position to which it has been set by the pins 82 or 83 of lever 50 until the lost motion between these pins and the bell crank lever is taken up. The purpose of the lost motion between the pins is mainly to permit the switch operating lever 50 to return toward its upper position without releasing the ig-

8 ignition switch until the last part of the upward motion of lever 50. Therefore, if the room thermostat switch 13 and the boiler thermostat 16 should move to closed position before the lever 50 is completely returned to its normal supporting position, the ignition switch could not be closed until the bell crank lever 79 is rocked into position to release the ignition switch.

- 10 The operation of the thermostatic control means is necessarily somewhat involved, due to the necessity of meeting several contingencies that may arise in the operation of the oil burner, such as unintended manual
15 interference with the operation of the thermostatic switches, or possibly the automatic operation thereof before all parts of the apparatus are restored to normal position, from which the intended cycle of operation
20 starts.

Assuming the lever 50 and parts controlled thereby are in their normal starting position and the solenoid 19 is de-energized, with its armature dropped, as indicated in Fig. 4, then if both the boiler thermostat switch 16 and the room thermostat switch 13 are closed, because of the contraction of their respective thermostats under the influence of some predetermined
25 drop in temperature, the solenoid 19 becomes energized, lifting its armature 22 and the disk 23 carried thereby, thus causing this disk (Fig. 8) to rock the ignition switch 21 from its open position, as indicated in this
30 figure, upwardly to its closed position. This switch accordingly closes the circuit for the heater 32 of the expansion motor 34 and also the circuit of the ignition device 7. The expansion of motor 34 (Fig. 4) then slowly
40 rocks lever 50 downwardly. The arm 57 of this lever first engaging the left hand end of the motor switch supporting arm 55, first closing the switch 54 and then the switch 53. Upon the closing of switch 53, the motor 6
45 (Fig. 1) is set in operation, which causes the delivery of air and atomized fuel to the oil burner. The fuel is immediately ignited by the igniter 7 which has had ample time, between the closing of its switch 21 and the
50 closing of switch 53, to burn off any carbon or other obstructing matter which might interfere with the proper jumping of the spark. Switch 54 is in circuit with the switch 74 under the control of the stack
55 thermostat expansion motor 63. Therefore, if combustion takes place, as intended, the stack thermostat will be raised in temperature sufficiently to close switch 74 and the current for operating the motor may, there-
60 fore, pass through both or either of switches 53 and 54, when the switch operating mechanism is in its lowermost position.

Upon further downward movement of the switch operating lever 50, after the motor
65 switches 54 and 53 are closed for a definite

period, the arm 57* thereof engages the switch supporting arm 24 (Fig. 8) of the ignition switch rocking this switch to the open position indicated in Fig. 8, and against the pull of solenoid coil 19, as the
70 switch operating arm 24 bears against the disk 23 movable with the core 22 of the solenoid.

As the lever 50 nears its lowermost position, pin 82 thereon engages bell crank lever 79 rocking the latter into locking position above the switch supporting arm 24. Due to the resistance of spring 90 bearing against the bell crank lever 79, this lever remains in locking position during the return
75 of the switch operating lever 50 until pin 83 thereof engages the bell crank lever and restores it to a position where it will again permit the solenoid to throw the ignition switch to the "on" position, provided the
80 room thermostat switch 13 and the boiler thermostat switch 16 allow the current to again pass through the solenoid coil, but before the bell crank lever 79 is restored to releasing position, the lever 50 slowly rises
85 to the position where it is caught by latch 84 (Fig. 4). While moving to this position, the motor switch 53 is rocked by gravity to open position due to the arm 57 on lever 50, moving away from the switch supporting lever 55. When either the room thermostat
90 switch 13 or the boiler thermostat switch 16 open, because of a rise in temperature to some predetermined point, the armature 22 falls, engaging the right hand end of weighted latch lever 85, rocking the latch 84 away from the coacting element 86 on the lever 50. Then the lever 50 rises to its initial position, rocking bell crank lever 79 away from the
95 switch support 24, and all parts of the apparatus are then in normal position ready to repeat the cycle of operations.

The stack thermostat 61 performs the function of maintaining the motor circuit closed, in case required heat is developed within the time limit provided for combustion to take place. Stack thermostat, therefore, also functions to hold the motor circuit open in case of failure of combustion. In this regard it coacts with the switch 54 which is thrown to the "on" position on the downward movement of lever 50, but upon the upward motion of lever 50, switch 53 is first moved to the open position, due to its different inclination on the switch supporting arm 55 than the switch 54. Therefore, the operating motor cannot receive current through the switch 53 after a predetermined time from the starting of the motor, but will receive current through the switch 54 while the lever 50 is retained against further upward movement by the latch 84, provided the stack thermostat switch 74 is in closed position, this switch being in series with the motor and switch 54. The position of stack
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125
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thermostat switch 74 is dependent upon the temperature of the stack thermostatic device, the switch remaining open and the motor is stopped unless the desired rise in temperature occurs at the stack thermostat. Therefore, the continued operation of the oil burner is dependent upon its development of some fixed minimum temperature.

To review the operation in connection with the circuit diagram shown in Fig. 10, in which the normal condition is shown, when the two thermostats, the boiler thermostat 16 and the room thermostat 13, close, the solenoid is connected from the line 11 through the two thermostats to the line 10. As explained above, energizing the solenoid 19 causes the starting switch 21 to close. A circuit is then connected from line 10 through the switch 21 to two branches, one of which passes through the primary winding of the igniter coil 35 to the line 11, and the other branch passes through the coil of the heat motor 32 to the line 11.

Although but one specific embodiment of this invention has been herein shown and described, it will be understood that numerous details of the construction may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

We claim:

1. In an oil burner control apparatus, the combination with an oil burner and means for supplying fuel and air to said burner and ignition means, of a circuit for controlling said ignition means, said circuit including a switch, electro-magnetic means for operating said switch, thermostatic means for controlling the operation of said electro-magnetic means, and a timing mechanism arranged to automatically resist the operation of said electro-magnetic means after a predetermined length of time.

2. In an oil burner control apparatus, the combination with an oil burner and means for supplying fuel and air to said burner and ignition means, of a circuit for controlling said ignition means, said circuit including a switch, electro-magnetic means

for operating said switch, thermostatic means for controlling the operation of said electro-magnetic means, and a timing mechanism arranged to automatically resist the operation of said electro-magnetic means after a predetermined length of time, said timing mechanism being arranged to be releasable in one position by the action of said electro-magnetic means.

3. Electrical means for controlling the operation of oil burning apparatus, comprising the combination with an oil burner including an electric motor for delivering fuel thereto and an electrical ignition means, of circuits for controlling the operation of said motor and electrical ignition means, said circuits including a plurality of normally open switches, means for operating said switches including an electrically heated expansion motor and electro-magnetic means, said electro-magnetic means being under the control of a thermostatically operated switch and arranged to close one of said plurality of switches with which the ignition means is in series, an electrical heating element for said expansion motor also in series with said switch, means operated by said expansion motor for closing two of said plurality of switches, said two switches being arranged to be normally urged toward their open position and being in shunt with each other in the motor circuit, and an additional switch in series with one of said switches, and temperature responsive means for operating said additional switch, said temperature responsive means being arranged to be influenced directly by the heat of combustion, means operated by the switch operating means under the control of the expansion motor for locking one of said motor switches in closed position after its companion switch is permitted to return to open position, and said electro-magnetic means being adapted to release said locking means.

Signed at Chicago this 7th day of May, 1925.

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