July 1, 1930. H. W. SWEATT ET AL 1,768,940

THERMOSTATIC CONTROLLING APPARATUS

Filed March 26, 1923 3 Sheets-Sheet 1

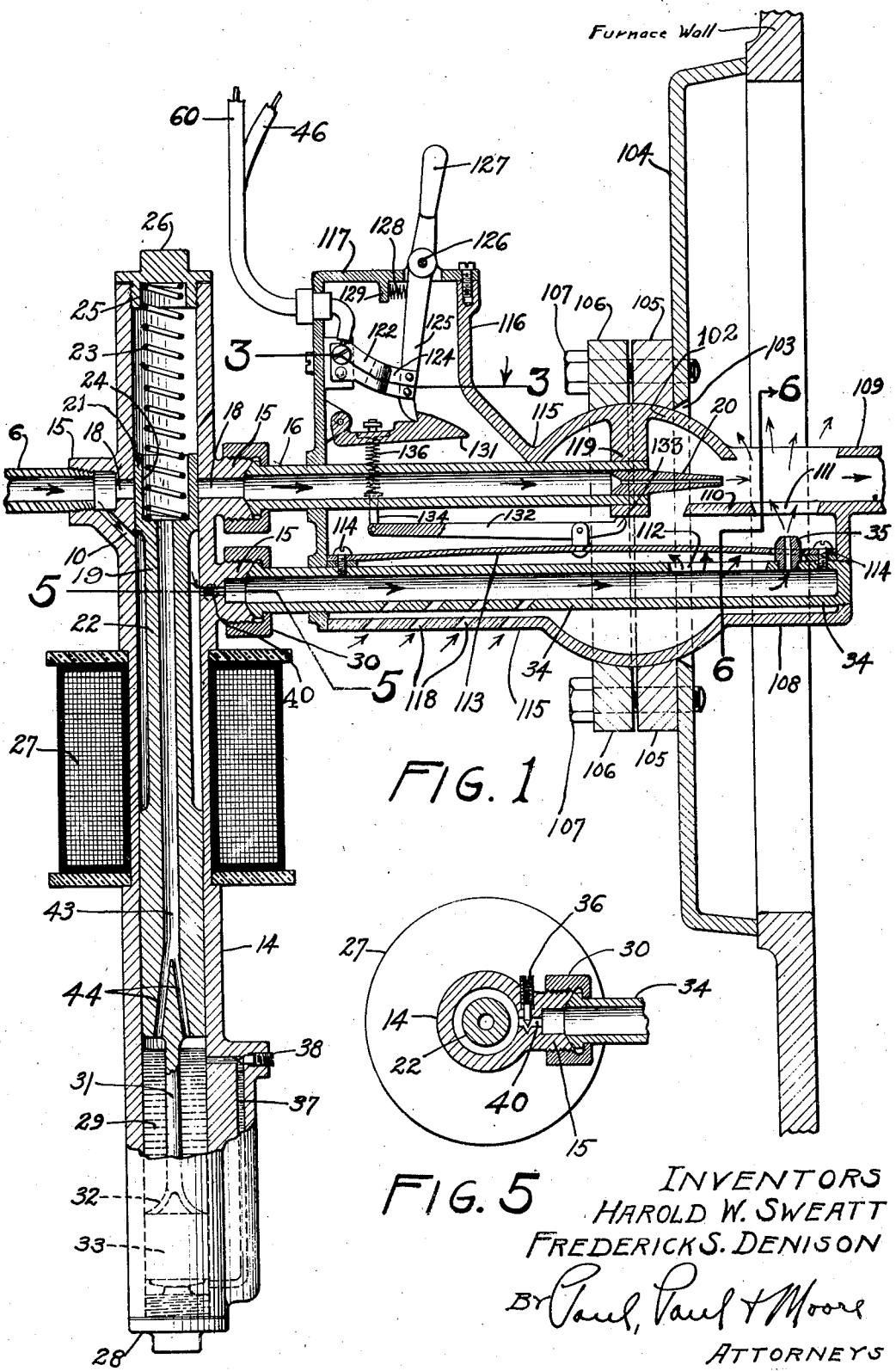


FIG. 1

FIG. 5

INVENTORS
HAROLD W. SWEATT
FREDERICK S. DENISON
BY Paul, Paul & Moore
ATTORNEYS

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THERMOSTATIC CONTROLLING APPARATUS

Filed March 26, 1923 3 Sheets-Sheet 2

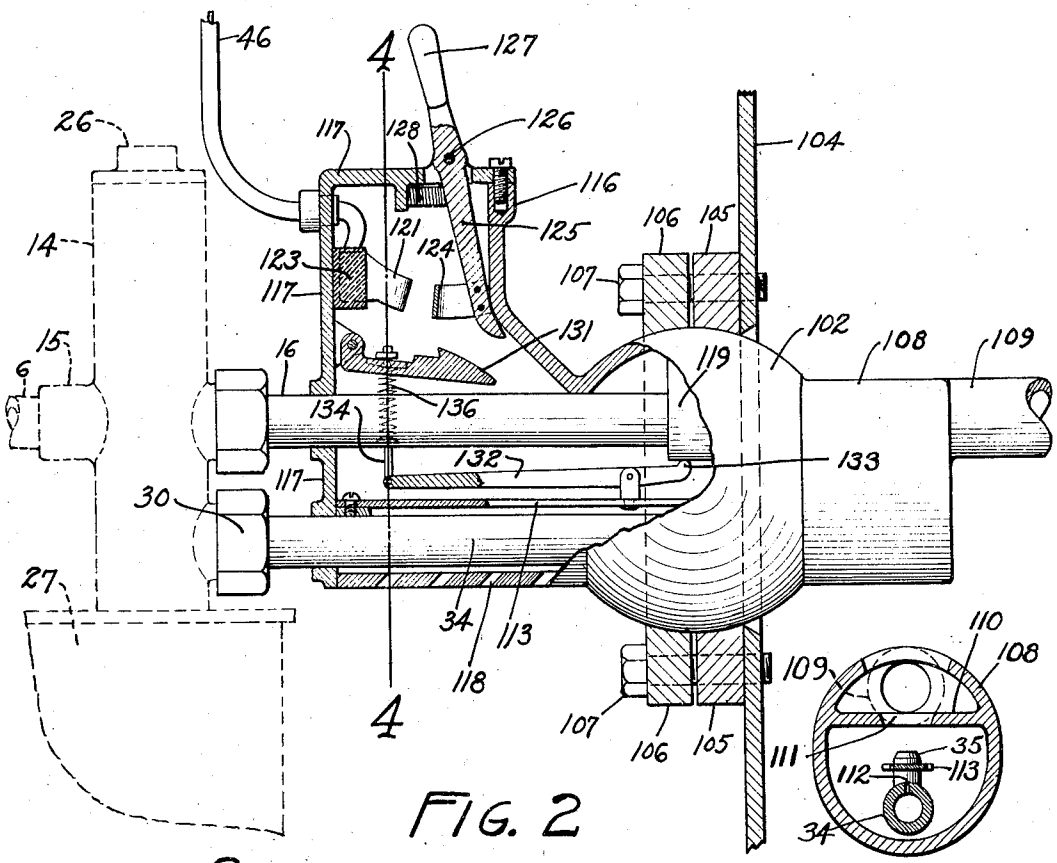


FIG. 2

FIG. 6

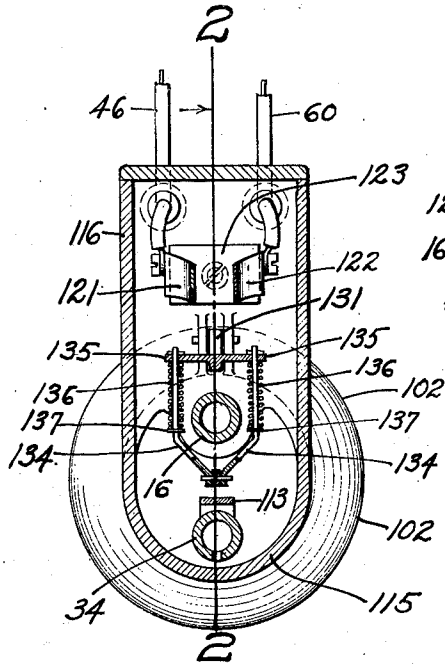


FIG. 4

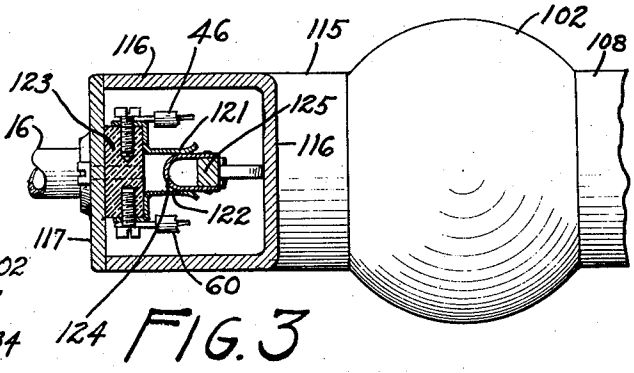


FIG. 3

INVENTORS
HAROLD W. SWEATT
FREDERICK S. DENISON
BY Paul, Paul & Moore
ATTORNEYS

July 1, 1930. H. W. SWEATT ET AL 1,768,940

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Filed March 26, 1923 3 Sheets-Sheet 3

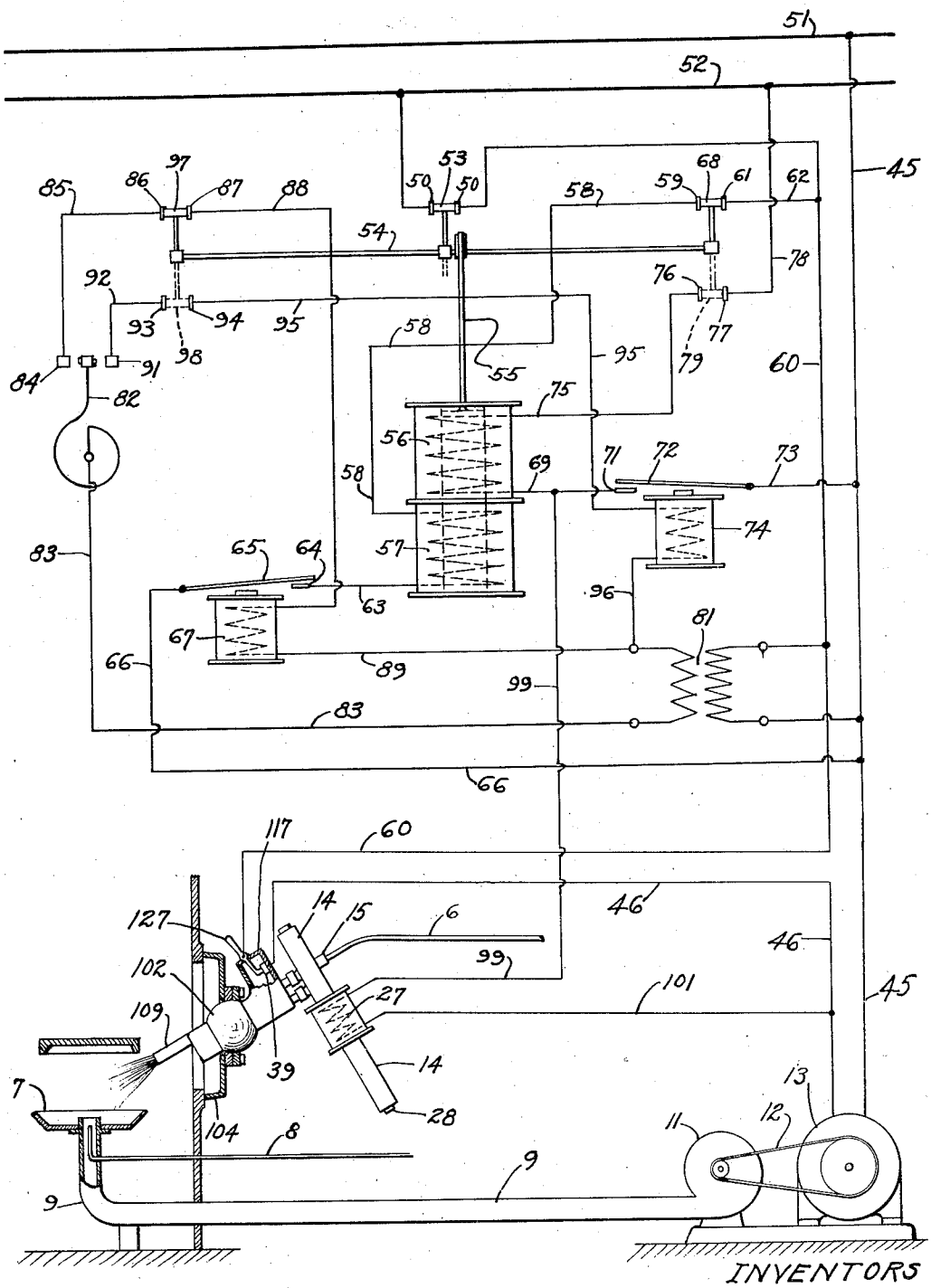


FIG. 7

INVENTORS
HAROLD W. SWEATT
FREDERICK S. DENISON
By Paul, Paul & Moore
ATTORNEYS

Patented July 1, 1930

1,768,940

UNITED STATES PATENT OFFICE

HAROLD W. SWEATT AND FREDERICK S. DENISON, OF MINNEAPOLIS, MINNESOTA, ASSIGNORS, BY MESNE ASSIGNMENTS, TO MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, OF MINNEAPOLIS, MINNESOTA, A CORPORATION OF DELAWARE

THERMOSTATIC-CONTROLLING APPARATUS

Application filed March 26, 1923. Serial No. 627,699.

This invention relates to improvements in thermostatic controlling apparatus such, for example, as is particularly useful in conjunction with heating plants of the oil-burning type. It is old in such installations to employ a pilot flame of gas furnished from the usual city main connections, such flame being adapted to ignite the vaporized fuel when a supply thereof is turned on. It is not claimed as new in this particular application to provide means to enlarge temporarily such a pilot flame which has been found advantageous in connection with these liquid fuel burners of the blower type. Such a pilot flame should be kept burning during the season of use of the heating plant, hence a small economical flame is desired. Furthermore, it is advisable to provide means to expand the pilot flame to ignite with certainty the vaporized fuel and also to prevent the possible extinction of the small pilot flame when employed in conjunction with blowers. Means for temporarily expanding such small pilot flame for ignition of the vaporized fuel and for subsequent contraction thereof are set forth in Patent Number 1,620,796 of April 26th, 1927, to Frederick S. Denison.

This present improvement includes means for automatically breaking the blower-motor circuit in the event such circuit shall have been closed, either manually or automatically, and the pilot flame shall have been extinguished. Such part of the improvements herein disclosed consists generally in the provision of a thermo-bar positioned to be affected by the pilot flame and adapted when in its normally heated expanded state by the pilot flame, to retain a switch member in its normal motor-circuit closing position and, when contracted due to absence of pilot flame, to cause the switch-member to break the motor-circuit.

The object therefore of this invention is to provide a new and improved thermostatic-controlling apparatus.

Other objects of the invention will more fully appear from the following description and the accompanying drawings, and will be pointed out in the annexed claims.

In the accompanying drawings, there has been disclosed a structure designed to carry out the objects of the invention, but it is to be understood that the invention is not confined to the exact features shown as various changes may be made within the scope of the claims which follow.

In the drawings:

Figure 1 is a view in vertical section of the solenoid-control for the pilot flame and showing the circuit breaker member of the blower-motor circuit in normal closing position and also showing the adjustable mounting of the apparatus in a furnace door;

Figure 2 is a view in side elevation of the apparatus, being partially broken away to show the circuit breaker member in circuit-opening position, the plane of section of the broken away part being substantially on line 2—2 of Figure 4;

Figure 3 is a view in horizontal section on the line 3—3 of Figure 1;

Figure 4 is a view in vertical section on the line 4—4 of Figure 2, showing the contact blades of the circuit-breaker member and also the means provided for operating the member-locking latch;

Figure 5 is a detailed sectional view on the line 5—5 of Figure 1, showing the pilot flame adjusting valve;

Figure 6 is a vertical sectional view on the line 6—6 of Figure 1 to show the gas by-pass for heating the thermo-bar; and

Figure 7 is a wiring diagram showing the controlling means adapted for substantially automatic operation in combination with a thermostatically controlled heating plant.

The selected embodiment of this invention here disclosed is shown in combination with a thermostatically controlled heating plant although it is to be understood that this novel

apparatus may also be advantageously employed in conjunction with a heating plant employing a blower-motor with a manually controlled circuit and wherein a pilot flame is used.

The major portions of the apparatus shown in the accompanying drawings (with the principal exception of the circuit-controlling switch) are disclosed in the above-mentioned prior co-pending application which sets forth a solenoid for enlarging a pilot flame upon energization of the blower-motor which vaporizes the liquid fuel and jets the vapor to the usual burner. This invention provides means for automatically cutting off the supply of fuel to the burner in the event of failure of the ignition means. Such means generally consists in the employment in the motor circuit of a circuit-breaker operable thermostatically by the condition of the pilot flame. The pilot flame is usually ignited in the fall and left burning during the winter season and hence its normal state may be called that in which the small flame is burning. The heat of the pilot flame maintains a thermo-bar in a normally heated and expanded condition. Such expanded condition maintains the circuit-breaker or switch in normally closed position so that the motor circuit, so far as this switch is concerned, is presented for opening and closing to a thermostat or for manual operation. However, when the pilot flame is extinguished either by accident or intention, the motor-circuit is interrupted with the resultant stoppage of the motor and hence, the fuel supply.

The means for furnishing a supply of combustible gas may be by way of a gas supply pipe 6 leading from a city main, or other usual source of supply not necessary to be shown, and adapted, through the intermediary of the novel valve structure to jet the combustible gas to a point adjacent the usual burner pan 7 of a liquid fuel burner apparatus. Of such an apparatus, there is here diagrammatically represented, a liquid fuel supply pipe 8 connected to a source and terminating upwardly within the end of the blower pipe 9 through which air is forced by the blower 11 driven by the belt 12 from the electric motor 13. The vaporization of the liquid fuel by the forced air is well-known in this art. The gas is discharged normally, during the seasonal run of the apparatus to provide a relatively small pilot flame which is adapted to be expanded by means of an electrically controlled valve device.

The valve device here shown comprises an elongated, substantially cylindrical housing 14 having opposed bosses 15 adapted to support and connect with the pipe 6 and the pipe 16 oppositely extending in alinement with the pipe 6. Each boss has a port 18 by means of which gas may enter within the cylindrical housing and may pass therefrom to the pilot flame. The inside of the housing is hollow and has slidably mounted therein a plunger 19 effecting a close sliding fit with the inner annular walls thereof. The upper end portion of the plunger provides a valve 21 to close the inlet and outlet ports 18 thereby to prevent passage of gas to the pipe 16 and the flame tip 20 thereby terminally carried. Adjacent this valve end of the plunger is a reduced plunger portion 22 which, when opposite the ports 18, permits passage of gas through the housing from the inlet port to the outlet port so that a relatively large amount of gas is fed to the pilot flame whereby the latter may be enlarged to ignite the vaporized fuel and also to avoid being blown out by the forced air from the blower 11 when in operation. In Figure 1, the portion of the plunger 19 which forms the valve 21 is shown in its normal passage-closing position which is also the lowered or descended position of the plunger within the housing 14. The plunger yieldably occupies such normal descended position by virtue of gravity when the housing is mounted in its upright position; however, spring-tension may be employed. As shown in Figure 1, a compression spring 23 may be mounted with its lower end terminally received within a recess 24 upwardly presented by the valve 21 while its upper end may be received within a recess 25 downwardly presented by the cap 26 received in threaded engagement upon the upper end of the housing 14 and preferably closing this housing and to prevent escape of gas therefrom. The relatively small supply of gas for the normal small pilot flame is ported through a by-pass 10 provided in the housing around the valve 21 when in seated position. In this novel apparatus the gas thus by-passed may escape through the port 40 through the opposite side of the housing and opening into another recessed boss 15 to which the coupling 30 secures the small pilot pipe 34 having an upwardly directed tip 35 from which a small pilot flame extends. Gaseous flow through this by-pass may be adjustably regulated by means of the needle-valve 36 received in threaded engagement in the housing and terminally projecting within the by-pass 40 to constrict the same as is shown in Figure 5.

The preferred means for effecting the opening of the valve 21 is that set forth in the above-mentioned pending application and is by way of an electromagnetic coil such as the solenoid 27 of a conventional type which is positioned about the housing. An electric circuit is provided for this solenoid and, upon energization of the solenoid, the metallic plunger will be upwardly pulled in accordance with the well-known functions of such electrical apparatus.

The energization of the solenoid 27 is preferably automatically effected as, for example, by means of a thermostat, as will be subse-

quently described. Furthermore, means are provided so that the energization of the solenoid is only momentary so that the plunger may be released after its upward travel and thereafter be permitted to resume its normal descended passage-closing position. In this novel device, the time-interval consumed by the plunger in moving to closing position may predetermined and adjusted to attain the desired interval which is advantageous for any given installation.

The lower end of the housing 14 is closed by means of the screw-plug 28 by which a fluid, such as oil 29, is retained therein. The lower portion of the plunger is reduced to form a stem 31 terminating in forks 32 integral with an open-ended sleeve 33. The lower edge of this sleeve forms an annular valve seat for a one-way valve so that oil may drop therepast upon ascent of the plunger and permits the sleeve freely to pass through the oil in its upward travel with the plunger. But, subsequent deenergization of the solenoid and tensioned gravitational descent of the plunger is damped or retarded as the valve tensionably resumes seated position. Oil displaced by plunger-descent is slowly ported around the descending sleeve by a by-pass 37, provided on one side of the housing casting. The rate of flow of the oil upwardly through the by-pass 37, and hence the length of time-interval required for damped plunger-descent, may be adjustably predetermined by means of the needle valve 38 adapted adjustably to constrict the by-pass.

It will be noted that, as the plunger is elevated from the position shown in Figure 1, there might be a tendency to compress the air confined within the housing between the upper end of the valve 21 and the cap 26. To overcome any such tendency a conduit 43 is bored axially through the major portion of the plunger and downwardly terminates in the two angled ports 44 so that, upon travel of the plunger, the air may oppositely pass. Such freedom of air flow within the housing not only prevents compression above the valve 21 but also prevents any creation of a partial vacuum in the lower portion of the housing between the upper surface of the oil and the lower end of the wide portion of the plunger.

As above stated, the solenoid is energized only momentarily and, the preferred energization is effected by connecting the solenoid circuit to the apparatus set forth in the above-mentioned prior co-pending application. Such apparatus may now be described in conjunction with the diagram of Figure 7 but without going into greater detail than is necessary to explain such use of the present invention.

Broadly, Figure 7, discloses a liquid fuel burner installation of the type employing a motor 13 adapted to drive the blower 11 to deliver air under pressure to the burner. The control of the blower-motor and solenoid are so inter-related that, when the motor circuit is closed, the solenoid circuit is closed, but the latter is opened again after a predetermined interval while the motor circuit remains closed. Furthermore, both of these circuits may be automatically opened by thermostatic means while the motor circuit is also closed thermostatically.

The thermostatic control of the motor may first be explained, thereafter the control of the gas-valve solenoid circuit, and finally the improved thermostatic emergency cut-out.

Generally considered, there is provided a switch having a pair of spaced terminals and a circuit-closer cooperable therewith to complete a circuit through such terminals. This circuit-closer is preferably operable by means of an electric current operating through an armature and solenoids of opposite polarity. Means are provided singly to energize these two solenoids or coils so that the armature may be moved in a direction to effect the desired opening or closing of the switch. The means here shown for singly energizing the coils is a thermostatic device.

The lead 45 of the motor 13 is directly connected to the side 51 of the main line circuit while the connected leads 46 and 60 of the motor are connected to the other side 52 of the main line through the novel cut-out 39 and a circuit-closer 53 and its spaced blades 50. This circuit-closer is shown in Figure 7 in closed position but is adapted to be upwardly rocked to open the motor circuit.

A convenient mode of rocking this circuit-closer both out of and into circuit-closing position is provided by means of the rock-shaft 54 which carries the circuit-closer 53. This rock-shaft is adapted to be rocked by an armature 55 reciprocably mounted within the alined cores of two solenoids which are adapted singly to be energized to produce opposite polarity so that the armature may be selectively moved in opposite directions. One solenoid may be referred to as the upper or circuit-closing coil 56 and the other, as the lower or circuit-opening coil 57.

The selective energization of these two coils is effected, in this apparatus, by means of a thermostat. Each coil is provided with a circuit leading to a suitable source of electric energy and each such coil-circuit is adapted to be electromagnetically closed or opened by the thermostat and the parts are so arranged that the upper or circuit-closing coil is energized by the cold side of a thermostat circuit while the lower or circuit-opening coil is energized by the hot side of the thermostatic circuit.

Each coil is provided with a circuit connected to the main line. The lower coil 57 has a wire 58 leading from the top of its winding to a contact blade 59 insulated from

a complementary contact blade 61 having a wire 62 connected to the lead 60 of the motor circuit. The lower coil also has a wire 63 leading from the bottom of its winding to a contact 64 projecting for circuit-closing engagement below a movable armature contact 65 operable to make-and-break this lower coil circuit. This armature-contact 65 is normally yieldably held out of engagement with the contact 64 by any suitable means. The armature-contact 65 is provided with a wire 66 in an electrical connection with the lead 45 of the motor. An electromagnet 67 is positioned beneath the armature-contact 65 and is adapted, upon energization by the hot side of the thermostat, to break indirectly the motor circuit, as later described. Thus, the lower coil 57 is provided with its circuit which may not only be opened and closed by means of an armature at one point but also may be opened and closed at another point across the blades 59 and 61. The closure of this latter break is by means of a circuit-closer 68 carried by the rock-shaft 54 and operable thereby. This circuit-closer 68 is thus co-operable with the motor circuit closer 53.

The upper coil 56 has a wire 69 leading from the bottom of its winding to a contact 71 projecting for circuit-closing engagement below a movable armature-contact 72 operably to make-and-break this upper coil circuit. This armature-contact 72 is normally and yieldably held out of engagement with the contact 71 by any suitable means.

The armature-contact 72 is electrically connected by the wire 73 to the lead 45 of the motor circuit. As electromagnet 74 is positioned below the armature-contact 72 in order, upon energization, to draw the contact 72 to the contact 71 to close the coil circuit across this break. The electromagnet 74 is adapted to be energized by the cold side of the thermostat in order indirectly to start the motor and, it may be noted in passing, that the gas-valve-solenoid circuit is adapted to be closed when the circuit through this upper coil 56 is closed. The wire 75 leads from the upper portion of the coil 56 to the knife blade 76, electrically insulated from the complementary knife blade 77 connected by the wire 78 to the main line 52. The break across the blades 76 and 77 is adapted to be closed by a circuit-closer 79, carried, similarly to the circuit-closer 68 by the rock-shaft 54. This circuit-closer 79 is here shown in dotted lines in order to indicate that it is not in circuit-closing position because the circuit-closer 68 is so shown, it being understood that these circuit-closers are oppositely moved. That is, when the circuit-closer 68 is in closing position, the circuit-closer 79 is in circuit-opening position and vice versa.

The electromagnets 67 and 74 are adapted to be selectively energized, preferably by a thermostatic circuit. Such circuit may derive its electric energy from the motor circuit through the transformer 81. The thermostatic circuit comprises the usual hot and cold sides with thermo-bar connection. Such a thermostat is diagrammatically represented in Figure 7, wherein the usual thermo-bar 82 is electrically connected to the secondary winding of the transformer by means of the wire 83. The hot contact 84 has a wire 85 terminating in the knife blade 86 which is insulated from its complementary knife blade 87 having a wire 88 running to the upper portion of the winding of the electromagnet 67 while the wire 89 runs from the lower portion thereof to the secondary or low-tension side of the transformer 81.

The cold side contact 91 is connected by the wire 92 to the knife blade 93 similarly insulated from its complementary knife blade 94 which in turn is connected by the wire 95 to the upper portion of the winding of the electromagnet 74 having its lower portion electrically connected by the wire 96 to the wire 89 of the secondary or low-tension side of the transformer 81. Circuit-closers 97 and 98 are carried upon the rock-shaft 54 and are similar in construction and operation to the circuit-closers 68 and 79 carried at the opposite end of the rock-shaft.

Before describing the incorporation of the gas-valve solenoid circuit and the emergency cut-out in this apparatus, the operation of the above parts may be first explained.

In the position of the parts in Figure 7, the apparatus is shown in position wherein the thermo-bar 82 has previously been bent by room temperature to cause electrical contact with the hot side contact 84 whereby current may flow from the secondary winding of the transformer 81, through the presented circuit, as follows: wire 83, thermo-bar 82, hot contact 84, wire 85, blade 86, circuit-closer 97, blade 87, wire 88, electromagnet 67, wire 89, and back to the secondary winding. The electromagnet 67 is thus energized with the result that the armature-contact 65 is downwardly pulled to effect electrical connection with the contact 64, whereby the following circuit is closed; lead 45, wire 66, armature-contact 65, contact 64, wire 63, opening-coil 57, wire 58, blade 59, circuit-closer 68, blade 61, and wire 62 to the other lead 60. Thus, the lower opening coil 57 is energized with the result that the armature 55 is inwardly pulled, the shaft 54 rocked and the circuit-closer 53 is raised to break the lead 60 of the motor circuit at the spaced insulated blades 50. The motor circuit is thus thermostatically opened resulting in cessation of the motor, blower, and burner functions.

The parts are re-set automatically for a call for heat by the cooling thermo-bar. As the rocker-shaft raises the thermostatic circuit-closer 97 and coil circuit-closer 68 their com-

plementary circuit-closers 98 and 79, respectively, are moved to engage and close the breaks across the blades 93—94 and the blade 76—77. Thus, when the thermo-bar bends to engage the cold contact 91, another circuit is closed from the secondary winding of the transformer 81, through the thermo-bar contact 91, wire 92, blade 93, circuit-closer 98, blade 94, wire 95, electromagnet 74, wire 96, to the secondary winding. The electromagnet 74 is thereby energized to attract the armature contact 72 to close with the contact 71 whereby a circuit is presented from the main line side 51, motor lead 45, wire 73, armature-contact 72, contact 71, wire 69, closing coil 56, wire 75, blade 76, circuit-closer 79, blade 77, wire 78, to the other main line side 52. The closing coil 56 is thus energized, the rock-shaft returned to the full-line position in Figure 7 and the motor circuit is closed, and the motor, blower and burner function.

Turning now to the incorporation of the gas-valve, solenoid circuit in this apparatus, it may be noted that, when the rock-shaft 54 is returned to its Figure 7 position, the circuit-closers 97 and 68 are likewise returned to the indicated closed position, while the circuit-closer 79 is simultaneously moved by the rock-shaft to open position so that the circuit through the closing coil 56 is opened. Thus, by connecting the solenoid 27 with the circuit of this coil 56, the solenoid 27 may be energized when the coil 56 is energized to start the motor. To this end, a wire 99 is connected to the coil wire 69 and to the winding of the solenoid 27. The other end of this winding is connected by the wire 101 to the motor lead 46. Thus, coincident with energization of the motor-starting coil 56, the solenoid 27 will be energized. Furthermore, as such energization of the coil 56 is only momentary (because its circuit is immediately opened by the circuit-closer 79) so also, the energization of the solenoid is only momentary. Such momentary energization of the solenoid is sufficient to elevate the plunger 19, so that, upon immediate de-energization, its timed descent may commence. When the plunger is elevated, the valve 21 is raised above the alined ports 18 so that the full or enlarged flow of gas is had through the pipe 16 to the flame tip 20 from which the flame plays upon the burner pan 7.

Reference may now be had to the emergency cut-out or circuit-breaker which is thermostatically operated for the automatic opening of the motor circuit when the small auxiliary pilot flame has been extinguished from any cause.

The housing for this circuit-breaker, its thermo-bar, the two gas pipes and associated parts is preferably made with a ball-like portion 102 which is adapted adjustably to project within a substantially circular opening 103 provided in the usual furnace door 104 and is mounted substantially to provide a universal joint. The socket is provided by the two plates 105 and 106 having arcuately curved inner surfaces to receive the portion 102. Preferably the arc of curvature of the two plate surfaces is struck upon a slightly shorter radius than the curvature of the ball-like portion 102 in order that upon tightening of the screws 107, the portion 102 may be held in a relatively fixed adjusted position so that the gas flame may be accurately projected to the burner pan 7. Forwardly of the portion 102 is a cylindrical section 108 which terminates with the barrel 109. The forward end of the pipe 34 is closed and terminates in the section 108 and the small pilot flame tip 35 extends upwardly to project the gas through the opening 111 in the horizontal wall 110 provided within the cylindrical section 108. Thus the small flame burns within the path of gas projected from the tip 20. Furthermore, a slot 112 is cut in the pipe 34 rearwardly adjacent the tip 35 so that a relatively small amount of gas may escape therethrough and burn adjacent a thermo-bar 113 secured to the pipe 34 by the screws and spacing blocks 114. The housing rearwardly terminates in another cylindrical section 115 with an upwardly projecting wall 116. This rear end of the housing is closed by a suitably shaped cover 117. In order to supply air to the small pilot pipe 34, its under face and the under face of the cylindrical section 115 are provided with diagonally alined apertures 118. The front end of the pipe 16 and its tip 20 are conveniently supported by an integral boss 119 inwardly depending from the ball-like portion 102.

The circuit-breaker or switch has its member mounted within the substantially rectangular space formed by the upright wall 116 and the cover 117. The relatively fixed members consist of the two spaced blades 121 and 122 mounted upon the insulated base 123 secured to the cover. The wire 46 from the motor is electrically connected to the blade 121 while the wire 60, which forms a continuation of this motor lead to the main line side 52, is electrically connected to the blade 122. These blades are thus in series with one lead from the motor to the main line and hence, unless the gap between the blades be suitably closed, the motor circuit is interrupted. The circuit-closer is provided by the U-shaped knife 124 carried by the lever 125 which is pivoted upon the pin 126 and, projecting through the cover 117, terminates in the insulated handle 127. The compression spring 128 mounted between the cover rib 129 and the lever tends to move the lever from its circuit-closing position shown in Figure 1 to the opening position shown in Figure 2.

A thermostatically controlled detent is provided to retain the lever knife in circuit-closing position to which the knife is adapted

to be manually moved upon lighting of the small pilot flame. This detent is adapted automatically to release the knife, upon extinction of the small flame, whereby the knife moves to circuit-opening position. Such detent is provided by the latch 131 pivotally carried betwen brackets inwardly projecting from the upright wall of the cover 117. The normal position of the latch may be referred to as that indicated in Figure 1 wherein the latch is shown in elevated position so that its notch is engaged by the downwardly terminal toe of the knife lever 125. Means are provided to retain the latch in its normal position when the thermo-bar 113 is in its expanded convex form shown in Figure 1 due to heat from the ignited gas escaping through the slot 112. The small pilot flame is composed substantially of the ignited gas from the slot 112 and that from the jetting tip 35 which directs a portion thereof more accurately into the path of gas delivered by the main tip 20. The above-mentioned latch-retaining means includes a lever 132 pivotally mounted in a bracket carried by the thermo-bar adjacent its middle portion as is indicated in Figure 1. The portion of the lever on the front side of its pivotal mounting is relatively short and upwardly terminates in a finger 133 adapted to abut against the under face of the boss 119 so that any upward movement of the middle portion of the thermo-bar is multiplied and communicated to the rear portion of this lever which carries a pair of yoke members 134 pinned thereto. As is shown in Figure 4, these yoke members are shaped to pass upwardly upon each side of the pipe 16 and pass through apertures in the wings 135 which integrally and laterally extend from the latch 131. The latch is tensionably upwardly held by means of a compression spring 136 coiled about each yoke member and held between collars 137 and the under face of the wings.

The latch thus yieldably held in elevated position upon expansion of the thermo-bar and in the path of the pointed lower end of the lever 125 so that, when the handle is moved from the position shown in Figure 2 to that of Figure 1, the lever end may ride over the latch end portion and enter the notch so that the lever will be locked in such circuit-closing position. However, when the pilot flame becomes extinguished for any reason, or is not lighted, the contracted thermo-bar causes the yoke members to assume a lower position with resultant depression of the latch and disengagement of the lever, if locked, or non-engagement of the lever if attempt be made to move the lever to circuit-closing position.

Having thus described our invention what we claim as new and desire to secure by Letters-Patent, is:

1. In a device of the class described a pilot pipe having a flame orifice, a switch having a movable member, means tending to hold the movable member in one circuit controlling position, a latch for holding the member in an opposite circuit controlling position, a thermo-bar secured to the pipe in opposition to the orifice, a stop, a lever attached to said thermo-bar, and having one arm engaging the stop, and connections between the opposite arm of the lever and said latch, the arrangement being such that when flame is applied the thermo-bar bulges in one direction to dispose the latch at latching position and the arrangement further being such that on extinction of flame the thermo-bar moves in an opposite direction to move the latch from latching position.

2. A device of the class described having a gas supply pipe, a pilot pipe arranged to ignite gas delivered by the first mentioned pipe and having a flame orifice, a switch, a thermo-bar element arranged to be heated by the pilot flame, and connected at opposite ends to form a bridge adapted to be bowed when heated, a lever pivoted upon the thermostatic element having one arm engageable with the first mentioned pipe, and connections between the opposite arm of the lever and the switch arranged to open and close the switch, as the thermostatic element moves in opposite directions.

3. A casing having a burner pipe leading therefrom with the casing open to allow delivery of fuel outwardly from the pipe, a pilot pipe adjacent the burner pipe and having a tip arranged to deliver flame at the flame end of the burner pipe, and further having a slot as an auxiliary flame orifice, a thermo-bar connected at two points only to the burner pipe to bridge the auxiliary orifice, a switch having a movable element, a latch for normally holding the switch closed, a lever upon the thermo-bar having one arm engaging the burner pipe as a top, and connections between the opposite arm and the latch such that when the thermo-bar is heated the latch remains in latching position, and when cooled withdraws the latch from latching position.

4. A pilot pipe having a flame orifice, a thermo-bar connected at two points to the pipe, in a manner to have flame from the orifice play upon the thermo-bar at a point intermediate its connecting points, said pilot pipe having a burner tip passing loosely through the thermo-bar.

5. A pilot pipe having two flame orifices, a thermo-bar connected to the pipe at two points spaced apart and arranged to bridge one of the orifices, and to allow flame from the other orifice to burn at a point outwardly beyond the thermo-bar.

6. A pilot pipe having a burner tip, and a flame orifice arranged adjacent the tip, a thermo-bar connected to the pipe at two points spaced apart in a manner to bridge the

flame orifice, the arrangement being such that flame produced through the orifice causes the element to buckle away from the pipe, and said tip being arranged to deliver flame at a point outwardly beyond said bar.

In witness whereof, we have hereunto set our hands this 15th day of November, 1922.

HAROLD W. SWEATT.
FREDERICK S. DENISON.