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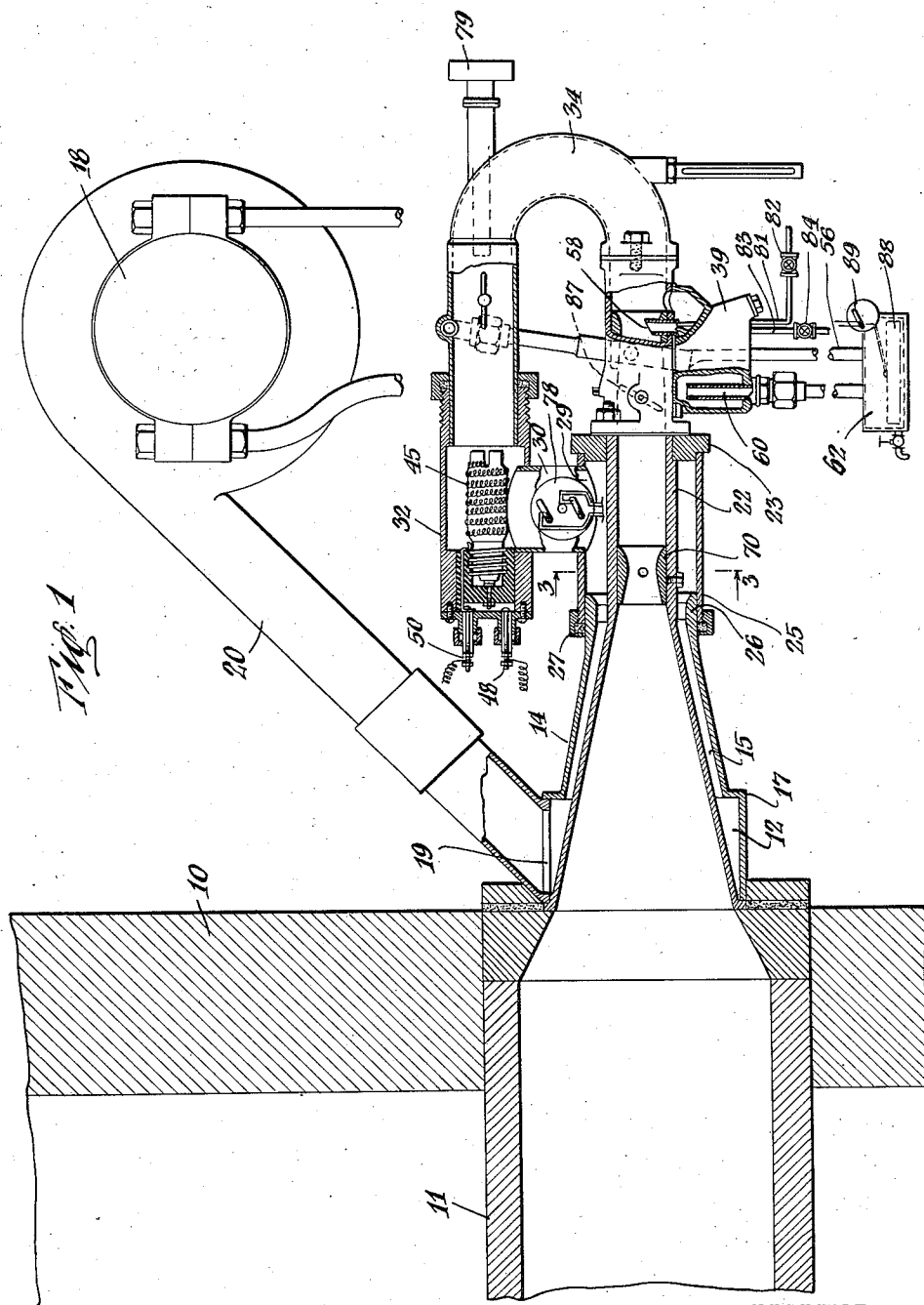
J. J. SLOYAN

2,031,335

CONTROL FOR HEAT GENERATORS

Filed July 2, 1932

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

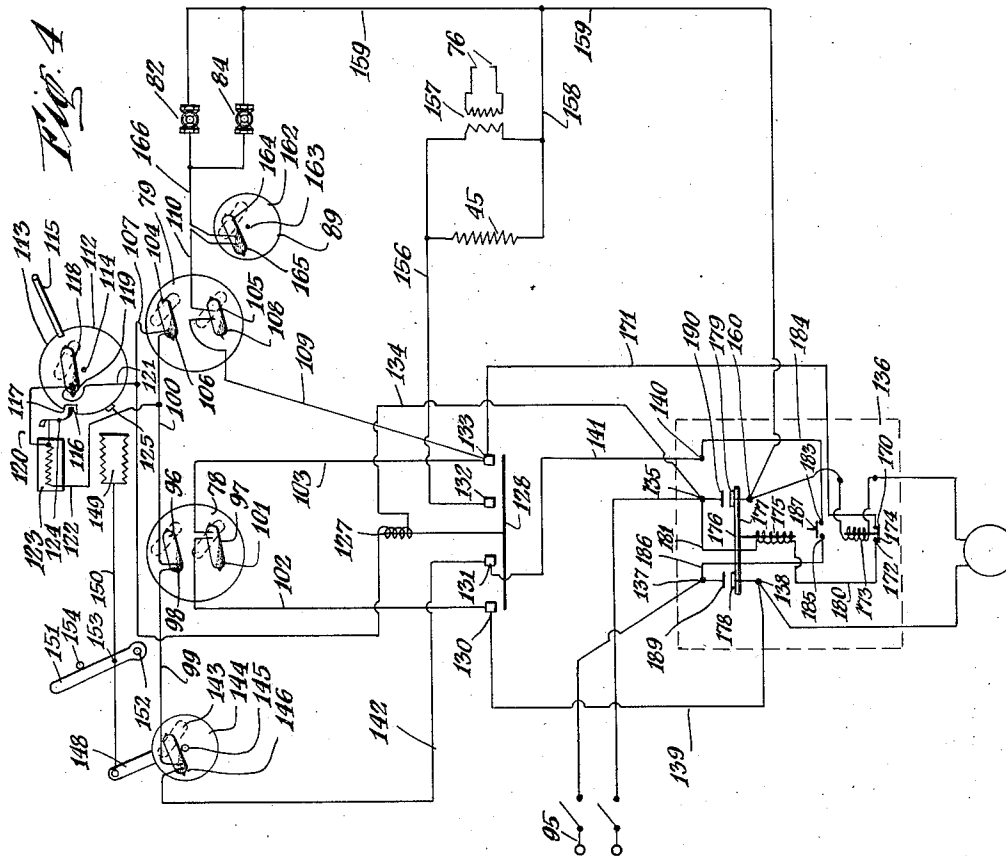


Fig. 3

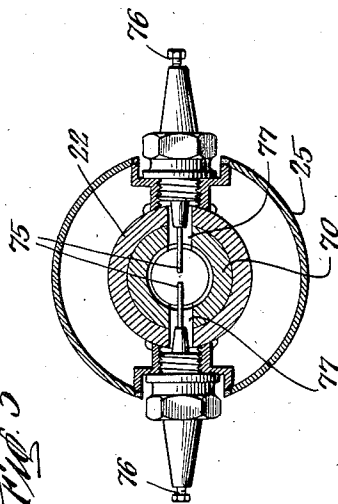
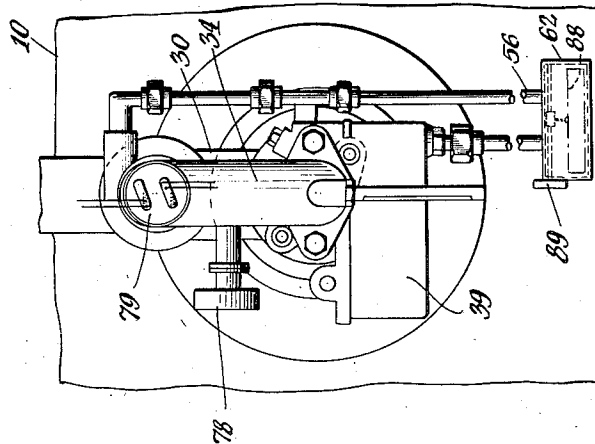


Fig. 2



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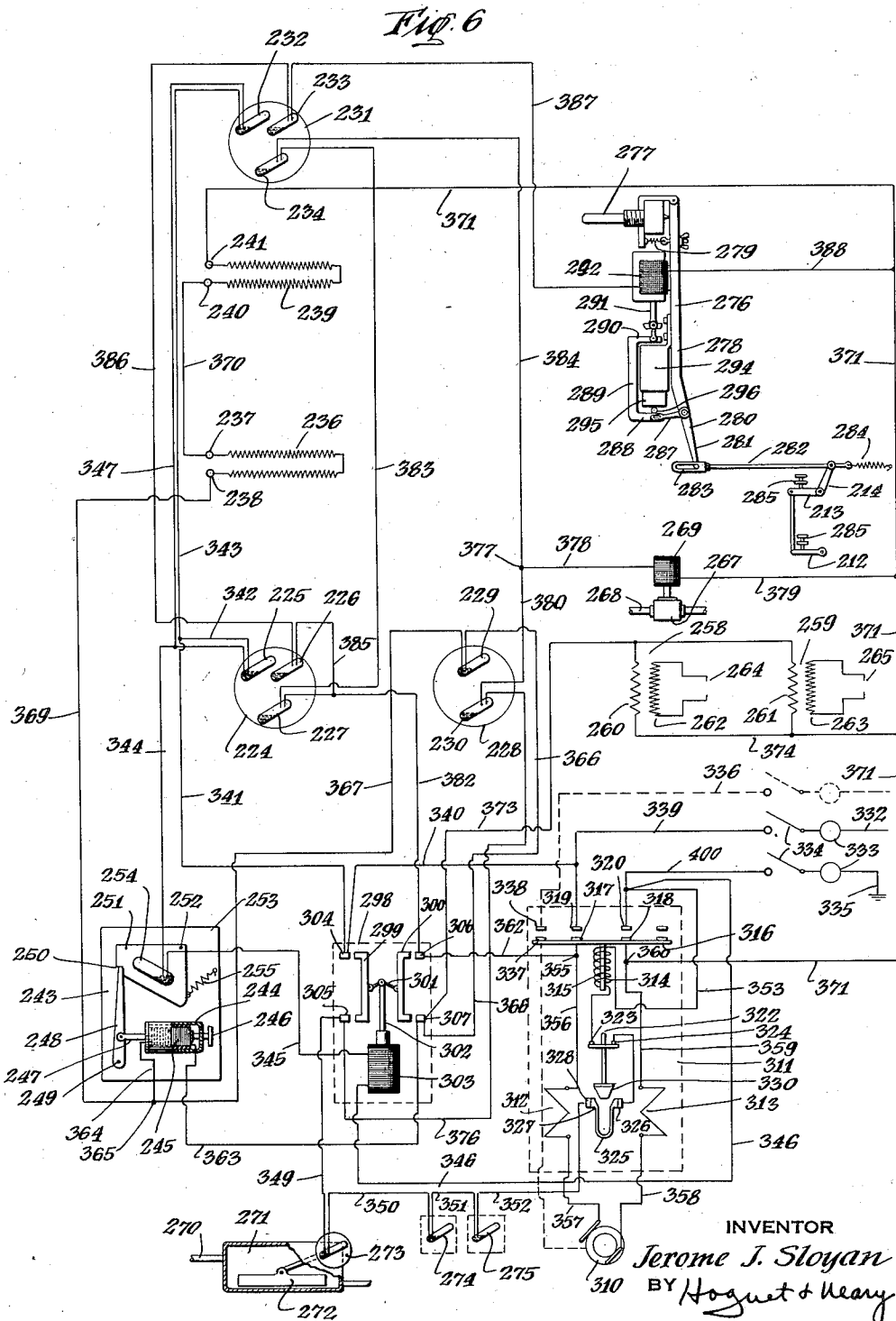
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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,031,335

CONTROL FOR HEAT GENERATORS

Jerome J. Sloyan, Red Bank, N. J.

Application July 2, 1932, Serial No. 620,593

4 Claims. (Cl. 158—28)

This invention pertains to the general class of heating devices and particularly to automatic and semi-automatic controls for such devices.

In my copending application, Serial No. 502,055 filed December 13, 1930, I have shown and described a burner, together with electrical controls therefor. This application comprises a continuation in part of said copending application.

The invention will be more fully understood upon reference to the drawings in which like reference characters have been appended to like parts in the various figures, and in which

Fig. 1 is an elevation, chiefly in section, of a burner;

Fig. 2 is an end view;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic illustration of one form of control;

Fig. 5 is a diagrammatic illustration of another form of control;

Fig. 6 is a diagrammatic illustration of a further form of control particularly adapted to automatically control two burners, in simultaneous operation;

Fig. 7 is a diagrammatic illustration of the location of the thermostatic switching devices for the form of control illustrated in Fig. 6.

Referring to Figs. 1, 2 and 3, at 10 is shown a furnace wall through which extends a combustion chamber 11. To the mouth of the combustion chamber is secured an ante-combustion chamber 12. Any means may be employed for connecting the ante-combustion chamber 12 to the combustion chamber 11. Sheath 14 surrounds ante-combustion chamber 12 and is spaced therefrom so as to provide an air passage 15.

Sheath 14 is shown formed so as to provide an annular enlargement 17 which opens at one side edge into the air passage 15. Connection between a blower 18 and the enlargement 17 is provided through an opening 19 in the sheath 14.

Other forms of air passages are shown and described in my copending application, Serial No. 620,595 filed July 2, 1932. The particular description of an air passage herein is merely for the purpose of showing means for preheating air by means of heat derived from the sustained combustion of fuel in the burner.

Ante-combustion chamber 12 is shown as merging into a straight portion 22. Portion 22 is shown provided with a collar 23 for supporting one end of sleeve 25. The other end of sleeve 25 is shown fitted about the end 26 of sheath 14, a packing nut 27 being provided to form a tight connection.

A tubular member 30 leads from opening 29 in sleeve 25 and opens into a heating chamber 32 containing an electrical heating element 45 having electrodes 48 and 50. Heating chamber 32 opens into a conduit 34, which in turn leads to the air inlet of carburetor 39. The outlet of carburetor 39 opens into the extended portion 22 of ante-combustion chamber 12.

The general path of the air and eventually of the combustible mixture is as follows: The air enters from blower 18 into blower pipe 20, then passes through opening 19 into enlargement 17 of air passage 15, then into the more restricted portion of air passage 15, then in between sleeve 25 and extension 22, then upwardly through tubular member 30 into chamber 32, then through a conduit 34 into carburetor 39, where it is mixed with fuel. From here the resultant combustible mixture passes through portion 22 into ante-combustion chamber 12 via a safety device 70 illustrated as a venturi.

The blower 18, of course, may be inserted at any other point in the set-up that is between the air passage 15 and the carburetor, or between the carburetor and the ante-combustion chamber, or might even be placed in the stack, the particular description of the burner and its associated parts being merely for the purposes of illustration.

The carburetor 39 is shown provided with an overflow 60 leading to a sealed receptacle 62 in which the pressure is equalized with that of the float chamber and that of conduit 34 by means of a pipe 56.

Ignition is accomplished by means of electrodes 76 inserted into the path of the combustible mixture through apertures 77 in venturi 70, the ends 75 of electrodes 76 being, of course, spaced from each other.

As part of the automatic and semi-automatic starting and operating equipment, I insert a thermostatic switching device 78 of any suitable type in the air stream upstream from the heating element 45 and downstream from the air passage 15. The temperature responsive element of thermostatic switching device 78 is illustrated as extending into tubular member 30. The thermostatic switching device illustrated comprises two mercury tube switches mounted upon a rotating base. The arrangement is such that at low temperatures the mercury switches are in the positions shown in Fig. 1 with one switch closed and the other switch open. As the air flowing through air passage 15 increases in temperature due to sustained combustion in ante-combustion chamber 12, the rotating base of thermostatic switch-

ing device 78 eventually rotates clockwise, as seen in Fig. 1, whereupon the mercury switch which was formerly closed opens and the mercury switch which was formerly open closes.

5 A thermostatic switching device 79, in all respects similar to that shown at 78, is placed in the conduit 34 downstream from heating element 45.

10 Carburetor 39 is shown with a fuel inlet pipe 81 provided with an electrically operated valve 82. Carburetor 39 is also provided with a drain pipe 83 having an electrically operated valve 84. Pipe 83 leads to any suitable receptacle, not shown.

15 Carburetor 39 is, of course, provided with the usual volume controlling mechanism illustrated as a butterfly 87.

20 Receptacle 62 is provided with a float 88 which controls a mercury switch 89 to which wires 110 and 166 (see Fig. 4) are connected, wire 166 leading to valves 82 and 84. The arrangement is such that when the float 88 is at the bottom of receptacle 62, switch 89 is closed, and when float 88 is raised by overflow from carburetor 39, switch 25 89 opens. Fuel valve 82 opens with a flow of current and drain valve 84 closes with a flow of current, and vice versa.

30 Substantially automatic starting and regulating mechanism is shown diagrammatically in Fig. 4. At 95 is illustrated a single throw double pole switch which is connected to a suitable source of electrical energy. At 78 is diagrammatically illustrated the thermostat located in the tubular element 30 of Fig. 1. This thermostat 35 has two mercury tubes 96 and 97. The tubes as illustrated in full line are in cold position. It will be noted that the mercury illustrated at 98 in tube 96 closes a circuit through conductors 99 and 109 whereas the mercury 101 in tube 97 has 40 flowed away from the electrodes on the ends of conductors 102 and 103 to open the circuit through the same.

Thermostatic switching device 79 which projects into conduit 34 has two mercury tubes 104 45 and 105. The thermostatic switching device 79 is also illustrated in full lines in cold position. In this position the mercury 106 in tube 104 closes a circuit between conductors 100 and 107. The mercury 108 in tube 105 is in the opposite end of 50 the tube from the electrodes on the ends of conductors 109 and 110. Tubes 96 and 97 of thermostatic switching device 78 and tubes 104 and 105 of thermostatic switching device 79 are mounted upon bases which are adapted to turn clockwise 55 with increase in temperature and turn counterclockwise with decrease in temperature. I arrange tubes 96 and 97 so that when turning with their bases in a clockwise direction a circuit will be established through conductors 102 and 103 before the circuit through conductors 99 and 100 60 is broken.

A timing switch illustrated generally at 112 is connected across conductors 100 and 107. The timing switch comprises a base 113 mounted to 65 rotate about an axis 114. A handle 115 on one side of base 113 would cause the base to rotate clockwise except for the latch 116 which engages a depression 117 in the edge of base 113. Mounted upon base 113 is a tube 118 containing mercury shown at 119 as well as electrodes on the 70 ends of conductors 120 and 121. In the position shown, the mercury 119 in tube 118 is adapted to close a circuit through conductor 122, resistance element 123, conductor 120 and conductor 121. 75 This construction is merely diagrammatic in

character and any approved structure may be substituted therefor. For instance, the resistance element 123 which expands and contracts responsive to temperature changes is conveniently filled with graphite resistance discs.

When a sufficient current flows through resistance element 123 for a predetermined time it eventually expands, thus turning latch 116 about its axis 124 to release the base 113 and permit the same to rotate clockwise, thus causing the 10 mercury 119 to flow to the other end of tube 118 to break the circuit established by the mercury through the electrodes on the ends of conductors 120 and 121. A stop 125 adapted to engage latch 116 may be provided to limit the rotation of the 15 base 113.

Conductor 107 leads to a relay 127 which is adapted to operate an armature 128. The construction of the relay 127 and armature 128 is 20 such that when no current is flowing through the relay, the bar of the armature is spaced from contacts 130, 131, 132 and 133. When a current flows through relay 127, the bar of the armature is drawn into engagement with contacts 130, 131, 132 and 133 to electrically connect the same. 25 Conductor 134 connects relay 127 with binding post 135 on automatic starter 136 to be hereinafter described.

One pole of switch 95 is connected to binding post 135 and the other pole is connected to binding post 137.

Contact 130 is connected to binding post 138 on automatic starter 136 by means of conductor 139. Contact 130 is also connected to conductor 102. 35

Contact 131 is connected to binding post 140 on automatic starter 136 through conductor 141. Contact 131 is connected to conductor 142 which leads to one end of tube 143 mounted upon a base 144 adapted to rotate about an axis 145. 40 Adjacent the electrode on conductor 142 is an electrode on conductor 99 and a circuit is established through these electrodes by mercury 146 when the tube 143 is in the position shown. Axis 145 has mounted on one of its ends butterfly 87 45 of carburetor 39 (see Fig. 1). Arm 148 secured to axis 145 is connected to a master thermostat shown diagrammatically at 149 by means of rod 150. A lever 151 pivoted at 152 is connected at 153 to rod 150. Thermostat 149 is located within 50 the zone to be heated by the burner. For instance, thermostat 149 might be located in a room of a building or at any other point, its function being the control of butterfly valve 87 of carburetor 39 shown in Fig. 1. A removable pin shown diagrammatically at 154 is adapted to be positioned 55 in the path of lever 151 to prevent clockwise movement thereof.

Contact 132 is connected through conductor 156 to heating element 45 and transformer 157. The 60 other terminals of heating element 45 and transformer 157 are connected to conductor 158 which in turn connects to conductor 159 which leads to terminal 160 on automatic starter 136.

Contact 133 is connected with conductor 103. 65 Contact 133 is also connected with conductor 109 which leads to tube 105 of thermostatic switching device 79.

Switch 89 controlled by float 88 in receptacle 62 may conveniently comprise a base 162 mounted 70 on a shaft 163 which in turn is controlled by float 88 referred to in connection with Fig. 1. Base 162 may carry a tube 164 having a small amount of mercury 165 and having in one end spaced electrodes on the ends of conductors 110 75

and 166. The operation of the switch 89 is such that when the float 88 is in the bottom of receptacle 62 the mercury 165 electrically connects conductors 110 and 166. As the float 88 rises, due to an overflow from the float chamber of the carburetor, base 162 rotates clockwise causing the mercury 165 to flow to the other end of the tube 164 to disconnect conductors 110 and 166. This breaks the circuit through valves 82 and 84 connected in parallel between conductors 166 and 159.

Contact 133 is also connected to terminal 170 on automatic starter 136 by means of conductor 171. Spaced from terminal 170 is the terminal 172. Terminals 170 and 172 comprise a portion of an overload relay 173 having an armature 174 which opens and closes a circuit through the terminals 170 and 172.

A relay 175 having an armature 176 comprising a bar 177 of insulating material with contacts 178 and 179 is connected to the terminal 172 by means of the conductor 180. The other side of relay 175 is connected to the terminal 135 by means of conductor 181.

Blower motor 182 is connected across contacts 178 and 179 through the overload relay 173, the arrangement being such that relay 173 opens the circuit through terminals 170 and 172 when the blower motor 182 becomes overloaded.

Terminal 183 is connected to terminal 140 by means of a conductor 184 and terminal 185 is connected to terminal 137 by means of a conductor 186. Terminals 183 and 185 may be connected by means of a push button 187.

The operation of the starting and stopping mechanism is as follows: Push button 187 is depressed, thus connecting terminals 183 and 185. This closes a circuit from terminal 137 through conductor 186, terminals 185, 183, conductor 184, terminal 140, conductor 141, contact 131, conductor 142, tube 143, conductor 99, tube 96, conductor 100, tube 104, conductor 107, relay 127, conductor 134, and terminal 135. Relay 127 draws armature 128 into engagement with contacts 130, 131, 132 and 133, thus electrically connecting these contacts. Contact 133 is thus connected to contact 131. This closes a circuit through terminal 137, conductor 136, terminals 135 and 183, conductor 184, terminal 140, conductor 141, contact 131, armature 128, contact 133, conductor 171, terminals 170 and 172 (relay 173 being normally closed), conductor 180, relay 175, conductor 181, and terminal 135. Relay 175 moves its armature 176 so that contact 178 engages a contact 189 connected to terminal 137, and contact 179 engages a contact 190 connected to terminal 135. This in turn connects contact 130 with terminal 137 through wire 139, terminal 138, and contacts 189, 178 since terminal 138 is electrically connected to contact 178. Push button 187 may now be released because contact 131 in the circuit of relay 127 and contact 133 in the circuit of relay 175 are connected to the contact 130 through the armature 128.

The closing of relay 175 starts blower motor 182. Blower 182 is connected across terminals 138 and 160 by means of the conductors shown. The conductor between blower 182 and terminal 160 has interposed therein overload relay 173. It can be seen that closing of relay 175 connects blower 182 directly across the line. Butterfly 87 of carburetor 39 is attached to axis 152 and, with the thermostat 149 and its associated mechanism locked in the position shown by the stop 154, the butterfly 87 is slightly open so as to

permit a small flow of air from blower 18 through air passage 15, tubular member 30, past thermostatic switching device 78, over heating element 45, through air conduit 34 past thermostatic switching device 79, carburetor 39, venturi 70, into the ante-combustion chamber 12.

Contact 132 being engaged by armature 128, a circuit is closed through contact 132, conductor 156, heating element 45, transformer 157, conductors 158 and 159, terminal 160, contacts 179 and 190 and terminal 135, terminal 160 being electrically connected to contact 179. A spark is thus established across electrodes 76. Heating element 45 heats the air passing around it, which is, of course, small in quantity. When the flowing air and the associated parts reach a temperature suitable for vaporization of the fuel, thermostatic switching device 79 in air conduit 34 moves clockwise as seen in Fig. 4, moving the tubes 104 and 105 to the positions shown in dotted lines. Movement of the thermostatic switching device 79 closes a circuit through contact 133, conductor 109, conductor 110, conductor 156, valves 82 and 84, conductor 159, terminal 160, contacts 179 and 190 and terminal 135. Feed valve 82 opens to permit fuel to enter carburetor 39 and drain valve 84 closes to prevent draining of such fuel from the carburetor. As will hereinafter appear, opening of switch 104 connects resistance element 123 in series across the line instead of in parallel with the ends of conductors 100 and 107, which condition obtains when switch tube 104 is closed.

After the fuel reaches the proper level in carburetor 39 it begins to flow up into jet or jets 58 and is vaporized by the flowing air. The resulting combustible mixture is ignited as it passes through venturi 70 by the spark passing between electrodes 76.

The flame begins to heat ante-combustion chamber 12 which in turn begins to heat the air passing through air passage 15. When the air passing through the air passage 15 reaches a desired temperature, suitable in itself for proper vaporization of fuel, it actuates thermostatic switching device 78 causing it to turn clockwise bringing the tubes 96 and 97 into the positions shown in dotted lines. The opening of switch tube 96 opens the circuit through relay 127, causing armature 128 to disengage contacts 130, 131, 132 and 133. This opens the circuit through heating element 45 and transformer 157 and de-energizes resistance element 123. The closure of switch tube 97 closes a circuit from contact 130, through conductor 102, tube 97, conductor 103 and contact 133 so that fuel valve 82 remains open and drain valve 84 remains closed. Relay 175 also remains closed.

The turning of the thermostatic switching device 78 signifies that the device is properly warmed up and that the rate of combustion may be increased to meet requirements. Stop 154 holding lever 151 may be released at this time so as to permit normal operation of the thermostat 149. This may be done manually or automatically, for instance by some mechanism connected to thermostatic switching device 78 to be actuated by the clockwise movement thereof.

The timing switch 112 acts merely as a safety device. Before the thermostatic switching device 79 turns clockwise practically no current flows through the timing switch in view of the small drop between its terminals. However, when the circuit through the tube 104 is open, the timing switch 112 is placed in series with 75

the circuit through conductors 100 and 107. The timing switch permits sufficient current to flow to hold relay 127 closed. The resistance element 123 of timing switch 112 is set so as to release latch 116 to permit clockwise movement of the base 113 after a desired time interval, say, for instance, ten minutes. Clockwise movement of the timing switch opens the circuit through its tube 118 and through the relay 127.

Under normal starting conditions the circuit through relay 127 will be broken by the tilting of tube 96 of thermostatic switching device 78 before the circuit is broken by the timing switch 112. However, should the mixture coming from the carburetor fail to ignite for any reason, the air passing about ante-combustion chamber 12 will not be heated, and, therefore, will not cause thermostatic switching device 78 to operate to open relay 127. In this event relay 127 is opened by the timing switch 112 after the expiration of the predetermined time interval and the burner is shut down.

If, after the burner is in operation, the flame should become extinguished for any reason, ante-combustion chamber 12 will begin to cool, thus failing to heat the air passing about it to the required temperature to hold thermostatic switching device 78 in its clockwise position. Thermostatic switching device 78 will then turn counterclockwise back to its starting position, opening the circuit through tube 97 which in turn breaks the circuits through fuel valve 82 and drain valve 84 causing the fuel valve 82 to close and the drain valve 84 to open. Opening of the circuit through tube 97 also breaks the circuit through relay 175. This shuts off blower motor 182. All of the parts return to their original positions except tube 143. Flame extinction will simultaneously cause thermostatic switching device 79 to return to its original position which will also break the circuit through valves 82 and 84.

Any irregularities in the float chamber of the carburetor causing excess fuel to overflow through pipe 60 into receptacle 62 will cause float 88 to rise, turning switch 89 clockwise as seen in Fig. 4, which in turn tilts tube 164 to the position shown in dotted lines. This opens the circuit through valves 82 and 84 to shut off the supply of fuel and to drain the carburetor. The shutting off of the fuel supply extinguishes the flame and the device shuts down as described in the previous paragraph.

Tube 143, which is connected to thermostat 149, must be re-set before re-starting because the thermostat 149, when the device shuts down, will normally hold the arm 148 to the right in Fig. 4, holding the tube 143 in the position shown in dotted lines. When the tube 143 is in this position, it is impossible to close the circuit through the relay 127 to start the device.

It is, of course, also necessary to re-set the timing switch 112 if it has operated. If the timing switch 112 is not re-set, the relay 127 will be opened when thermostatic switching device 79 turns counterclockwise, which in turn will shut down the device.

It can be readily seen that it is impossible to start and operate the device except under normal conditions. If any difficulty should arise, such difficulty must be entirely removed before the burner can be restarted. For instance, fuel difficulties causing the float 88 to rise in receptacle 62 requires the receptacle to be drained before switch 89 will be returned to normal position.

The operator, of course, will at once realize that the cause of the overflow of fuel must also be immediately corrected.

Ignition difficulties will prevent thermostatic switching device 78 from turning clockwise or will cause this thermostat to return to its original position, in either event the device will be shut down.

Failure of the heating element 45 will prevent thermostatic switching device 79 from turning clockwise. This will prevent fuel from being delivered to the carburetor 39.

Any abnormal condition causing an abnormal load upon blower motor 182 will cause relay 173 to open the circuit through relay 175 which in turn will disconnect the whole device from the line.

It can be readily seen that the hook-up shown in Fig. 4 makes the device substantially automatic, fully safe and foolproof. When the system operates normally, operation may be stopped by opening switch 95, by shutting off the fuel supply or by any other means which might suggest itself to persons skilled in the art.

My invention, however, is not limited to the hook-up shown in Fig. 4. The invention broadly covers the control of a burner by means of the temperature of the air flowing to the carburetor.

In Fig. 5 I have shown a hook-up in which thermostatic switching device 79 has been eliminated as well as the thermostat 149 and its associated mechanism. Timing switch 112 has also been eliminated. Contact 131 is connected directly to relay 127 through tube 96 by means of conductors 195 and 196. Tube 105 has been eliminated from the circuit passing through contact 133 and tube 164. Otherwise, the parts are exactly similar to those shown in Fig. 4.

In operation the depression of the push button 187 operates relay 127. This in turn closes relay 175. Blower 182 is started, current is supplied to the heating element 45, and the flowing air is raised in temperature. Current is supplied to magnetic fuel valve 82, thus causing it to be held in open position and to drain valve 84, thus closing the same. A spark is established between electrodes 76. After the flowing air has reached a proper temperature, a manually operated fuel valve 200 is opened permitting fuel to flow from the source of supply through valve 82 to the carburetor. The heated flowing air now vaporizes and mixes with the fuel in the carburetor and the resulting mixture is delivered into ante-combustion chamber 12 where it is ignited by the spark between electrodes 76. After the ante-combustion chamber 12 begins to heat up so as to heat the air flowing through air passage 15, thermostatic switching device 78 will turn clockwise as seen in Fig. 5, thus opening the circuit through relay 127 and closing the circuit through contact 130, conductor 102, tube 97, conductor 103, contact 133, etc., which holds the relay 175 closed, fuel valve 82 open and drain valve 84 closed. The opening of relay 127 disconnects heating element 45 and transformer 157.

A form of the invention adapted more particularly for the control of a plurality of burners is disclosed in Figs. 6 and 7.

Fig. 7 discloses two burners 210 and 211. Burners 210 and 211 have throttle valves 212 and 213 connected to a common control arm illustrated at 214 in Fig. 6.

Burners 210 and 211 may be of any design. The burner illustrated comprises an ante-combustion chamber 215 surrounded by an air heat-

ing chamber 216 which opens into a conduit 217 leading to a preliminary air heating chamber 218. Chamber 218 leads into a conduit 219 leading to carburetor 220, the outlet 221 of which delivers a combustible mixture which is eventually burned in ante-combustion chamber 215 after passing through venturi 222.

The burners illustrated are similar in all respects and are positioned with respect to each other as shown in Fig. 7 merely for clarity in the description of the automatic control.

In burner 210 thermostatic switching device 224 having three mercury switches 225, 226 and 227 is positioned with its temperature reactive element in the air stream, downstream from the air heating chamber 216 and upstream from the preliminary air heating chamber 218. As shown, the thermostatic switching device 224 is inserted in the conduit 217.

A second thermostatic switching device 228 is positioned in the air passage between the preliminary air heating chamber 218 and the ante-combustion chamber 215 so as to be downstream from the preliminary heating chamber 218. Thermostatic switching device 228 has two mercury switches 229 and 230.

Burner 211 has merely one thermostatic switching device 231 having mercury switches 232, 233 and 234. Thermostatic switching device 231 has its temperature reactive element inserted in the air stream, downstream from the air heating chamber 216 and upstream from the preliminary air heating chamber 218.

Thermostatic switching devices 224, 228 and 231 may be of the conventional bi-metal type and operate by rotating through an arc in response to changes in temperature. As shown, these thermostatic switching devices are in cold position and each thermostatic switching device rotates clockwise from the position shown when the air passing its reactive element has reached a certain specific predetermined temperature to open the mercury switches formerly closed and to close the mercury switches formerly open. Upon cooling of the air below the setting of the individual thermostatic switching device, it returns to its original position.

Preliminary heating chamber 218 of burner 210 contains an electrical heating element illustrated at 236 in Fig. 6. Heating element 236 has electrodes 237 and 238 connected in the control circuit.

Preliminary heating chamber 218 of burner 211 contains an electrical heating element illustrated at 239 having electrodes 240 and 241 connected in the control circuit.

Delayed action switch 243 consists of a cylinder 244 which is filled with graphite discs 245. An adjustment screw 246 may be employed to increase or decrease the pressure on the discs to change the resistance characteristic. A bi-metallic element 247 is so positioned with respect to the graphite discs 245 that expansion of the element 247 in response to the heat generated in discs 245 will cause arm 248 to rotate counterclockwise about its pivot 249. Cooling of the element 247 will return the arm 248 to the position shown in Fig. 6. Arm 248 when in the position shown is adapted to engage a notch 250 in block 251 pivoted at 252 on base 253 and carries a mercury switch 254 illustrated in closed position.

Expansion of element 247 in response to heating of discs 245 will, if the expansion is sufficient, move arm 248 out of notch 250 thereby permitting block 251 to move counterclockwise in response

to resilient member 255, thereby opening mercury switch 254.

It is, of course, understood that the quantity of heat generated in discs 245 will depend upon, first, the rate of current flow, second, the resistance to the flow, and third, the duration of the flow.

As illustrated in Fig. 6, discs 245 are in series with heating elements 236 and 239, and the rate of current flow will be the same as that throughout this part of the circuit under certain conditions to be described hereinafter. The duration of the flow is the factor intended to be employed, and the duration of flow may be adjusted by adjusting the resistance through discs 245, as will be seen hereinafter.

The function of delayed action switch 243 is to cause a complete shutdown by opening mercury switch 254, in the event that either burner is incapable of heating the air in its air heating chamber 216 to a predetermined temperature within a predetermined time interval after fuel has been supplied and ignited. Ignition failure will also cause its operation.

Should delayed action switch 243 be operated, it is so constructed that it will be necessary to manually reset the same before the device can be restarted. This would be done, of course, after previously removing the cause for the shutdown.

On the other hand, switch 243 is intended to remain in closed position as long as combustion in both burners is taking place properly.

Transformers 258 and 259, comprising primaries 260 and 261 and secondaries 262 and 263 respectively, are employed for ignition purposes, the primaries 260 and 261 being supplied with current of proper voltage by the circuit and secondaries 262 and 263 being connected across electrodes illustrated generally at 264 and 265 respectively. Of course, it is understood that the electrodes 264 and 265 will be positioned in the path of the combustion mixture at proper points and for convenience in description electrodes 264 will be regarded as inserted in the burner 210 and electrodes 265 as inserted in burner 211.

Of course, it is understood that any other form of ignition may be employed, provided it can be controlled in a manner similar to transformers 258 and 259, as hereinafter described.

Fuel valve 267 is electrically operated, such as by a solenoid, and controls the flow of fuel in fuel line shown broken at 268, which supplies fuel to each of the burners 210 and 211. Fuel valve 267 is so constructed that it is opened by the flow of current through its solenoid 269 and automatically closed on discontinuance of such flow.

Carburetors 220 are provided with overflows illustrated at 270, which lead to a container 271 having a float 272 connected to a mercury switch 273 in a manner so that when the float is at the bottom of the container as illustrated in Fig. 6 the mercury switch is closed, and when it is raised by overflow of fuel in carburetors 220 the mercury switch is opened.

If there is a positive pressure on the fuel in the float chambers of carburetors 220, container 271 is preferably sealed and means provided for an equalization of pressure between container 271 and the float chambers of carburetors 220 in order to facilitate the flow of excess fuel from carburetors 220 to the container 271.

Mercury switch 273 is connected in the control circuit in a manner so that if and when it

is opened by the overflow of fuel from carburetors 220 the burners 210 and 211 are shut down.

Additional mercury switches 274 and 275 are illustrated in series with the mercury switch 273 and may be operated by any means which may be used to register the existence of unsafe operating conditions which demand correction before operation can be resumed, such as failure of the butterfly valves 212 and 213 to close and reduce the rate of combustion in response to regulator 276, or the existence of low water in the boilers etc., or a time switch may be installed at this location to effect starting and stopping of the burners at predetermined intervals. These switches are connected in series so that the opening of any or all will cause the furnace to become inoperative.

This specific regulator in substance comprises a temperature, or pressure, speed or other responsive element 277, which is adapted to rotate arm 278 against the action of a resilient member shown in 279. At the end of arm 278 is hinged a fulcrum of bell crank 280 having one arm 281 connected to rod 282 through a slot 283. Rod 282 is connected to butterfly control arm 214. A resilient member 284 tends to hold the butterfly valves of burners 210 and 211 in minimum operating position, the amount of combustion taking place under minimum operation being made adjustable by the conventional adjustment illustrated at 285.

The other arm 287 of bell crank 290 is pivoted on leg 288 of U-shaped member 289. The other leg 290 of U-shaped member 289 is connected to core 291 of solenoid 292 secured to arm 278.

Solenoid 292 is connected in the control circuit and the operation of regulator 276 is such that movement of arm 278 is not reflected in rod 282 unless armature 291 is drawn up into solenoid 292 by the flow of current therethrough, in which case rod 282 is directly responsive to movements of arm 278.

As illustrated in Fig. 6, arm 278 is in the position of maximum operation of burners 210 and 211; therefore, if armature 291 were drawn up into solenoid 292 with arm 278 being in the position shown, the burner would be thrown wide open almost momentarily from a position of minimum operation. In order to avoid any possible dire results of such a rapid change in rate of combustion, I provide means for causing the change in combustion rate to take place gradually on connecting the butterfly valves to the regulator 276, but at the same time preserving the function of rapid disconnection on failure of the current in solenoid 292.

The means illustrated comprises an inverted cylinder 294 having a piston 295 resting upon leg 288 of U-shaped member 289, so as to move with leg 288 in its upward movement in response to solenoid 292. A ball 296 for contacting piston 295 may be provided on leg 288 if desired.

Piston 295 fits sufficiently loosely in cylinder 294 to permit the escape of air around the piston at a desired rate depending upon the character of the delayed action desired.

Inasmuch as the pressure in cylinder 294 will be atmospheric at the beginning of the upward movement of piston 295 and is, therefore, insufficient to substantially retard the movement of piston 295, slot 283 is provided at the end of rod 282 so that arm 281 of bell crank 280 in moving clockwise, as illustrated, will not cause the movement of rod 282 until piston 295 has moved upwardly to a sufficient extent to create

a pressure in cylinder 294 sufficient to materially retard the rate of clockwise movement of arm 281, and consequently the rate of increase of the rate of combustion.

It will be seen from the above that the flow of current in solenoid 292 will connect regulator 276 gradually to the butterfly valves 212 and 213 of burners 210 and 211, and failure of current in solenoid 292 will substantially instantaneously disconnect regulator 276 and permit the butterfly valves to return to positions of minimum operation.

A double pole relay is shown at 298. Relay 298 has contact bars 299 and 300, which are insulatedly mounted on mechanism illustrated conventionally at 301, which is operated by movement of armature 302 of solenoid 303.

Contact bar 299 is adapted to contact spaced terminals 304 and 305, and contact bar 300 is adapted to contact spaced terminals 306 and 307. The contact movements of contact bars 299 and 300 takes place simultaneously, contact of contact bar 299 with terminals 304 and 305 and contact of contact bar 300 with terminals 306 and 307 taking place by movement of armature 302 into solenoid 303 by virtue of the flow of current through solenoid 303, and the contact of contact bars 299 and 300 being broken upon failure of current supply to solenoid 303. Solenoid 303 is connected in the control circuit.

A blower motor is shown at 310.

At 311 is shown a conventional "across the line" A-C starter equipped with thermal-overload coils 312 and 313.

Solenoid 314 of starter 311 has an armature 315 to which is attached a contact bar 316 of insulating material carrying the conventional four contacts.

Contacts 317 and 318 on bar 316 engage stationary contacts 319 and 320 respectively upon a flow of current in solenoid 314 to, among other things as will hereinafter appear, close a circuit through the blower motor 310.

The circuit through the solenoid 314 includes a switch-button 322 which forms a switch with contacts 323 and 324. The circuit continues through a bi-metallic element 325 having a fixed pole 326 and a movable pole 327 adapted to form a switch with contact 328. Any abnormal current demand by the motor is registered by an increase in temperature of the thermal-overload coils 312 and 313. Such rise in temperature causes the bi-metallic element 325 to change in shape in a manner so as to move pole 327 away from contact 328 to break the circuit through solenoid 314 and permit bar 316 to fall so as to open the switches formed by contacts 317 and 319 and contacts 318 and 320.

Button 322 has attached thereto the conventional frustro-conical member 330 which is adapted to be depressed to break the circuit between contacts 323 and 324 and at the same time to facilitate the return of pole 327 to its contacting position with contact 328. Upon release of the button 322 the circuit is again closed through solenoid 314.

A conventional single phase supply line, having one side grounded at 335, is shown at 332. That one side of the line should be grounded is obviously not necessary. Fuses are shown at 333 and a double pole switch at 334. An additional wire for a three phase connection is shown dotted at 336, in which case switch 334 would be of a triple pole type. Wire 336 continues to motor

unit 310 and contains a switch comprising contacts 337 and 338 operated by bar 316.

Now let us suppose that thermostatic switching devices 224, 228 and 231 are in cold position. The mercury switches of these thermostats are, therefore, in the following positions: 225 is closed, 226 is open, 227 is open, 229 is closed, 230 is open, 232 is closed, 233 is open, and 234 is open.

In delayed action switch 243, arm 248 is in notch 250 and, therefore, mercury switch 254 is closed.

Fuel valve 267 is closed.

Throttle valves 212 and 213 are in positions of minimum fuel consumption, being retained in these positions by spring 284.

Regulator 276 is disconnected from rod 282 and, therefore, from throttle valves 212 and 213 inasmuch as no current is flowing through solenoid 292.

Contact bars 299 and 300 are in open positions because no current is flowing through solenoid 303. Bar 316 is in open position because no current is flowing through solenoid 314.

Push button switch 322 is closed.

The bi-metallic element switch comprising parts 325, 326, 327 and 328 is in closed position.

Let it be assumed that no abnormal conditions exist which would cause mercury switches 273, 274 and/or 275 to be open.

Switch 334 is open.

Now let us close switch 334. Following the current from the hot side of line 332 for the purposes of simplicity in description, the current flows to contact 319 over wire 339; to contact 304 over wire 340 which is connected to wire 339; from contact 304 over wire 341 which divides into wires 342 and 343; over wire 342 through mercury switch 225; over wire 344 through mercury switch 254; over wire 345 through solenoid 303; over wire 346 and then over wire 400 back to the opposite side of line 332.

Mercury switch 232 is connected in parallel with mercury switch 225, and inasmuch as it is closed, current will flow between wires 341 and 344 over wire 343, mercury switch 232 and wire 347. Consequently, as long as either mercury switch 225 or mercury switch 232 is closed, current will flow as indicated.

Relay 298 is now closed in view of the flow of current through solenoid 303. This connects contacts 304 and 305 as well as contacts 306 and 307.

Current will now flow from contact 305 over wire 349 and through mercury switch 273; over wire 350 and through mercury switch 274; over wire 351 and through mercury switch 275; over wire 352 to contact 328; from pole 327 over element 325, through contact 336, contact 324, switch element 322, contact 323, solenoid 314, over wire 353 and then over wire 400 back to the opposite side of line 332.

Solenoid 314 operates and raises bar 316 as seen in Fig. 6 so as to close the switches formed by contacts 317 and 319 and contacts 318 and 320.

Current may now flow from contact 319 through contact 317 to terminal 355. From terminal 355 current may flow over wire 356, through thermal-overload coil 312, over wire 357, through motor 310, over wire 358, through thermal-overload coil 313, over wire 359, and through terminal 360, contacts 318 and 320 to the opposite side of line 332.

The blower starts and flow of air is established through burners 210 and 211 through paths above described. The amount of air that is permitted

to flow is small because throttle valves 212 and 213 are substantially closed.

Current may now flow from terminal 355 to contact 306 over wire 362. Contact bar 300 is closed. Current may, therefore, flow to contact 307, then over wire 363 through graphite discs 245, and over wire 364 to terminal 365.

Current may also flow from contact 307 over wire 366, through mercury switch 229, over wire 367 to terminal 365.

The resistance offered by the graphite discs 245 is so high as compared to the negligible resistance of wires 366, mercury switch 229 and wire 367 that practically no current flows through the graphite discs at this time.

From terminal 365 current continues over wire 369 to electrode 232, through heating element 236 in preliminary air heating chamber 218 of burner 210 to electrode 237, over wire 370 to electrode 240, through heating element 239 in preliminary air heating chamber 218 of burner 211 to electrode 241, over wire 371 to terminal 360, through contacts 318 and 320 back to the opposite side of line 332.

The flowing air in each of burners 210 and 211 is now being heated as it passes through preliminary air heating chamber 218.

Going back to contact 307 of relay 298, current flows over wire 373, through the primaries 260 and 261 of transformers 258 and 259 respectively, over wire 374, wire 371, and through terminal 360, contacts 318 and 320, back to the opposite side of line 332.

A spark is, therefore, established across electrodes 254 and 265 of burners 210 and 211 respectively.

When the air passing over heating elements 236 and 239 of burners 210 and 211 respectively becomes heated to a predetermined desired temperature, the temperature reactive element of thermostatic switching device 228 which is downstream from preliminary air heating chamber 218 of burner 210 (a similar thermostatic switching device may be positioned downstream from the preliminary air heating chamber 218 of burner 211 and its mercury switches connected in series with the mercury switches 229 and 230 respectively, if desired) will tilt the mercury switches 229 and 230 so as to open mercury switch 229 and close mercury switch 230.

The current flowing to the heating elements 236 and 239 must now flow entirely through graphite discs 245, because of the opening of mercury switch 229.

The closing of mercury switch 230 causes current to flow from contact 305 over wire 376, through mercury switch 230 to terminal 377. From terminal 377 current flows over wire 378, through solenoid 269, over wire 379, wire 371, through terminal 360, contacts 318 and 320 back to the opposite side of line 332.

This opens fuel valve 267 and permits fuel to flow to carburetors 220 of burners 210 and 211. The fuel so delivered is metered and mixed with the small quantity of heated air that is passing through the carburetors. The heat of the air assists in vaporizing the fuel and a combustible mixture is delivered through each throttle valve 212 and 213 of the respective burners, is ignited by electrodes 254 and 265 of the respective burners, and is burned in the ante-combustion chambers 215 of the respective burners.

Combustion, of course, will take place at the minimum rate, and the igniters as well as the

heating elements 236 and 239 will function continuously.

The flame in each burner heats the inner wall of its adjacent air heating chamber 216, and heat is thus transferred to the flowing air. After the burners have become sufficiently warm to safely operate in accordance with the demand, which is evidenced by the ability of ante-combustion chambers 216 to continuously heat the air to a predetermined temperature, thermostatic switching devices 224 and 231 oscillate in response to the temperature of such heated air.

It is quite probable that thermostatic switching devices 224 and 231 will not as a practical matter be adjusted so accurately as to turn simultaneously. However, since mercury switches 225 and 232 are connected in parallel, the opening of one of these switches in itself will not affect the circuit.

Since mercury switches 226 and 233 are in series and mercury switches 227 and 234 are in series, the closing of only one switch in each series arrangement will not affect the control circuit. It requires oscillation of both thermostatic switching devices 224 and 231 to close the circuits controlled by mercury switches 226, 233, 227 and 234.

Let us assume, therefore, that both thermostatic switching devices 224 and 231 have oscillated. This indicates that the flame in each burner is operating properly since it is heating the air passing through its air heating chamber 216 to a predetermined desired temperature.

Upon the opening of mercury switches 225 and 232, the current flow through solenoid 303 ceases thereby releasing armature 302 and opening relay 298. Contact 307 is no longer connected to the line, hence no longer furnishes current to transformers 258 and 259 which now become inoperative. Heating elements 236 and 239 become inoperative since they have been receiving their current from contact 307 through wire 363, graphite discs 245, terminal 365 and over wire 369, wire 370 and wire 371. Delayed action switch 243, of course, also becomes inoperative.

Solenoids 314 and 269, which previously received current from terminal 305, now receive current from terminal 306 over wire 382, through mercury switch 227, over wire 383, through mercury switch 234, and over wire 384 which is connected to terminal 377 from which solenoid 269 previously received its current, since terminals 377 and 305 are connected by wire 380, mercury switch 230 and wire 376. Terminal 377, instead of receiving current from contact 305, now supplies contact 305 with current. Therefore, solenoid 314 which receives its current from contact 305 remains energized.

From the foregoing it will be seen that mercury switches 227 and 234 should close just prior to the opening of mercury switches 225 and 232 during the clockwise movement of thermostatic switching devices 224 and 231 or the opening and closing should at least be simultaneous so that solenoid 314 will always be energized.

Solenoid 292 of regulator 278 is also energized by virtue of the closing of a circuit through wire 385 which is connected to wire 382, mercury switch 226, wire 386, mercury switch 233, wire 387, solenoid 292 and wire 388 which connects to wire 371.

Upon solenoid 292 becoming energized, its armature 291 is drawn upwardly into its winding to connect regulator 276 to throttle valves 212 and 213 as previously described. The positions of throttle valves 212 and 213, which control the

rates of combustion, are now determined by the expansion and contraction of the element 277 of the regulator 276.

The burners are now in full operation.

A discussion of the difficulties which might prevent the normal starting cycle follows.

The essentials for starting are:

Mercury switch 229 must be closed. Either thermostatic switching device 224 or thermostatic switching device 231 must be sufficiently cool so that either mercury switch 225 or mercury switch 232 will be closed. This is necessary so that relay 298 may be closed by flow of current through its solenoid 303. Mercury switches 254, 273, 274 and 275 must be closed. Pole 327 must engage contact 328. Switch 322 must be closed.

Should relay 298 close without the closing of starter 311, nothing is accomplished. Starter 311 must be closed before current can flow in any circuit save that which effects the closing of relay 298. Before a start can be made, it is necessary that at least one of the burners be out of operation a sufficient length of time to permit its thermostatic switching device upstream from its preliminary heating chamber 218 to have cooled and to have returned to cold position. Let it be assumed that there are no unsafe conditions which would have opened mercury switches 273, 274 or 275.

Let it be assumed for purposes of illustration that thermostatic switching device 224 has reverted to cold position and that thermostatic switching device 231 is still in hot position and that the safety switches 273, 274 and 275 are closed. Relay 298 will close as well as starter 311 because mercury switch 225 is closed. The blower will start operating.

Inasmuch as mercury switch 226 is open, regulator 276 is disconnected from throttle valves 212 and 213, and these valves are in their positions of minimum combustion. Both heating elements 236 and 239 will be energized and if thermostatic switching device 228 was also in cold position, it will soon oscillate to hot position and fuel valve 267 will open. Fuel valve 267 was formerly closed because both mercury switches 230 and 227 were open. Inasmuch as mercury switch 229 is now open, current for the heating elements 236 and 239 will have to pass through graphite discs 245.

Since relay 298 is closed, the transformers 258 and 259 are operating and upon the opening of the fuel valve 267, combustion should be re-established in both burners.

Let it be assumed that the adjustment of 246 is such that the heat generated in graphite discs 245 is sufficient to expand element 247 to force arm 248 out of notch 250 to permit the opening of mercury switch 254 at the end of six minutes.

If thermostatic switching device 224 fails to oscillate to hot position within six minutes, mercury switch 254 will open, relay 298 will open and inasmuch as mercury switch 227 is open, starter 311 will also open and all of the parts will return to their original positions except, of course, switch 243 which must be manually reset. The necessity of resetting delayed action switch 243 is indicative of trouble which should be corrected before another attempt is made to start.

Let us assume on the other hand that thermostatic switching device 224 oscillates to hot position in response to combustion in burner 210, but that combustion in burner 211 has failed or is not up to par. Thermostatic switching device 231 will then eventually return to cold position, thereby opening mercury switch 234 which in turn

causes starter 311 to open and all of the parts returned to their original positions.

If thermostatic switching device 231 returns to cold position before thermostatic switching device 224 oscillates to hot position, the same cycle of operations follows as under normal starting conditions with both burners cold and unless thermostatic switching device 231 returns to hot position, mercury switch 254 will open to shut down the burners.

It is, of course, understood that, upon a shutting down, blower 310 stops, fuel valve 267 closes, regulator 276 is disconnected from throttle valves 212 and 213, heating elements 236 and 239 are de-energized, and transformers 258 and 259 become inoperative.

If the flame in either burner should fail during continuous operation, either thermostatic switching device 224 or 231 will return to its cold position, thereby opening either mercury switch 227 or mercury switch 234 resulting in the breaking of current through solenoid 314 and starter 311 opens to shut down the device.

It will be seen that the burners will shut down regardless of the type of trouble which might occur, such as improper supply of fuel, improper mixture of fuel, failure to ignite, improper burning, etc.

The delayed action switch 243 may be set for any time interval. Experience has shown that intervals up to six or even ten minutes are long enough to permit the flames to evidence their ability of being of good quality and are not of such lengths as to make operation unsafe. The latter is due to the fact that valves 212 and 213 are in their minimum positions and consequently only a very small quantity of fuel will be delivered during this period.

The novel control is particularly useful when two or more burners are connected to separate combustion chambers which communicate with a common set of tubes or common stack. Failure of any burner so connected demands the shutdown of all the burners in the battery and the correction of that fault which caused the shutdown before a permanent recycling will result.

In the case of two or more burners being connected to a common combustion chamber, the passage of free air into the chamber without its being mixed with the proper proportion of fuel is prevented also.

During normal operation the most likely reason for a shutdown will be failure of current supply from the line 332. This would cause a complete shutdown as will be seen from the above. In order for a re-start to occur after re-establishment of the current supply at line 332, it will be necessary for either thermostatic switching device 224 or thermostatic switching device 231 to return to cold position. This is because contacts 317 and 319 will have separated upon de-energization of solenoid 314 by the failure of current in the line 332, and their contact is necessary in order for a flow of current through solenoid 314 to take place when relay 298 is open. Relay 298 is always open during normal operation.

Should the flame in either heat generator become extinguished for any reason whatsoever, this will cause a temporary shutdown that will be followed most likely by an incomplete starting cycle and a permanent shutdown will then take place by opening of the mercury switch 254.

Failure of flame might be caused by fuel stoppage in either carburetor 220. The thermostatic switching device upstream from the preliminary

air heating chamber 218 of the particular burner affected will cool and return to cold position. This will be followed by a temporary set of shutdown operations as above described. A re-start will immediately follow. The starting cycle will proceed normally. Should the affected burner fail to re-ignite or should the ignition be imperfect, or the flame poor, this will, as described above, cause a complete shutdown by opening switch 254.

A unique feature of the circuit is that an overload on the blower motor will cause a shutdown by the abnormal heating of elements 312 and 313 which will cause pole 327 to leave contact 328 and break the circuit through solenoid 314.

It will be noted that to start the burners it is necessary that at least one is cold or cooled. This provision is made for two reasons, first, to permit any uncombusted inflammable vapor which may have been delivered into any combustion chamber prior to the shutdown to be condensed or dispelled from the burner, thereby lessening the hazard of an explosion on a restart, and, second, to insure that a spark for ignition purposes will accompany the re-start.

By sealing the relay 298, starter 311 and thermostatic switching devices 224 and 231, it will be impossible for anyone to tamper with the starting mechanism to cause the igniters to function except as called for by the starting cycle. This will prevent explosions inasmuch as the igniters will not operate after a shutdown until after inflammable vapors have either condensed or have been dispelled.

If either of the heating elements 236 or 239 should be out of order, thermostatic switching device 228 will not oscillate to hot position, consequently fuel will not be supplied and, therefore, combustion cannot take place. Although the blower 310 and the transformers 258 and 259 will continue to operate, there is no danger in such continuous operation. However, means may be provided to stop both, for instance, inserting a device in wire 373 or in wire 374 similar to delayed action switch 243 which would cause a complete shutdown. Such provision, however, unnecessarily complicates the circuit.

It is to be strictly understood that the particular description herein is purely for the purposes of illustration and that the invention is in no way limited to the specific parts or descriptions set forth.

While the invention has been described in connection with heat generators, oil burners, etc., it is in no way limited thereto but may have many other applications.

It is, of course, obvious that many modifications may be made within the scope of the claims without departing from the spirit of the invention.

It is, of course, understood that the regulator shown at 276 may be inserted in the control circuit shown in Figs. 4 and 5. For instance, in Fig. 4 the regulator 276 might be substituted in place of the lever 151, stop 154 and thermostat 149, with similar circuit connections.

It is also understood that the form of control circuit shown in Fig. 6 might be adapted for one burner 210 only by eliminating the duplications made necessary by the second burner 211 or may be adapted to any number of burners by increasing the number of the parts which have been duplicated.

It is also understood that the fuel drain valve 84 might be added to the form shown in Fig. 6

and may be controlled in the same manner as in the form shown in Figs. 4 and 5.

Many other additions or modifications may be made without departing from the spirit of the invention.

I claim:

1. In combination with a burner having ignition means, a fuel feeding means and an air supply means, including an air heating chamber operatively associated with said burner to be heated thereby and an auxiliary air heater positioned intermediate said chamber and burner for initially heating the air; a control system comprising circuits including a main control switch closed in response to a demand for heat, a first temperature responsive switching mechanism in said air supply means intermediate said auxiliary heater and burner having contacts closed when hot controlling initiation of fuel feed, a second temperature responsive switching mechanism in said air supply means intermediate said chamber and auxiliary heater and having contacts closed when cold controlling operation of said auxiliary heater and ignition means and initial operation of said air supply means and contacts closed when hot prior to the opening of the cold contacts maintaining operation of said blower and fuel feeding means whereby upon a demand for heat, fuel feed is delayed until the temperature of the carbureting air reaches a determined value.

2. In combination with a burner having a fuel supply means, ignition means and air supply means provided with an air heating chamber operatively associated with said burner to be heated thereby, an auxiliary air heater arranged between said chamber and said burner for initially heating said air, a control system comprising circuits including a main control switch adapted to be closed in response to a predetermined demand for heat, a temperature responsive switching mechanism in said air supply means intermediate said auxiliary heater and burner having contacts closed when cooled to a predetermined degree to initiate the control of said air supply means, said ignition means and said auxiliary heater and having contacts closed when heated to a predetermined degree to control the flow of fuel, a second temperature responsive switching mechanism in said air supply means intermediate said air heating chamber and said auxiliary air heater having contacts closed when cooled to a predetermined degree controlling the operation of said auxiliary heater and ignition means and initially controlling the operation of said air supply means and contacts closed when heated to a predetermined degree maintaining the operation of

said air supply, a thermal time-limit cut out switch having a resistance heater connected in shunt around the contacts of said first temperature responsive switching mechanism that are closed when cooled to a predetermined degree, whereby when such contacts are opened, said switch heater will be energized to thereafter open said cut out switch.

3. In combination with a burner having ignition means, a fuel feeding means and a carbureting air supply means including an air heating chamber operatively associated with said burner to be heated thereby and an auxiliary air heater positioned intermediate said chamber and burner for initially heating the air; a control system comprising circuits including a main control switch closed in response to a demand for heat, a first temperature responsive switching mechanism in said air supply means intermediate said auxiliary heater and burner controlling initiation of fuel feed, a second temperature responsive switching mechanism in said air supply means intermediate said chamber and auxiliary heater controlling the operation of said auxiliary heater and ignition means and the initial operation of said air supply means and cooperating with said first switching mechanism to maintain operation of said blower and fuel feeding means whereby upon a demand for heat, fuel feed is delayed until the temperature of the carbureting air reaches a determined value.

4. In combination with a burner having a fuel supply means, ignition means and air supply means provided with an air heating chamber operatively associated with said burner to be heated thereby, an auxiliary air heater arranged between said chamber and said burner for initially heating said air, a control system comprising circuits including a main control switch adapted to be closed in response to a predetermined demand for heat, a temperature responsive switching mechanism in said air supply means intermediate said auxiliary heater and burner controlling said air supply means, said ignition means, said auxiliary heater and the flow of fuel, a second temperature responsive switching mechanism in said air supply means intermediate said air heating chamber and said auxiliary air heater controlling the operation of said auxiliary heater and ignition means and cooperating with said first switching mechanism to control the operation of said air supply means and fuel feed, and an electrically actuated time limit cut out switch jointly controlled by said first and second switching mechanisms to energize said cut out switch with the initiation of said fuel feed.

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