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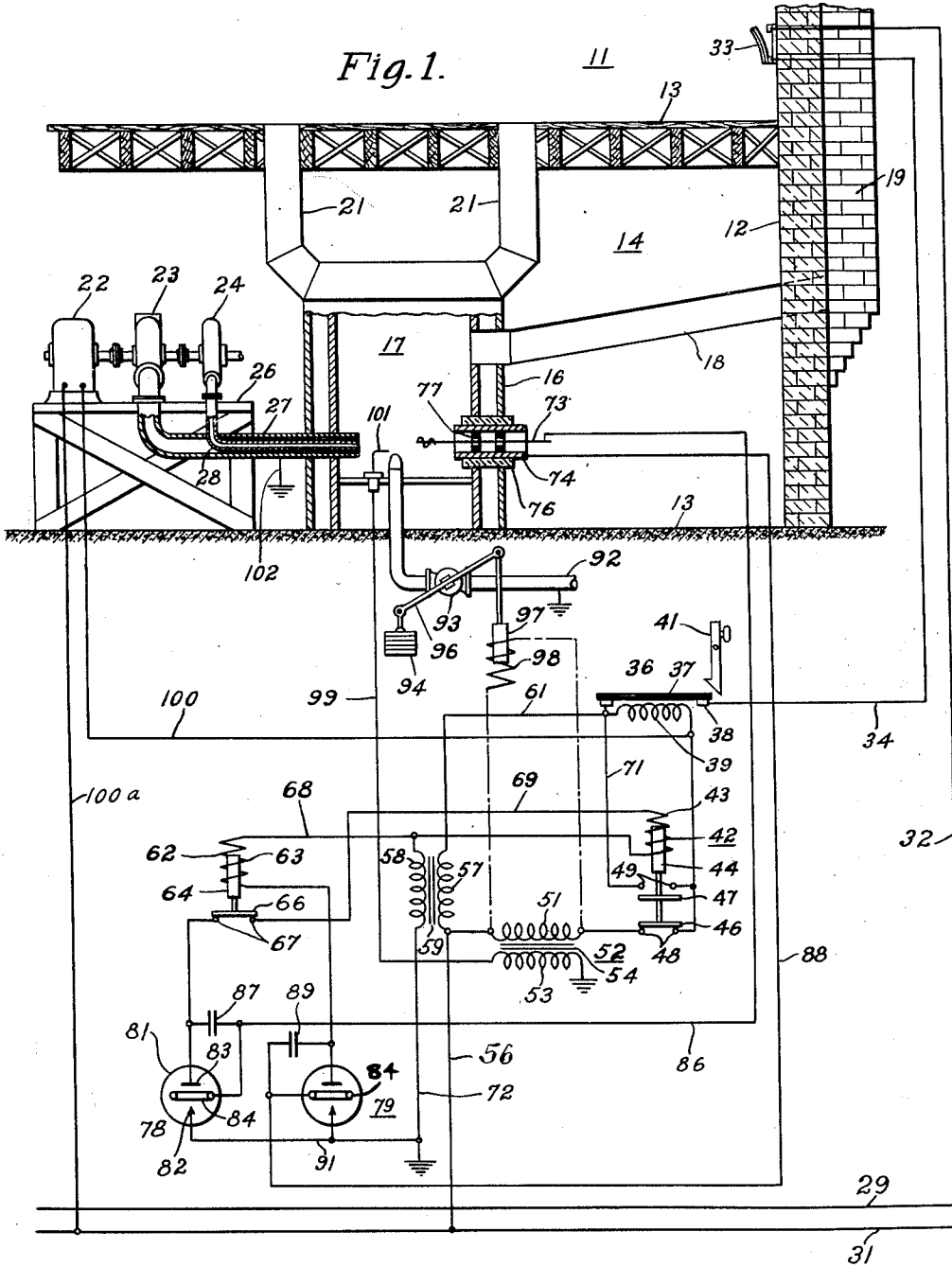
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OIL BURNER CONTROL SYSTEM

Filed Nov. 9, 1928

3 Sheets-Sheet 1



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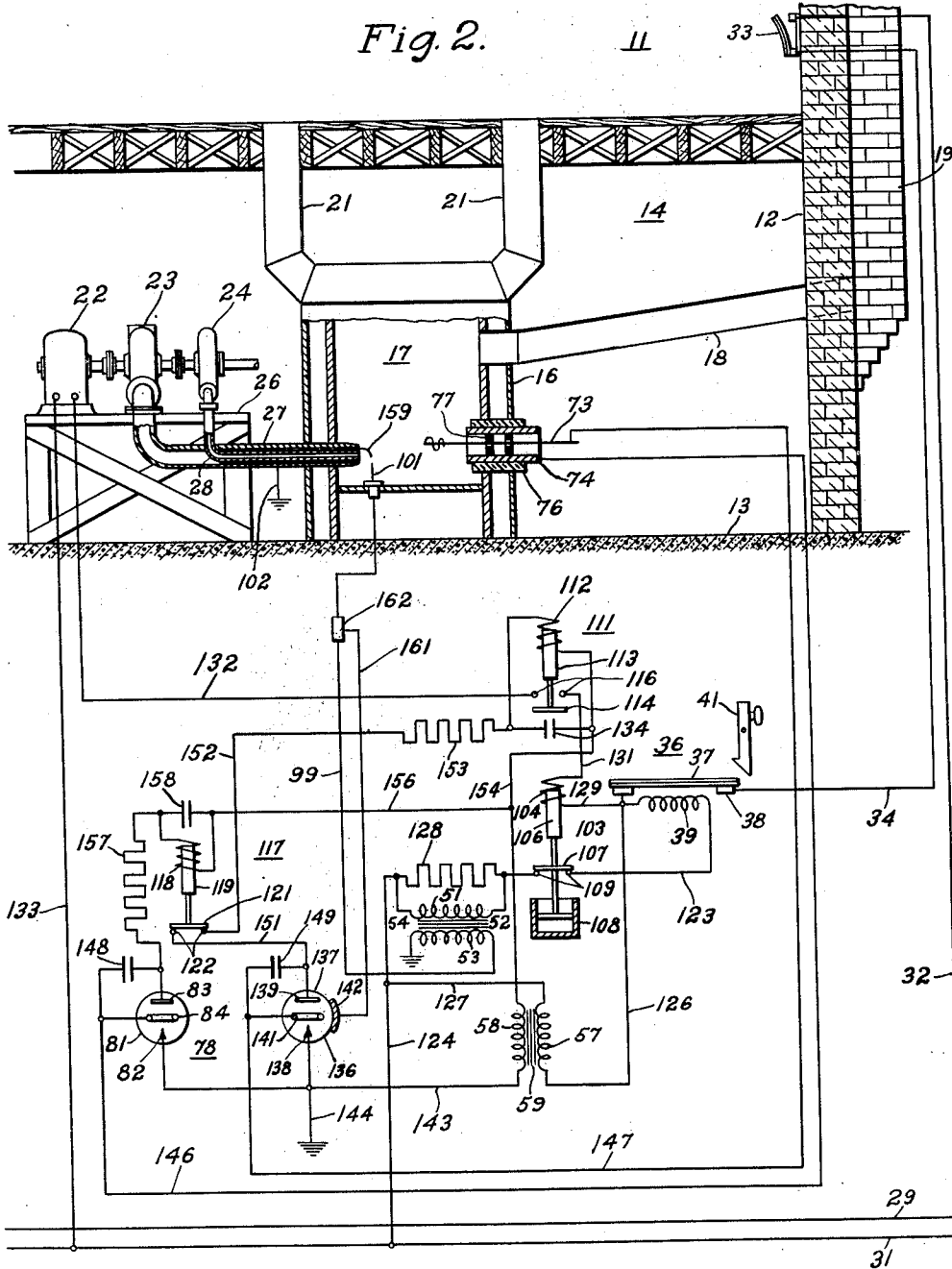
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Fig. 2.



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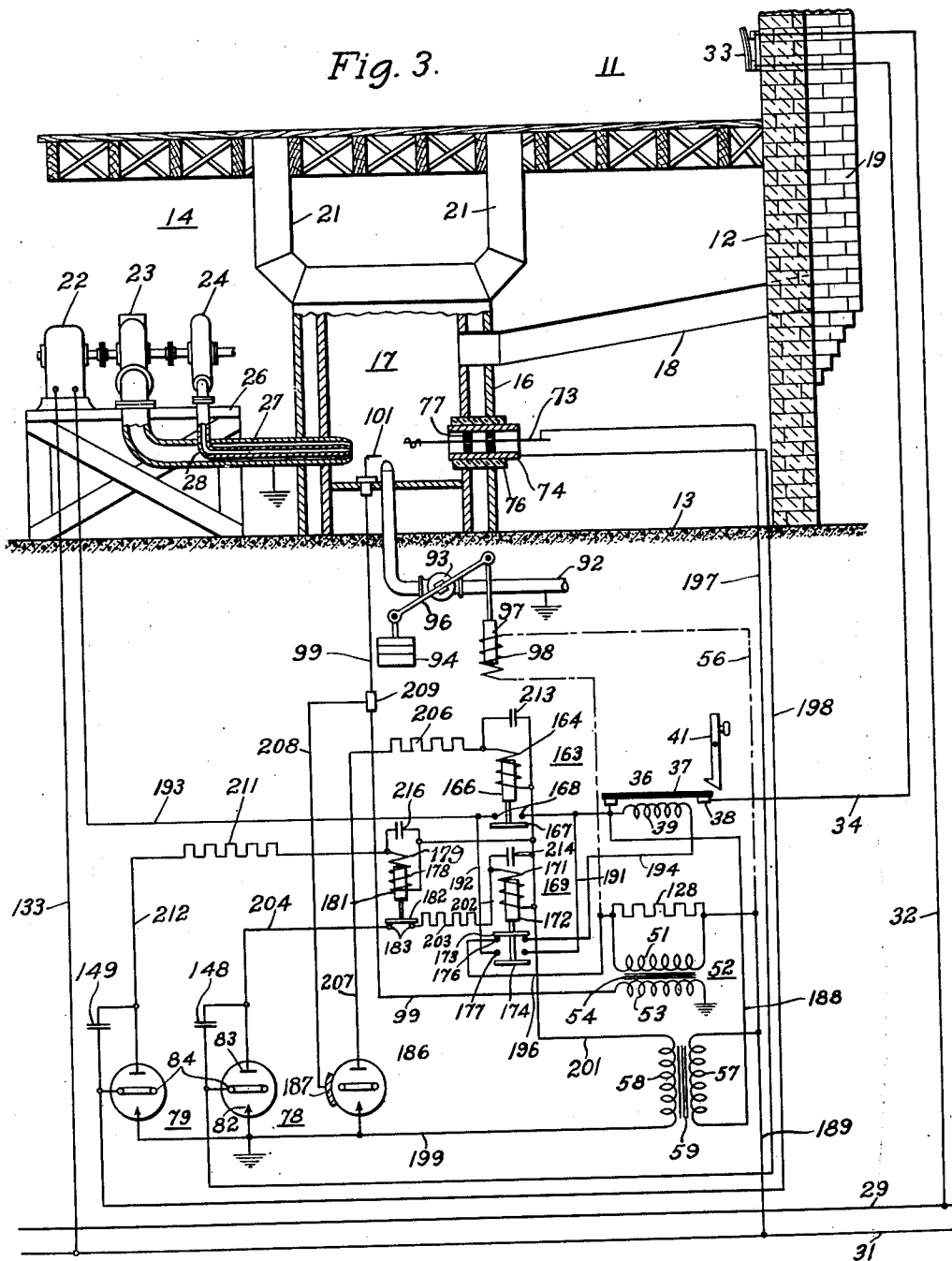
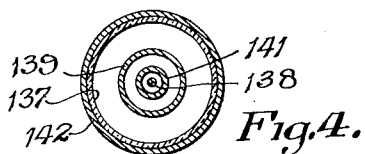
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3 Sheets-Sheet 3



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OIL BURNER CONTROL SYSTEM

Application filed November 9, 1928. Serial No. 318,294.

Our invention relates to control systems and particularly to fuel burner control systems.

An object of our invention is to provide a relatively simple and highly efficient control system for a fuel burner.

Another object of our invention is to provide a fuel burner control system embodying a plurality of grid glow tubes for controlling the operation of the system, the grid glow tubes responding substantially instantaneously to changes in conditions controlling them.

Another object of our invention is to provide a control system for fuel burners applicable both to short time and to long time delay mechanisms, and which will permit any reasonable time delay for shut down without the sacrifice of safety.

Another object of our invention is to provide a control system for fuel burners which will prevent the supply of fuel to the furnace unless the ignition is such that it will ignite the fuel, that will quickly de-energize the ignition means upon appearance of a flame, and that will quickly re-energize the ignition means upon failure of the flame.

A still further object of our invention is to provide a relatively simple means for checking for flame terminal leakage which means will shut down the system in case the leakage is such that unsafe conditions would result.

In practising our invention, we provide in combination with a heating furnace, a fuel-feeding means, an electrical ignition means, a flame electrode, a tubular member of electric-conducting material surrounding the flame electrode, and a plurality of plural electrode electrical discharge devices, connected respectively to the flame electrode and to the tubular electric-conducting member. Means are also provided for energizing the grid glow tubes and a time delay circuit interrupter, and contactors are provided which are selectively controlled by the grid glow tubes to properly control the system under all conditions of operation.

In the drawings,

Figure 1 is a view partially in side eleva-

tion and partially in section, of a room and a furnace with a diagram of connections of a control system embodying our invention,

Fig. 2 is a similar view of a modified form of control system embodying our invention,

Fig. 3 is a similar view of a still further modification of a control system embodying our invention, and

Fig. 4 is a view in section of a grid-glow tube of the type provided for checking the ignition.

Referring more particularly to Fig. 1 of the drawings, we have there illustrated a room 11, illustrated schematically only as bounded on the one side by a wall 12 and at the bottom by a floor 13, this latter being located above a suitable basement room or chamber 14. It is to be understood that any room or chamber or any combination of rooms or chambers may be heated by means of a furnace designated generally by the numeral 16. This operation is controlled by a system embodying our invention and to be hereinafter described in detail.

Any desirable or suitable type of furnace 16 may be used and it is therefore illustrated generally only as comprising a plurality of walls surrounding a furnace chamber 17 in which combustion of fuel takes place, the products of combustion leaving through a flue 18 which extends into a chimney 19 operatively associated with the wall 12. Hot air pipes 21 conduct the heated air from the furnace to the room 11.

As the system embodying our invention is particularly adapted to the control of heating means using liquid or fluid fuel, we have elected to describe the system embodying our invention as applied to an installation using fluid fuel. An electric motor 22 drives an air pressure means 23 and oil pump 24, the three members being shown as mechanically connected together and mounted on a suitable support or table 26 closely adjacent to the furnace 16. Interfitting conduits 27 and 28 are provided for the air and oil respectively, the outer ends of these conduits being located in the furnace chamber and the action of the fuel feeding means being to provide a sup-

ply of vaporized oil under suitable pressure within the furnace chamber 17.

A source of supply of electric energy comprises supply circuit conductors 29 and 31.

5 The supply circuit conductor 29 is connected through a conductor 32 to one terminal of a room thermostat 33, located in the room 11 at some suitable point therein. The other terminal of the room thermostat 33 is connected by conductor 34 to one terminal of a
10 time relay circuit interrupter 36 comprising a bi-metallic strip 37, a contact terminal 38 which is engaged by or disengaged from the free end of the strip 37 and a heating coil 39 for energizing the strip 37. In addition thereto, a manually operable latch 41 is provided so located relatively to the movable end of the strip 37 as to hold the strip in its open position when the same has been actuated thereto by heat from the coil 39.
20 While we have illustrated and described a specific embodiment of a latching time delay circuit interrupter, we do not desire to be limited to this particular type as we may use a mercury switch suitably controlled in the same manner or in fact any type of time delay circuit interrupter which remains in its closed position for a predetermined and preferably adjustable length of time after energization and is then latched in its open position, manual operation of the latching means being required to permit the strip to return to its closed position.

A contactor 42 comprises an actuating coil 43, a movable core member 44 and two contact bridging members 46 and 47, which respectively engage or are disengaged from stationary contact terminals 48 and 49. Bridging member 46 engages the terminals 48 when the
40 coil 43 is deenergized, while bridging member 47 engages terminals 49 when coil 43 is energized. One terminal of the heating element 39 is connected to the fixed end of the strip 37 while the other terminal of the heating element is connected to one of the contact terminals 48 and also to one of the contact terminals 49.

The other contact terminal 48 is connected to one terminal of a primary winding 51 of an ignition transformer 52, which transformer comprises in addition to the primary winding 51, a secondary winding 53, and a suitable core 54. The other terminal of the primary winding 51 is connected by a conductor 56 to the supply circuit conductor 31.
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A second transformer is provided and comprises a primary winding 57, a secondary winding 58 and a core 59. One terminal of the primary winding 57 is connected to the conductor 56 and the other terminal of the winding is connected to the fixed terminal of the bi-metallic strip 37 hereinbefore described, by a conductor 61.
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A second electromagnetic relay or contactor 62 comprises an actuating coil 63, a core

64, a contact bridging member 66 actuated by the core and a plurality of fixed contact terminals 67. One terminal of the actuating coil 63 is connected by a conductor 68 to one terminal of the secondary coil 58 and also to one terminal of the actuating coil 43 of the contactor 42. The other terminal of the actuating coil 43 is connected by a conductor 69 to one of the contact terminals 67 of the contactor 62.
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A conductor 71 connects the junction point of the heating element 39 and the fixed end of the bimetallic strip 37 to the other terminal 49 of the contactor 42. A conductor 72 connects the other terminal of the secondary winding 58 to ground.
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A flame electrode 73 surrounded by an electric conducting tubular member 74 is located in one of the furnace walls or in a predetermined position in the furnace wall of the furnace. The tubular member 74 is suitably insulated by an electric insulating tubular member 76 and the flame electrode 73 is insulated from the member 74 by suitable insulating means 77. The flame electrode is of electric conducting material and the location of the structure comprising the members 73 and 74 is such that the inner end of the electrode 73 will either be in direct operative engagement with a flame of the burning fuel or will be in electric conducting relation thereto, through the heated air immediately surrounding the flame or filling the chamber 17.
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A plurality of plural electrode electric discharge devices 78 and 79 are provided. Each of these in the present instance comprises a suitable casing 81, which is made of electric insulating material, preferably a high grade glass and an anode 82, a cathode 83 and a control grid 84, are located within the casing.
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The plural-electrode discharge devices 78 and 79 are more clearly disclosed in an application Serial No. 149,290, filed November 19, 1926, by D. D. Knowles and assigned to the Westinghouse Electric and Manufacturing Company. The device 78 includes more particularly the glass envelope or casing 81, a centrally located wire anode 82 shielded by a glass tube except at its upper end, and of relatively small size, a cylindrical metallic cathode 83 of larger size, a control grid electrode 84, also of small size, located parallel to the anode and also shielded by a glass tube except at its upper end. The upper end of the control grid is located near to the end of the anode and directly in the path of any glow discharge between the anode and the cathode. All of the electrodes and the glass shields associated therewith are mounted in a glass press, suitable leads extending through the press from the electrodes to terminal members in a base, which may be of the kind usually employed in radio tubes.
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The glass envelope is filled with an inert gas, such as neon, at a low pressure. The gas within the tube is in a condition of more or less initial ionization because of exceedingly penetrating rays which are present everywhere. When a voltage is applied between the anode and cathode of the tube 78 the ions and electrons will flow to their respective electrodes. Because of the fact that electrons move at a much higher rate of speed than ions, a free electrode between the anode and the cathode will be struck or impacted by many more electrons than ions in a given length of time so that the potential of that electrode will be much more negative than positive. Since all the electrons and ions between the anode and the cathode are moving toward the anode and the cathode, respectively, there will be a concentration of ions at the cathode and a concentration of electrons at the anode. Since a great many more electrons than ions are located close to the anode, and since they are moving at a much higher rate of speed than the ions, the grid electrode, if free, will receive a high negative charge which blocks a further flow. If a leakage path is provided for the grid electrode, as by connecting the grid electrode to the anode through a flame, the negative blocking charge is removed or, at least, to a point where the resultant voltage between the anode and the cathode will give the electrons and ions velocity by the time they reach the anode. The resulting ions in the vicinity of the anode and attracted to the grid constitute about the grid a positive ion sheath, the thickness of which depends on how negative the grid may be. The outer surface of this sheath is approximately potential of the glow discharge in which it is located, hence the grid no longer has any effect on the discharge between the anode and the cathode.

When a grid glow tube is subjected to alternating current, as by connecting the anode and the cathode to a suitable source of supply of alternating-current energy, the current flow through the tube ceases at the end of each cycle when the anode is positive, and when the whole mechanism of breakdown must be repeated at the beginning of each cycle when the anode is positive. If the control condition of the grid is varied, such as by the cessation of a furnace flame initially engaging the flame electrode 73 and, therefore, the control grid 84, the glow discharge tube ceases to conduct a current there-through. Because of the fact hereinbefore set forth, if the anode electrode of a grid glow tube is much smaller than the cathode, a relatively very small current will flow between the anode and the cathode during this half cycle when the anode is negative and the cathode is positive, and hence the current traversing the grid glow tube is a pulsating

direct current when the voltage applied to the tube is alternating in character.

It will, therefore, be seen that, when the grid electrode is connected to a suitable flame electrode and the anode is connected to a ground so that there will be a conducting path from ground through the ionized gases in and surrounding the flame to the flame electrode and therefrom to the grid electrode, the tube will conduct current to operate a relay when the fuel is burning and provides a flame and will not permit current to traverse the tube when the flame is out.

While a specific construction of glow discharge tube has hereinbefore been described, we do not wish to be specifically limited to that construction as any grid controlled glow discharge tube which is rendered electric conducting by the presence of a flame or non-conducting by the absence of a flame may be used. An additional requirement must be made of the tube to permit of checking the proper intensity of ignition. This requirement being that it be so constructed as to respond to the proper sparking conditions and the tube hereinbefore described is one embodying a construction to meet this requirement.

The flame electrode 73 is connected by means of a conductor 86 to the control electrode 84 of the tube 78. A condenser 87 is connected between the cathode 83 and the control electrode 84 and serves to desensitize the tube so that a predetermined change of potential of the flame electrode and of the control electrode 84 must be effected before the tube becomes conducting.

The tubular electric-conducting member 74 is connected by a conductor 88 to the control electrode of the tube 79 and a capacitance 89 is connected between the control electrode and the cathode of this tube in the same manner as described hereinbefore in connection with the tube 78. The two anodes of the tubes 78 and 79 are connected together by a conductor 91 and thereby to the conductor 72.

As it may be desirable in certain installations of this general kind to provide a pilot flame for the fluid fuel, we have shown a gas pipe 92, the flow of gas therefrom being controlled by a valve 93 which is maintained in a normally closed position by a weight 94 secured to one end of a lever 96. The other end of this lever is connected to a core member 97 of an electro-magnetic relay comprising in addition to the core member 97, an actuating coil 98, the terminals of which are connected to the terminals of the primary winding 51 of the ignition transformer 52.

One terminal of the ignition transformer secondary 53 is connected to ground while the other terminal is connected by a conductor 99 to a suitable electrode 101, located within the furnace chamber and in operative

relation to the outlet of the pipe 92. It may be noted that the conduit 27 is provided with a ground circuit 102 in order to insure that this conduit as well as the metallic casing of the furnace shall be properly grounded.

The cathode 83 is connected by a suitable conductor to the other contact terminal 67 of the contactor 62.

The junction point of the outer end of the heater 39 and the contact terminals 48 and 49 is connected by a conductor 100 to one terminal of the winding of the motor 22, while the other terminal of the motor winding is connected by a conductor 100a to supply circuit conductor 31.

Referring now to Fig. 2 of the drawings, we have there illustrated a substantially similar installation of rooms to be heated as was hereinbefore described in connection with Fig. 1 of the drawings, a substantially similar furnace structure being shown as well as a similar fuel feeding means.

The construction and location of the flame electrode and of the tubular electric conducting member surrounding the same are also the same as the one hereinbefore set forth in connection with Fig. 1. In view of this, these parts have been designated by the same numeral and only those parts of the control system which are different from those described in Fig. 1 will be specifically enumerated and described.

A time delay latching circuit interrupter 36 is provided as was hereinbefore set forth in connection with Fig. 1 of the drawings. An ignition transformer 52 is provided of substantially the same type as hereinbefore set forth and a second transformer is also provided as hereinbefore set forth.

A time delay circuit interrupter of the contactor type is designated by numeral 103 and comprises an actuating coil 104, a core member 106, a contact bridging member 107 and a suitable delay device 108. A pair of contact terminals 109 are adapted to be engaged by or to be disengaged from the bridging member 107. The operation of this contactor is such that upon energization of the coil 104, the engagement of the bridging member 107 with the terminals 109 will continue for a predetermined length of time. Upon deenergization of the coil 104, reengagement of the bridging member 107 and the terminals 109 will be effected substantially instantaneously. It is to be understood that any type of time relay circuit interrupter effective for the same purpose may be used instead of the particular structure shown.

A second contactor 111 comprises an actuating coil 112, a core member 113, a contact bridging member 114 and a pair of contact terminals 116. The bridging member 114 is disengaged from contact terminals 116 when coil 112 is deenergized.

A third contactor 117 comprises an actuating coil 118, a core 119, a contact bridging member 121, and contact terminals 122. The bridging member 121 is in engagement with the terminals 122 when the coil is deenergized.

One terminal of the heating element 39 is connected to the fixed end of the bi-metallic strip 37 and the other end of the element 39 is connected by a conductor 123 to one of the terminals 109. The other terminal 109 is connected to one terminal of the primary winding 51 of the ignition transformer, the other terminal of which is connected by a conductor 124 to supply circuit conductor 31. The fixed end of the bi-metallic strip 37 is connected by a conductor 126 to one terminal of the primary winding 57 of the second transformer, the other terminal of the winding being connected by conductor 127 to conductor 124.

A resistor 128 is connected in parallel circuit relation to the primary winding 51 for a purpose to be hereinafter set forth in detail.

The junction point of the element 39 and the bi-metallic strip 37 is connected by conductor 129 to one terminal of the actuating coil 104, the other terminal of which is connected by a conductor 131 to one of the contact terminals 116 of the relay 111. The other terminal 116 is connected by a conductor 132 to one terminal of the motor energizing winding, the other terminal of which is connected by conductor 133 to the supply circuit conductor 31. A condenser 134 is connected across the terminals of the actuating coil 112, in order to improve the operation thereof.

A plurality of plural electrode electrical discharge devices are provided, one of which is the same as was hereinbefore set forth in connection with Fig. 1, and we have designated this by the same numeral, i. e. 78. A second device 136 may be of slightly different construction but as here shown, comprises a casing 137, an anode 138, a cathode 139, a control electrode 141, and an outside partially covering member 142 of electric-conducting material.

The anodes 82 and 138 are connected together and to one terminal of the secondary winding 58 by a conductor 143, a ground connection 144 being provided for this conductor and the anodes. A conductor 146 connects the control electrode 84 to the tubular electric-conducting member 74. A conductor 147 connects the electrode 141 to the flame electrode 73. Condensers 148 and 149 are connected between the control electrode and the cathodes of the respective tubes 78 and 136.

The cathode 139 is connected by a conductor 151 to one of the contact terminals 122 while the other contact terminal 122 is connected by a conductor 152 to one terminal of a limiting resistor 153, the other terminal

of which is connected to one terminal of the actuating winding 112. The other terminal of the actuating winding 112 is connected by a conductor 154 to the other terminal of secondary winding 58, and by a conductor 156 to one terminal of the actuating coil 118. The other terminal of the coil 118 is connected to one terminal of a limiting resistor 157, the other terminal of which is connected to the cathode 83 of the tube 78. A condenser 158 is connected in shunt circuit relation to the actuating coil 118.

One terminal of the secondary winding 53 of the ignition transformer is connected to ground, while the other terminal is connected by a conductor 99 to an electrode 101, a co-operating electrode 159 being provided on the conduit 27 in order to provide a gap between which sparks may be generated to ignite the fuel.

The covering or layer 142 of electric-conducting material is connected by a conductor 161 to an electric conducting member 162, which may be in the form of a tubular member through which the conductor 99 extends.

Relating more particularly to Fig. 3 of the drawings, we have there illustrated a modified form of a control system, the room or rooms to be heated, the furnace, the fuel feeding means, the flame electrode structure and the gas pilot flame structure being substantially as hereinbefore set forth in connection with Fig. 1 of the drawings. A primary time delay circuit interrupter 36 is provided as was hereinbefore set forth in connection with Fig. 1 of the drawings.

An ignition transformer 52 is provided as was hereinbefore set forth and a second transformer is provided as was hereinbefore described in connection with Fig. 1 of the drawings.

A contactor 163 comprises a coil 164, a core 166, a contact bridging member 167 and contact terminals 168.

A second electromagnet contactor 169 comprises a coil 171, a core 172, two contact bridging members 173 and 174 and fixed contact members 176 and 177, cooperating with the respective bridging members 173 and 174. The bridging member 173 is in engagement with the contact members 176, and the bridging member 174 is disengaged from the contact terminals 177, when the coil 171 is de-energized.

A third electromagnet relay 178 comprises a coil 179, a core member 181, a contact bridging member 182 and a plurality of contact terminals 183. The bridging member 182 is in engagement with the contact terminals 183 when coil 179 is deenergized.

Two grid glow tubes of the kind hereinbefore described are also provided and these have been designated by the numerals 78 and 79 as they are identical in construction and

use as hereinbefore set forth in connection with these members shown in Fig. 1 of the drawings.

A third plural electrode electrical-discharge device 186 is provided and while we have shown the same as a grid glow tube having a plurality of electrodes including a control electrode, the control electrode is not made use of in this system of control, a coating or covering 187 of electric-conducting material being provided as was hereinbefore set forth in connection with the discharge device 136.

The junction point of the bi-metallic strip 37 and the heating element 39 is connected by a conductor 188 to one terminal of the primary winding 57, the other terminal of which is connected by a conductor 189 to supply circuit conductor 31.

The junction point of the heating element 39 and the fixed end of the bi-metallic strip 37 is connected by a conductor 191 to one of the fixed terminals 177 and is connected also to one of the fixed contact terminals 168. The other contact terminal 177 is connected by a conductor 192 to the other contact terminal 168 and by a conductor 193 to one terminal of the energizing winding of the motor 22, the other terminal of the winding being connected by a conductor 133 to the supply circuit conductor 31.

The other terminal of the heating element 39 is connected by a conductor 194 to one of the contact terminals 176 and the other contact terminal 176 is connected by a conductor 196 to one terminal of the primary winding 51 and of the resistor 128 connected in parallel therewith. The other terminal of the primary winding 51 is connected to the conductor 189.

One terminal of the secondary winding 53 is connected to ground while the other terminal thereof is connected by a conductor 99 to a sparking electrode 101 as was hereinbefore set forth.

The flame electrode 73 is connected by a conductor 197 to the control electrode 84 of the tube 78. The tubular electric-conducting member 74 is connected by a conductor 198 to the control electrode of the tube 79.

The anodes of the tubes 78, 79 and 186 are connected together and to one terminal of the secondary winding 58, by a conductor 199. The other terminal of the winding 58 is connected by conductor 201 to one terminal of the actuating winding 171, to one terminal of the actuating winding 179 and to one terminal of the actuating winding 164 of the respective contactors.

The other terminal of the winding 171 is connected by a conductor 202 to one terminal of a limiting resistor 203, the other terminal of which is connected to one of the terminals 183 of the relay 178. The other

terminal 183 is connected by a conductor 204 to the cathode 83 of tube 78.

The other terminal of the winding 164 of the relay 163 is connected to one terminal of a limiting resistor 206, the other terminal thereof being connected by a conductor 207 to the cathode of tube 186.

The electric-conducting member 187 surrounding the casing of the electric discharge device 186 is connected by a conductor 208 to an electric conducting member 209 which is in inductive and in electrostatic relation relatively to the conductor 99.

The other terminal of winding 179 is connected to one terminal of a limiting resistor 211, the other terminal of which is connected by conductor 212 to the cathode of discharging device 79.

A condenser 213 is connected in parallel circuit relation with the winding 164, a condenser 214 is connected in parallel circuit relation with the winding 171 and a condenser 216 is connected in parallel circuit relation with the winding 179.

Condensers 148 and 149 are connected between the control electrode and the cathode of the respective discharge devices 78 and 79 as was hereinbefore set forth.

We have shown in this figure of the drawings a gas pilot flame and reference may be had to Fig. 1 of the drawings and the description thereof for the details thereof.

Referring more particularly to Fig. 1 of the drawings, the system is there shown in its inoperative position, the supply circuit conductors 29 and 31 being energized, the room thermostat 33 being open, the circuit interrupter 36 being normally closed, the contactors 42 and 62 being in the positions shown in that drawing and the coil 98 being deenergized so that the supply of gas of a pilot flame is shut off.

If the temperature in the room drops to a predetermined minimum value, the thermostat 33 will close and effect the closing of a circuit beginning with conductor 29 and extending through conductor 32, thermostat 33, conductor 34, bi-metallic strip 37 and to the junction point of the bi-metallic strip 37 and the heating element 39, from which point a plurality of branch circuits may be traced.

One of these circuits includes the heating element 39 and from there to one of the contact terminals 48, through bridging member 46, primary winding 51 and conductor 56 to supply circuit conductor 31.

Another branch circuit includes the heating element 39, conductor 100, the energizing winding of motor 22 and from there through conductor 100a to supply circuit conductor 31.

Another branch circuit starts at the above-mentioned junction point and includes conductor 61, primary winding 57 and conductor 56 back to supply circuit conductor 31.

The closing of the room thermostat 33, therefore, energizes the heating element 39, the primary winding 51 of the ignition transformer, the primary winding 57 of the second transformer, which may be termed the grid glow tube transformer, and energizes also the motor 22.

The energized ignition transformer and particularly the secondary winding thereof, operates to provide sparks between the electrode 101 and the suitably fashioned end of the pipe 92 to ignite a pilot flame provided as follows: The winding 98 is connected as has already been set forth, in parallel circuit relation to the primary winding 51, and it is therefore energized simultaneously with the winding 51. The core member 97 thus energized by the coil 98, operates to open the valve 93 to permit gas to flow into the chamber 17 and this gas is ignited by the sparking hereinbefore mentioned.

Simultaneously with this operation, the motor 22 has been energized and is effective within a very short interval of time to deliver atomized fluid fuel within the furnace chamber 17, which atomized fluid fuel will be ignited by the pilot flame provided as hereinbefore set forth.

Let it be assumed that the flame is of the proper size so that the flame electrode 73 has its inner end located in direct operative engagement within the flame or that there is provided an electric conducting path between the inner end of the flame electrode and the flame of the burning fuel by heated air. If this is the case, the blocking charge which has accumulated as was hereinbefore set forth, on the control electrode 84 of the tube 78 will be dissipated and the tube 78 will become conducting. This provides a circuit which may be traced from one terminal of the secondary winding 58, through conductors 72 and 91, through the tube 78, from there through the contact bridging member 66 and contact terminals 67 of relay 62, through conductor 69, winding 43 and from there back to the other terminal of winding 58 of the grid glow tube transformer.

The energized coil 43 causes upward movement of the core 44 and of the contact bridging members operatively associated therewith, whereby the bridging member 47 operatively engages the contact terminals 49 with the result that the heating element 39 is short-circuited and the time relay circuit interrupter 36 is rendered inactive.

The upward movement of the bridging member 46 disengages it from the contact terminals 48 whereby the circuit through the primary winding 51 of the ignition transformer is interrupted and therefore, no further sparking will be provided. Simultaneously with the deenergization of the primary winding 51, the winding 98 is deenergized with the result that the weight 94

causes the return of the valve to its closed position, whereby the gas of the pilot flame is shut off.

This condition will continue if no abnormal operating conditions occur, until such time as the room thermostat opens the circuit of the entire system upon the temperature in the room 11 reaching a predetermined maximum value. Upon drop of the temperature to predetermined minimum value, the same cycle of operations as hereinbefore set forth will occur, provided of course, that all of the parts of the system operate in the desired proper manner.

Let it be assumed, however, that for some reason, the flame does not appear or that it is not such as to provide the conducting path through the flame electrode, the flame, the grounded portions of the furnace and fuel feeding means and from there through the grounded conductor 91 into the tube and to the control electrode thereof. In this case the tube 78 will not become conducting to energize the coil 43 as hereinbefore set forth, and the heating element 39 will not be short-circuited but will, after a predetermined length of time, cause interruption of the circuit by movement of the free end of the strip 37 which is held by the latch 41. This will shut down the entire system and it may be noted that as no further supply of heat to the room 11 is available, the room thermostat 33 will remain closed, the heating element 39 will remain deenergized, and the bi-metallic strip 37 will remain latched in its open position. It is necessary that an operator move the latch 41 to release the bi-metallic strip 37, it being understood of course, that an investigation will be made as to the reasons for failure of the system to operate properly and that these conditions will be corrected, after which the system can again be put into operation.

Let it be supposed that abnormal operating conditions occur in connection with the flame electrode, as for instance, that excessive current leakage occurs therefrom. The tubular electric-conducting member 74 insulated from the flame electrode and from the furnace structure will be in the path of such leakage current and when such leakage occurs, the blocking charge on the control electrode 84 of the tube 79 will be dissipated and the tube 79 will become conducting.

The insulating members of the flame electrode assembly are, of course, subject to deposits of soot which may provide a conducting path between the flame electrode and a ground. Such a conducting path between the flame electrode and the ground would cause the tube 78 to operate whether or not a flame was provided by the ignited fuel. Because of the construction of the flame electrode assembly, any leakage between the electrode 73 and the ground must go by way of the tubular conducting member 74. Any

leakage current between members 73 and 74 only will not cause operation of the system as long as there is no flame.

When there is a flame, the control electrode of tube 79 will have a conducting path through the leakage resistance and the flame in series to the ground. If this leakage resistance is low enough, tube 79 will permit of sufficient current traversing it to operate the contactor 62 and to open the circuit of coil 43, thereby causing contactor 42 to be deenergized. When contactor 42 is deenergized, the short circuit on heating element 39 is removed, which causes the bi-metal strip 37 to open the circuit to the fuel-feeding means and to the control, after a certain time delay, thus causing a shut-down of the system and making necessary a manual resetting of this time-delaying device before the automatic action of the control system is restored.

Any leakage between the member 74 and a ground will provide a conducting path including the anode of the tube, a ground, the leakage path either through or around the insulating member 76, the tubular conductor 74, conductor 88 and the control electrode or grid 84 of tube 79. If this leakage is of a sufficiently high value to dissipate the blocking charge on the grid electrode of tube 79, the tube will be traversed by a current of sufficient value to operate relay 62. This will prevent operation of relay 42 so that the heating element 39 is not short circuited. This means further that any attempt to start the burner will result in the time-delay device 36 shutting down the whole system within a predetermined time.

If a leakage occurs between both the member 73 and the member 74, as well as between the member 74 and ground, the same sequence of operations will result because the tube 79 is the first to respond as its control electrode is not dependent upon the appearance of a flame to effect dissipation of its blocking charge.

It will, therefore, be evident that any terminal leakage effects a shut-down of the system and is, therefore, a vital safety feature. The importance of such a safety feature may be realized by considering what might happen if there were no leakage checking element provided in the system. In such a case, a leakage path would be directly from the electrode 73 to ground and would result in tube 78 causing the burner, or more particularly the fuel feeding means, to operate continuously as long as the room thermostat was closed. If, during this time, the fuel failed temporarily as might be caused by a slug of water in the fuel, or a momentary obstruction in the conduit, the flame would be extinguished and, when the fuel did reappear, there might be a delayed ignition because of the hot spots in the furnace structure, and

this might result in an explosion or, at least, in a puff-back, or if the fuel did not ignite at all the furnace would be flooded with atomized fuel.

5 If the design and construction of the furnace body and the location of the flame electrode structure as shown in the drawings are not such as to prevent engagement of the member 74 by a flame, the flame electrode
10 structure may be located beside the conduits 27 and 28, so that only the flame electrode 73 will be operatively engaged by the flame or by the hot gases of combustion.

Should the flame be extinguished because
15 of momentary failure of fuel or for any other reason, the circuit through grid glow tube 78 is interrupted, thereby interrupting the circuit through coil 43. The bridging member 46 engages contact terminals 48 whereby the
20 circuit through primary winding 51 is re-established. This reenergizes the ignition means and also permits of flow of gas for the pilot flame, which is quickly reestablished by the ignition means and is effective to again
25 ignite the fuel. The time interval for these steps in the operation of the system, is very small, being determined more particularly by the speed of operation of the coils and contactors and being on the order of a few
30 seconds.

Referring more particularly to Fig. 2 of the drawings, the system is there shown in its inoperative condition, that is with the room thermostat 33 open, and the supply
35 circuit conductors 29 and 31 connected to a suitable source of supply of electric energy.

When the temperature in the room drops to a predetermined minimum, the room thermostat 33 will close and will energize a plurality of circuits, the common portion of which may be traced as follows: from conductor 29 through conductor 32, thermostat 33, conductor 34 and through bi-metallic strip 37 to the fixed contact terminal thereof. One
40 circuit may be traced from this point through heating element 39, conductor 123, bridging member 107 and through primary coil 51 and the parallel-connected resistor 128 and through conductor 124 to the other supply
45 circuit conductor 31. Another branch circuit may be traced from the junction point of the heating element 39 and the bi-metallic strip 37, through conductor 126, primary winding 57 of the grid glow tube transformer, and through conductors 127 and 124
50 to the supply circuit conductor 31.

This energizes the ignition means and establishes a circuit including the secondary winding 53, conductor 99, sparking electrode
60 101, cooperating electrode 159, and from there through the grounded circuit to the other terminal of secondary winding 53. If the sparking is of the proper character, the current in the conductor 99 will be of such
65 character as to ionize the tube 136 through

the electric conducting member 162 and the conducting layer 142 on the grid glow tube. This tube is ionized only if and when the sparking between the electrodes 101 and 159
70 is of the proper operative character and the result as regards the grid glow tube 136 is that it becomes conducting when subjected to a proper voltage.

In order to more clearly understand why the tube 136 responds only to a spark discharge having the proper intensity to ignite the fuel, it may be noted that the cathode is cylindrical and that the grid and the anode are centrally located within this cylinder. It must be noted also that there are two
75 paths from the cathode to a ground, one through the tube directly to the anode, and the other through the impedance of such elements in the circuit as resistor 153, coil 112, condenser 134 and the secondary winding 58
80 of the transformer.

Let us consider first the condition which exists when the spark gap is too wide to permit of a spark from between; there will then exist in the secondary circuit of the ignition transformer an alternating-current potential having a frequency equal to that of the supply circuit. Under this condition, there will be a condenser current traversing the following circuit: from one terminal of the secondary 53 of transformer 52, through conductor 99 operating as one plate to a condenser over that portion of its length surrounded by the cylindrical or conducting member 162, by condenser action to the conducting member 162 constituting the other plate of a condenser, through conductor 161 to the conducting covering 142 constituting another condenser plate, by condenser action to the cathode 139 operating as another plate of a condenser, through the conductor 151, contact members 122, bridging member 121, conductor 152, resistor 153, coil 112, and condenser 134 in parallel, conductor 154, secondary winding 58, conductors 143 and 144 and
90 back through a ground to the other terminal of the secondary winding 53 of the ignition transformer. This path will offer the lowest impedance to this condenser current of low frequency. The resulting ionization in the tube exists only between the cathode 139 and the conducting covering 142.
95

Considering the other condition, with the spark electrodes substantially directly short circuited there is not even a condenser current traversing the circuit because the secondary voltage of the ignition transformer is reduced to zero and, therefore, there will be no response of the tube.
100

Considering a third condition in which there is a good spark of sufficient intensity to properly ignite the fuel, a high-frequency oscillating voltage and current will be set up in the secondary circuit of the ignition transformer in a manner well known in the art.
105 110 115 120 125 130

These high-frequency impulses are transmitted to the cathode of the tube in exactly the same manner as were the low-frequency impulses hereinbefore mentioned. Since the rest of the circuit which before offered a low impedance path to the low-frequency impulses now provides a high-impedance path to the high-frequency impulses, these latter impulses will traverse the space between the cathode and the anode, which space offers a relatively low impedance to the high-frequency impulses, and the impulses will flow from the anode through conductor 144 and the ground and back to the other side of the secondary of the transformer.

These high-frequency impulses ionize the gas between the cathode and the anode and cause the grid electrode to assume a potential equal to that of the space surrounding it, or, in other words, dissipating the blocking charge so that the tube 136 is now traversed by a current to operate relay 111.

Considering a fourth condition in which the spark electrodes are so close together that there will not be a large enough spark to properly ignite the fuel, we have found that if the capacitance between members 99 and 162 is made small enough, not enough energy is traversed to the tube to ionize it sufficiently to permit current to pass between the anode and the cathode. As the length of the spark is increased from the assumed short distance between the spark electrodes, the high-frequency energy present in the secondary circuit of the ignition transformer is increased until there is sufficient energy transmitted to the tube to cause it to be traversed by a current sufficiently large to operate the relay.

As the grid glow tube transformer has been energized simultaneously with the ignition transformer, a circuit will be provided including the secondary winding 58, conductor 143, the grid glow tube 136, conductor 151, the bridging member 121, conductor 152, resistor 153, actuating coil 112 and through conductor 154 to the other terminal of winding 58. The contactor 111 is thereby energized and the bridging member 114 is caused to engage the cooperating contact terminals 116, whereby another branch circuit is established, beginning at the junction point of the heating element 39 and the bi-metallic strip 37. This circuit includes conductor 129, winding 104 of relay 103, conductor 131, bridging member 114, conductor 132, energizing winding of motor 22, and through conductor 133 to supply circuit conductor 31.

The energized motor will be operative within a relatively short period of time to provide atomized fuel in the furnace chamber 17 and with all of the steps in the portion of the system properly operative, this atomized fuel will be ignited and will pro-

vide a flame of the proper character within the furnace chamber 17.

If, and when the flame of the burning fuel is of the proper character, a circuit will be established which may be traced from the ground connection of conductor 144, electrodes 138 and 141, conductor 147, flame electrode 73, through the flame and back through the grounded structure of the conduit or furnace, to conductor 144. The blocking charge on the control electrode 141 is thereby removed and the circuit heretofore established and including the actuating coils 104 and 112 will remain energized so long as the instant conditions continue.

The relay or contactor 103 is provided with a time delay which is slightly less than the time delay of the circuit interrupter 36 and the contactor 103 will presently interrupt the circuit controlled thereby, whereby the ignition transformer is deenergized and the sparking between the electrodes 101 and 159 is stopped.

The cessation of this sparking removes a source of ionization and the tube would become non-conducting if the blocking charge were still on the control electrode. This blocking charge is, however, removed by the action of the flame electrode, so that the tube will continue to be electric conducting.

It may be here noted that the resistor 128 connected in parallel with the primary winding 51 of the ignition transformer is provided for the purpose of insuring a larger current value traversing the heating element 39 so that the same may be properly operative even though abnormal conditions may obtain in either the primary or secondary circuit of the ignition transformer. It may happen for instance that the secondary circuit is entirely interrupted and the same condition may prevail with regard to the primary winding 51. In the latter case, no current would traverse the ignition transformer circuit. The value of the ohmic resistance of resistor 128 is such that the current traversing it will be sufficiently large to cause heating element 39 to effect opening of the circuit interrupter 36.

In case of abnormal operating conditions, more particularly a current leakage from the flame electrode 73, the following sequence of operations will occur. The leakage current from the electrode 73 will be conducted to and through the tubular electric-conducting member 74 and the blocking charge which has accumulated and remained on the control electrode 84 of the tube 78 will be dissipated and the tube 78 will become electric-conducting. This will establish a circuit beginning with winding 58 and including conductor 143, electrodes 82 and 83 of the tube 78, limiting resistor 157, actuating coil 118, conductors 156 and 154, back to the secondary winding 58. The bridging member 121 of relay

or contactor 117 is thereby disengaged from the contact members 122 and the circuit heretofore existing and including more particularly actuating winding 112 is interrupted.

5 This results in the immediate deenergization of the motor 22 and also in the reclosing of the contactor 103 to reenergize the heating element 39 and the ignition transformer. It is to be noted that the time delay mechanism 108 is operative only in the interrup-
10 tion of the circuit, the circuit remaining closed for a predetermined length of time after the energization of the coil 104 but permitting the immediate reclosing of the relay upon deenergization of the winding 104. Thermostat 36 will open after a predeter-
15 mined time and shut down the entire system.

If the supply of atomized fuel is interrupted momentarily only, then the relay coil 20 112 is deenergized, motor 22 and coil 104 are deenergized and the same steps will be gone through as were hereinbefore set forth in the initial starting. If the supply of fuel is discontinued for a relatively long period of
25 time, the heating element 39 will be energized for a sufficient length of time to cause opening movement of the strip 37, which will then be latched in its open position by the means 41.

30 However, the strip 37 will only be actuated after the system has been carried through the steps which precede the ignition of the flame. That is to say, when the fuel supply is interrupted, the tube 136 is deen-
35 ergized; the relay 111 is deenergized and the relay 103 is deenergized. The ignition is, therefore, energized and in turn causes the tube 136 to become reenergized. The relay 111 is reenergized, as is also the relay 103.
40 When the contactor 107 is disengaged from the fixed contacts 109 after an interval predetermined by the timer 108, the tube 136 is deenergized if the flame is not ignited. Im-
45 mediately following the extinction of the tube 136, the relays 111 and 103 are deenergized and the heating current is thus maintained in the heater 39 before the heater has cooled to an appreciable extent. The heater
50 39, therefore, continues to increase in temperature until the contact element 37 becomes disengaged from the element 38 unless in the meantime the supply of fuel has been con-
55 tinued and a flame has been ignited in the burner.

If it should happen that the sparking is not of the proper character to ensure ignition of the fuel, the ionization of tube 136 will not be effected and the circuit through actu-
60 ating coil 112 will not be established. The motor will, therefore, not be energized and no atomized fuel will be provided. The heating element 39 will, therefore, remain energized and the strip 37 will be actuated to its open latched position whereby the entire sys-
65 tem is shut down.

If the sparking is of the proper character, but the fuel fails to ignite, the hereinbefore described circuit including the flame elec-
trode 73 will not be established. As the con-
70 tactor 103 has been actuated to a position to interrupt the circuit through the primary winding 51, at a time somewhat later than the energization of the motor, the ionization of the tube 136 effected by the inductive and
75 capacitative linkage of the conductor 99 and the covering 142 of the tube 136, will have been discontinued. As the blocking charge on the grid 141 is not dissipated, there being
80 no operative connection between the flame electrode and a flame, the tube 136 is electrically non-conducting and the circuit initially established therethrough and through the ac-
tuating coil 112 will be deenergized, the mo-
85 tor will stop and the interrupter 36 will be moved to its open position and shut down the entire system. It is to be noted that in this instance the operation of the interrupter
36 is dependent on the fact that the relay
103 closes without time lag and that in conse-
90 quence thereof the heater 39 does not become cooled appreciably during the interval during which the relay 103 is in open position. The operation of the system in this con-
95 nection has been explained hereinabove and need not be repeated.

Referring more particularly to Fig. 3 of the drawings, when the room thermostat 33 closes, a plurality of circuits will be estab-
lished having the following portion in com-
100 mon; from supply circuit conductor 29, through conductor 32, thermostat 33, conductor 34, and through bi-metallic strip 37 to the junction point thereof with the heat-
ing element 39. One branch circuit includes
105 heating element 39, conductor 194, bridging member 173, conductor 196, primary winding 51 and resistor 128 connected in parallel circuit relation, and through con-
ductor 189 to supply circuit conductor 31. This energizes the ignition transformer. An-
110 other branch circuit begins at the junction point hereinbefore mentioned and includes conductor 188 and primary winding 57 of the grid glow tube transformer and from
115 there through conductor 189 to supply circuit conductor 31.

The energized secondary winding 53 provides sparks of the proper character between the electrode 101 and the end of the gas pipe
120 92, which is here provided in order to insure prompt and reliable ignition of the atomized fuel as soon as the same is provided by the fuel feeding means.

If and when the sparking is of the proper character, the electric-conducting layer 187
125 of the grid glow tube 186 is energized, whereby a conducting circuit therethrough is provided substantially as follows: From one terminal of winding 58 through conductor 199,
130 tube 186, conductor 207, resistor 206, winding

164 and back through conductor 201 to the other terminal of the secondary winding 58.

This energizes the contactor 163, resulting in the closing of a circuit beginning at the junction point of the bi-metallic strip 37 and including bridging member 167, conductor 193, the energizing winding of motor 22 and back through conductor 133 to the supply circuit conductor 31.

The energized motor will cause atomized fuel to appear in the furnace chamber 17 and if the fuel is properly ignited, the flame electrode 73 will be included in a circuit substantially as described hereinbefore. The grid glow tube 78 will thus become conducting and a circuit will be established, including winding 58, conductor 199, electrodes 82 and 83 of tube 78, conductor 204, resistor 203, actuating winding 171, and back through conductor 201 to the secondary winding 58 of the grid glow tube transformer.

The energized contactor 169 causes movement of the bridging members 173 and 174 in an upwardly direction, whereby the circuit including the heating element 39 and the primary winding 51 together with the resistor 128 is deenergized, and the ignition means is therefore deenergized. The engagement of the bridging member 174 with contact members 177, effects short-circuiting of the cooperating contact members of contactor 163. This is necessary for the reason that the energizing circuit through tube 186 and through the coil 164 is interrupted as soon as the ignition means is deenergized and the engagement of the bridging member 167 and contact terminals 168 is thereby interrupted. This would deenergize the motor 22 if the shunt circuit established by the contactor 169 as hereinbefore described were not provided.

If current leakage occurs from the flame electrode 73, the tubular electric-conducting member 74 will be affected and the blocking charge which has accumulated on the control electrode 84 of the tube 79 will be dissipated and a circuit will be established which may be traced from secondary winding 58, through conductor 199, through the tube 79, conductor 212, resistor 211, actuating coil 179 and conductor 201 to the other terminal of the secondary winding 58.

The energized contactor 178 will operate to interrupt the circuit through the actuating coil of contactor 169, thereby reestablishing the conditions hereinbefore described as existing at a predetermined time in the operation of the system.

It may be here pointed out that the use of a gas pilot flame is optional. Its use is particularly effective when fluid fuel of relatively low grade is used, which might not be easily ignited from a spark. Some burner systems require that a part of the burner be heated by a flame before the atomized

fuel is supplied, so that there will be a hot chamber to completely vaporize it.

The system illustrated in Fig. 1 of the drawings is particularly applicable to a burner having a short starting time delay only. The systems shown in Figs. 2 and 3 are applicable to burners having any lengths of time delay.

The circuit shown in Fig. 2 provides for deenergizing the ignition after a definite time delay regardless of when the ignition means becomes operative.

The circuit of Fig. 3 provides a means for deenergizing the ignition means as soon as the flame appears.

The condensers 87, 89 and 148 and 149 are provided in order to desensitize the respective grid glow tubes in order that the tubes will operate only when predetermined and relatively large changes in the operative conditions affecting or controlling them occur. Relatively small or accidental changes in the conditions controlling the tubes will not cause them to change from a conductive to a non-conductive condition or vice versa.

The resistors 153, 157, 203, 206, and 211 are provided in the respective circuits to limit the current traversing them and may be adjusted initially for the particular circuit in which they are located, or they may be made adjustable.

It may be noted that the system embodying our invention as illustrated more particularly in Fig. 1 of the drawings, provides a substantially direct control of motor energization, that is, as soon as current is established through the latching time delay circuit interrupter, the motor is energized. This is not the case in the systems shown in Figs. 2 and 3 but a second step in the operation of the system is necessary before the fuel feeding means is energized.

In all of these systems, the ignition means is deenergized after a suitable time in the operation of the system in order that radio transmission may be interfered with as little as possible.

The systems embodying our invention are of course applicable to different kinds of fuel feeding means and the requirements of the different fuel feeding and operating means applied to a furnace in combination with the use of fluid fuel are met successfully by the respective systems hereinbefore described.

In all of these systems a plurality of plural electrode electrical discharge devices are used, one of which is operative substantially continuously and controls the system in accordance with the conductivity of a flame of the burning fuel.

The other plural electrode electrical discharge device cooperates with the first named device to deenergize the system in case of current leakage from the flame electrode, which if not taken care of by some suitable

means would cause improper operation of the system with consequent danger in the operation thereof.

As hereinbefore stated, we prefer to employ a particular form of plural electrode electrical discharge device, called a grid glow tube, because of its inherent characteristics of operation and because of the amount of current which can be caused to traverse the same when it becomes electric conducting. The grid glow tube has been developed to a point where it is rugged and has relatively long life and a system of the kind embodied in our invention will therefore operate properly over relatively long periods of time and be relatively simple and direct as well as fast in operation.

Various modifications may be made in the device and system embodying our invention without departing from the spirit and scope thereof and we desire therefore that only such limitations shall be placed therein as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. In fuel burner control apparatus, an ignition system, a plural electrode electric discharge device capable of being excited by said ignition system, a fuel supply system capable of being actuated by the excitation of said discharge device, a contactor capable of responding to the condition of said fuel supply system to interrupt the action of said ignition system, and thereby to deenergize said electric discharge device and means responsive to the condition of the fuel adapted to hold said plural electrode tube in a state of excitation.

2. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said control system comprising means for energizing said fuel-igniting means, means, including an electric discharge device, having a plurality of principal electrodes and a control electrode, and an electrode associated with said fuel and said control electrode, for rendering said energizing means for said fuel-igniting means inactive when said fuel has been ignited, and means including a second electric discharge device having a plurality of principal electrodes and a control electrode, and an electrode associated with said flame electrode and with said control electrode of said last-named electric discharge device, for rendering said first-named electric discharge device ineffective when a leakage path has been established between said flame electrode and said electrode associated with said flame electrode.

3. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-

feeding means, said control system comprising means, associated with said operating means for said fuel-feeding means, for deenergizing said operating means after a predetermined time, means including an electric discharge device having a control electrode and a plurality of principal electrodes, and an electrode associated with said fuel and said control electrode, for rendering said deenergizing means for said operating means for said fuel-feeding means inactive when said fuel has been ignited before said predetermined time and means including a second electric discharge device, having a control electrode and a plurality of principal electrodes, and an electrode juxtaposed to said fuel electrode and associated with the control electrode of said last-named electric discharge device, for rendering said first-named electric discharge device ineffective when a leakage path is established between said fuel electrode and said electrode juxtaposed to said fuel electrode.

4. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said control system comprising means, associated with said operating means for said fuel-feeding means, for deenergizing said operating means after a predetermined time, means including an electrode associated with said fuel for rendering said deenergizing means for said operating means for said fuel-feeding means inactive when said fuel has been ignited prior to said predetermined time and means, including an electric discharge device having a control electrode and a plurality of principal electrodes and an electrode juxtaposed to said fuel electrode and associated with the control electrode of said electric discharge device, for rendering said means, for rendering said deenergizing means inactive, ineffective when a leakage path is established between said fuel electrode and said electrode juxtaposed to said fuel electrode.

5. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said control system comprising means, associated with said operating means for said fuel-feeding means, for deenergizing said operating means after a predetermined time, means including an electrode associated with said fuel for rendering said deenergizing means for said operating means for said fuel-feeding means inactive when said fuel has been ignited before said predetermined time and means, including an electric discharge device having a control electrode and a plurality of principal electrodes and an electrode juxtaposed to said fuel electrode and associated with the control

electrode of said electric discharge device, for rendering said operating means for said fuel-feeding means inactive when a leakage path has been established between said fuel electrode and said electrode juxtaposed to said fuel electrode.

associated with the fuel and with the control electrode of said electric discharge device for maintaining energized said electric discharge device, when said fuel is ignited, thereby to maintain said operating means for said fuel-feeding means in active condition. 70

In testimony whereof, we have hereunto subscribed our names this 6th day of November, 1928.

JOHN V. BREISKY. 75
THOMAS DRAPER.

6. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said igniting means being of the type capable of producing a high frequency disturbance when operating said control system comprising means for controlling the activity of said operating means for said fuel-feeding means and means for energizing said controlling means, said last-named energizing means including an electric discharge device having a plurality of electrodes, certain of said electrodes being electrostatically shielded by certain others of said electrodes, and means cooperating with said fuel-igniting means for applying said high frequency disturbance to said electric discharge device to energize said electric discharge device. 80

7. A control system for a fuel burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said igniting means being of the type capable of producing a high frequency disturbance when operative, said control system comprising means for rendering said operating means active and means for controlling said means for rendering said operating means active, said controlling means including an electric discharge device including a plurality of electrodes, said electric discharge device to be energized by the high frequency electrical disturbances produced by said igniting means, and shielding means for certain of said electrodes, said shielding means providing a leakage path for electrical disturbances of frequencies substantially less than the frequency of said ignition means. 85

8. A control system for a fuel-burner of the type including fuel-feeding means, means for operating said fuel-feeding means and means for igniting the fuel supplied by said fuel-feeding means, said control system comprising means for controlling the activity of said operating means, an electric discharge device having a control electrode and a plurality of principal electrodes for controlling the activity of said controlling means, means by which said electric discharge device is energized by said ignition means when said ignition means is in proper condition for igniting said fuel, means associated with said controlling means and coacting therewith in the energized condition thereof to deenergize said ignition means and thereby to deenergize said electric discharge device, and means 90

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