

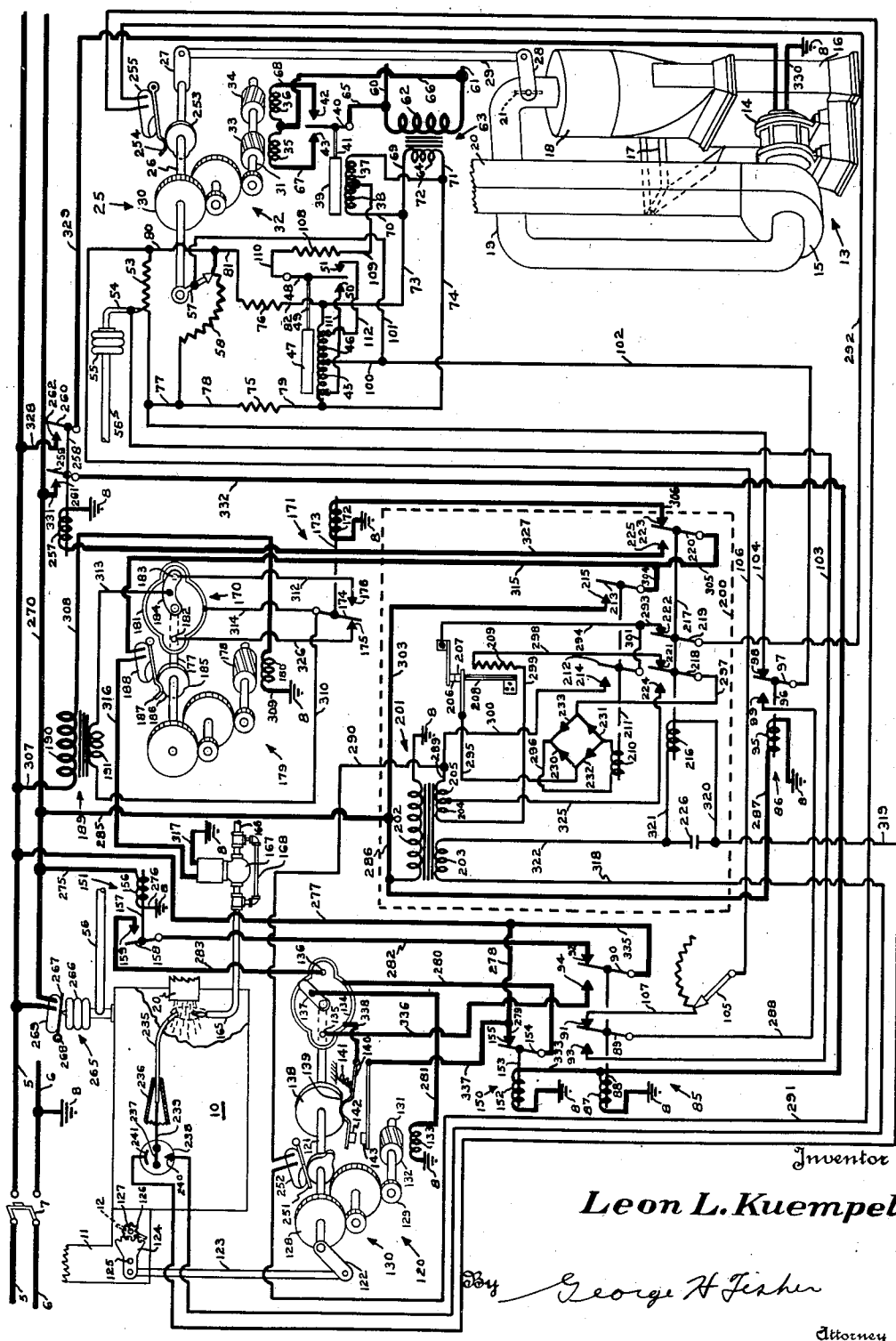
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POWDERED COAL BURNING SYSTEM

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POWDERED COAL BURNING SYSTEM

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The present invention relates to an improved control system for controlling the ignition and burning of fuel and is particularly directed to apparatus for burning finely divided solid fuel such as powdered coal.

One of the objects of the present invention is the provision of a burner/control system in which a damper, such as a stack damper, that has a starting position and at least one running position must be moved to such starting position before fuel can be initially supplied to the burner.

A further object of the invention is the provision of a variable fuel feeding system in which the fuel feed is normally varied so as to provide a plurality of fuel feed rates upon changes in the demand for fuel and in which the fuel feed controlling means must be moved to a predetermined fuel feeding position before the fuel delivery means may be placed in operation after which the fuel feed controlling means is controlled in accordance with the demands.

A further object of the invention is the provision of a burner control system in which a draft control means or stack damper must be moved to starting position and the fuel feed volume controlling means must be operated so as to permit a relatively small volume of fuel to be fed to the burner before the fuel feeding means can be placed in operation.

Further objects of the invention include the provision of systems of the type above described in which initiation of fuel feed to the burner is dependent upon the proper operation of an ignition means which is preferably of the flame producing type.

Another object of the invention is the provision of systems of the nature set out above wherein operation of the ignition means is terminated after a timed period together with provision for maintaining operation of the fuel feed means in the event combustion has been properly established during the time that the ignition means was in operation. Preferably, a single means is utilized to respond to proper operation of the ignition means, so as to permit the initial supplying of fuel, and to the main burner flame to maintain the supply of fuel to the burner after operation of the ignition means is terminated.

Other objects of the invention reside in the various combinations and sub-combinations to be hereinafter disclosed and will be found in the drawing, the accompanying description and the appended claims.

For a more complete understanding of the invention, reference may be had to the following

detailed description and accompanying single drawing which is a diagrammatic showing of one form of the invention.

Referring to the single figure of the drawing, it will be noted that the control system of the present invention is entirely electrical, power being furnished by a hot line 5 and a ground line 6, there being a manually operable switch 7 interposed in these lines by which the circuit to the control system may be manually completed or interrupted. For convenience of illustration, the ground line 6 is shown connected to ground at 8 and, throughout the description of the electrical circuits, the return lines from all of the various instruments and devices will be shown as connected to a similar ground 8.

The invention is shown as applied to a boiler 10 that includes a stack or chimney 11 which is provided with a stack damper 12. The boiler 10 is fired by powdered coal which is supplied thereto by a combined pulverizing and feeding mechanism generally indicated at 13. This pulverizing and feeding mechanism includes a motor 14 which drives a blower 15 and a pulverizer that is located in a casing 16. Coal is fed to the pulverizer by means of a hopper 17. When the motor 14 is energized, the pulverizer in casing 16 is operated and the blower 15 operates to suck the pulverized coal through a classifier 18 which only allows coal particles of the proper smallness to pass therethrough, after which the pulverized coal is drawn through a duct 19, passes through the blower 15 and is discharged to the boiler 10 through a discharge duct 20. For convenience of illustration, the duct 20 is shown broken away. In this manner, operation of the motor 14 serves to deliver a combination of powdered coal and combustion supporting air to the boiler 10. The duct 19 is provided with a damper 21 of the butterfly type which is operative to vary the amount of fuel and air delivered to the boiler 10 and thereby vary the rate of combustion. Such combination pulverizers and fuel feeders are well known in the art and do not constitute a part of the present invention except in combination with the control system now to be described.

The fuel control damper 21 is controlled by a motor mechanism generally indicated at 25. This motor mechanism 25 is of the modulating or proportioning type as will hereinafter become apparent and includes a main control shaft 26 to which is secured a crank 27. The crank 27 is connected to a similar crank 28 by means of a link 29, the crank 28 being in turn connected to the fuel control damper or valve 21. The main

operating shaft 26 further carries a gear 30 which is operatively connected to a rotor shaft 31 through suitable gear reducing mechanism 32. The rotor shaft 31 carries a pair of motor rotors 33 and 34 which are respectively provided with energizing or field windings 35 and 36. The field windings 35 and 36 are controlled by a relay that includes a pair of similar relay windings 37 and 38 which conjointly control the position of the plunger 39. The plunger 39 is connected to a relay switch arm 40 by means of a non-magnetic and non-conducting connecting link 41, the relay switch arm 40 being adapted to alternately engage a pair of relay contacts 42 and 43 upon reverse movements of the plunger 39. Relay coils 37 and 38 are controlled by a balanced solenoid mechanism which includes a pair of similar solenoid windings 45 and 46 which cooperate in the control of a single plunger 47. The plunger 47 is connected to a switch arm 48 by means of a non-magnetic and non-conducting link 49. The switch arm 48 is adapted to alternately engage a pair of contacts 50 and 51. During the normal operation of the system, the energizations of solenoid windings 45 and 46 are controlled by a pressure-operated variable resistance means herein shown as comprising a pressure-operated potentiometer that includes a control resistance 53 and a cooperating contact arm 54 that is controlled by a pressure-responsive device herein shown as a bellows 55. The bellows 55 is connected to the boiler 10 by a pipe 56, which is shown broken away for convenience of illustration, whereby the contact arm 54 is positioned upon the control resistance 53 in accordance with variations in boiler pressure. The main operating shaft 26 further operates a balancing contact arm 57 that is moved by the main shaft 26 back and forth across a balancing resistance 58. The arrangement is such that the main shaft 26 has an extreme movement of one quarter of a revolution or 90° whereby to position fuel control damper 21 between its open and closed positions by the linkage mechanism previously described. Electrical power is supplied to the motor mechanism 25 by means of line wires 60 and 61 which are connected to the primary 62 of a step down transformer 63, having a low voltage secondary 64. A wire 65 connects line wire 60 to the relay switch arm 40 and a wire 66 connects the line wire 61 to one end of each of field windings 35 and 36. The other end of field winding 35 is connected to relay contact 43 by a wire 67 and, in a like manner, the other end of field winding 36 is connected to relay contact 42 by means of a wire 68. The relay windings 37 and 38, in series, are connected across the secondary 64 of transformer 63 by means of wires 69, 70, 71, and 72. Similarly, the solenoid windings 45 and 46, in series, are connected across the secondary 64 by wires 69, 73, 71, and 74. The control resistance 53 and the balancing resistance 58, in parallel, are connected in parallel with the series connected solenoid windings 45 and 46 through two identical protective resistances 75 and 76 by means of wires 77, 78, 79, 80, 81, and 82.

Motor mechanism 25 is additionally controlled by a pair of relays generally indicated at 85 and 86. The relay 85 includes a relay coil 87 that operates an armature 88 which in turn controls a pair of switch arms 89 and 90. The switch arms 89 and 90 are normally respectively engaged with contacts 91 and 92 but are moved into respective engagement with contacts 93 and 94 upon energization of relay coil 87. The relay 86

comprises a relay coil 95 and a cooperating armature 96 that controls a single switch arm 97. The switch arm 97 normally engages a contact 98 but is moved from engagement therewith and into engagement with a contact 99 on energization of the relay coil 95.

The junction of solenoid windings 45 and 46, the balancing contact finger 57, and the switch arm 97 of relay 86 are all interconnected by means of wires 100, 101, and 102. The control contact arm 54 is connected to the contact 93 of relay 85 by means of a wire 103. One end of control resistance 53 is connected to contact 98 of relay 86 by a wire 104 and the other end thereof is connected to contact 91 of relay 85, through a manually operable rheostat 105 by means of wires 106 and 107. The junction of relay windings 37 and 38 are connected to switch arm 48 through a protective resistance 108 by means of wires 109 and 110. Contact 50 is connected to a small number of turns of solenoid winding 45 by means of a wire 111 and a wire 112 connects a small number of turns of the solenoid winding 46 to contact 51.

The stack damper 12 for the boiler 10 is controlled by a motor mechanism generally indicated at 120. This motor mechanism 120 includes a main shaft 121 to which a crank 122 is secured. The crank 122 operates a link 123 that is connected to a gear segment 124 pivoted as at 125. The gear segment 124 meshes with a pinion 126 that is in turn secured to the shaft 127 of the stack damper 12. The main operating shaft 121 carries a gear 128 that is connected to a motor pinion 129 through suitable reduction gearing 130. The motor pinion 129 is carried by a rotor shaft 131 to which is secured a rotor 132. Associated with the rotor 132 is an energizing or field winding 133. The main operating shaft 121 also controls a rotary switching mechanism that includes a substantially circular track 134 with which a pair of contact buttons 135 and 136 are associated. The contact buttons 135 and 136 are diametrical opposite one another and lie in the arc of curvature of the circular portions of track 134. A rotary brush 137 is controlled by main operating shaft 121 and is adapted to be constantly engaged with the track 134 or one of the buttons 135 or 136, the arrangement being such that the brush 137 can rest upon either of buttons 135 or 136 and be completely out of engagement with the track 134. Main operating shaft 121 also carries a cam 138 that is provided with an operating portion 139 that is adapted to depress a cam follower 140 which is normally urged upwardly by means of a spring 141. The cam follower 140 carries a contact 142 that is moved into engagement with a cooperating contact 143 when the cam follower 140 is depressed as shown in the drawing. At this time, the brush 138 is in the position upon track 134 wherein it is twice as far from button 135 as it is from button 136. The stack damper 12 is two-thirds closed with the motor mechanism 120 in this position.

The motor mechanism 120, besides being controlled by the switching mechanism which it operates and which has just been described, is additionally controlled by certain of the switches of the relay 85, by a relay 150 and by a relay 151. The relay 150 includes a relay coil 152 and a cooperating armature 153 that controls a switch arm 154. The switch arm 154 is normally in engagement with a contact 155 but moves therefrom

upon energization of relay coil 152. The relay 151 includes a relay coil 156 and a cooperating armature 157 that controls a switch arm 158. Switch arm 158 is normally disengaged from a contact 159 but is moving into engagement therewith upon energization of relay coil 156.

The powdered fuel and air delivered to the boiler 10 from the duct 20 is adapted to be ignited by an expanding pilot 165 which is connected to a main gas supply pipe 166 through an electrically operated valve 167. A by-pass pipe 168 serves to constantly permit a small flow of gas from the main gas supply pipe 166 to the pilot 165 so that a small flame is normally maintained at all times.

Upon energization of the gas valve 167, a large flow of gas is supplied to the pilot 165 whereupon its flame expands to the dotted proportions shown in the drawing as is usual in the art. The ignition valve 167 is controlled by a motor mechanism 170, which times the opening period of ignition valve 167, and by a relay 171. The relay 171 includes a relay coil 172 and a cooperating armature 173 that controls a switch arm 174. The switch arm 174 is normally engaged with a contact 175 but moves from engagement therewith and into engagement with a contact 176 upon energization of relay coil 172. The motor mechanism 170 includes a main operating shaft 177 which is connected to a motor rotor 178 through suitable reduction gearing 179. The motor rotor 178 is provided with an energizing or field winding 180. The motor mechanism 170 also includes a rotary switching mechanism that comprises a substantially circular track 181 and a pair of contact buttons 182 and 183. This rotary switching mechanism further includes a brush 184 that is operated by the main operating shaft 177. Main operating shaft 177 also carries a cam 185 that is provided with a depressed portion 186 upon which a cam follower 187 rides. The cam follower 187 carries a mercury switch 188, the arrangement being such that the mercury switch 188 is in open circuit position when the cam follower 187 is riding upon the depressed portion 186 of cam 185 and is in closed circuit position for all other positions of the cam 185. The motor mechanism 170 also includes a step-down transformer 189 that comprises a high voltage primary 190 and a low voltage secondary 191.

The control system further includes a pilot and burner flame responsive control system as well as a safety shut-down mechanism, this system and mechanism being shown enclosed by the dotted lines 200. This mechanism includes a combination transformer 201 and has a line voltage primary 202. This transformer 201 is provided with a high voltage secondary 203 of approximately 440 volts and a pair of series connected secondaries, or a center-tapped secondary, having secondaries or secondary portions 204 and 205. Each of these secondaries produces approximately 10 volts so that their combined voltage is approximately 20 volts. The safety shut-down mechanism includes a thermally operated safety switch having contacts 206 and 207 which are normally latched in engagement with each other by a bimetallic element 208 which is adapted to be heated under certain conditions by an electrical heating element or safety switch heater 209. The arrangement is such that if the safety switch heater 209 is energized for a predetermined length of time, the free end of bimetallic element 208 unlatches safety switch contacts

206 and 207, allowing them to be separated after which they must be manually reclosed and will only be latched closed in the event that the bimetallic element 208 has cooled sufficiently.

This safety mechanism also includes a first relay having a coil 210 that controls an armature 211. The armature 211 is connected to a pair of switch arms 212 and 213 that are normally disengaged from their respective contacts 214 and 215 but are moved into engagement therewith upon energization of the relay coil 210. A second relay, which is included in the safety mechanism, includes a relay coil 216 and an armature 217. The armature 217 is connected to three switch arms 218, 219, and 220 which are normally in engagement with respective contacts 221, 222, and 223. Upon energization of relay coil 216, these switch arms 218, 219 and 220 move from engagement with their contacts 221, 222 and 223 and the switch arms 218 and 220 move into engagement with contacts 224 and 225. The arrangement is such that switch arm 218 engages contact 224 before it disengages contact 221 so that these contacts are overlappingly controlled. Associated with the relay coil 216 is a condenser 226. Direct current is furnished to the safety switch heater 209 and the relay coil 210 from one or both of low voltage secondaries 204 and 205 by means of a copper oxide disc rectifier of any well known construction having current paths 230, 231, 232, and 233.

The flame responsive mechanism includes an electrode 235 which is adapted to be contacted by either the pilot flame when it is in its expanded condition or by the main flame issuing from the powdered coal burner. This electrode 235 is supported by a support partially shown at 236 and is connected to the grid 237 of a grid glow tube 238 by means of a wire 239. The grid glow tube 238 additionally includes the usual anode 240 and cathode 241.

The safety mechanism and flame responsive mechanism can only be initially placed into operation if the stack damper 12 and fuel control damper 21 have been moved to proper initial starting positions. To this end, the main operating shaft 121 of motor mechanism 120 is provided with a cam 250 that cooperates with a cam follower 251 which in turn carries a mercury switch 252. The arrangement is such that mercury switch 252 only closes when the motor mechanism 120 has operated the stack damper 121 to its full open position. Similarly, the main operating shaft 26 of motor mechanism 25 carries a cam 253 that operates a cam follower 254 which in turn carries a mercury switch 255. This arrangement is such that the mercury switch 255 is only closed when the fuel control damper 21 has been moved to some minimum fuel flow controlling position which may be varied from complete closed to some other desired minimum position by the manually operable rheostat 105 as will hereinafter be explained in detail.

The motor 14 and various other of the devices heretofore explained are controlled by a relay which includes a relay coil 257 and an armature 258. Armature 258 controls a pair of switch arms 259 and 260 that are normally disengaged from a pair of cooperating contacts 261 and 262. The switch arms 259 and 260 are moved into engagement with the contacts 261 and 262 upon energization of relay coil 257.

Operation of the whole system is dominated by a high limit pressure control 265 that is

shown as comprising a bellows 266 which responds to the pressure in boiler 10 and operates an arm 267 which is pivoted at 268. The arm 267 carries a mercury switch 269, the arrangement being such that mercury switch 269 is opened when the pressure in boiler 10 becomes excessive. The mercury switch 269 is interposed in a main line wire 270 which is connected to the hot line 5. In this manner, the main line wire 270 is only energized when the manual switch 7 is closed and when the boiler pressure is not excessive. The remaining circuit connections will be described in detail in the following detailed description of the operation of the complete system.

Operation

With the parts in the position shown, the system is inoperative by reason of the fact that the manual main switch 7 is in open position. The boiler pressure is therefore quite low so that the mercury switch 269 of the high limit pressure controller 265 is closed and the control contact arm 54 is engaged with the extreme left hand end of control resistance 53. The fuel control damper 21 is completely open and the mercury switch 255 is in open circuit position. The stack damper 12 is in two-thirds open position and the mercury switch 252 is also in open circuit position. If the main switch 7 is now closed, current will flow to the hot line 5 and also to the main line wire 270 since the mercury switch 269 is closed. Such closure of the main switch 7 results in energization of relay coil 156 by a circuit which goes from main line wire 270, a wire 275, relay coil 156 and wire 276 to ground 8. Energization of relay coil 156 moves switch arm 158 into engagement with contact 159 whereupon closure of main switch 7 also causes energization of field winding 133 of motor mechanism 120 as follows: hot line 5, wire 277, wire 278, wire 279, contact 155, switch arm 154, wire 280, track 134, brush 137, wire 281 and field winding 133 to ground 8. Main operating shaft 121 is thereupon rotated in a clockwise direction at relatively slow speed as viewed from the left. Crank 122 therefore lifts link 123 upwardly whereupon gear segment 124 is rotated in a clockwise direction and the stack damper 12 is rotated in counter-clockwise direction towards its full closed position. Brush 137 will also be rotated along track 134 away from button 135 and towards button 136. When brush 137 rides off of track 134 and rests completely upon button 136, the energizing circuit for field winding 133 will be interrupted. At this time, the stack damper 12 will be completely closed. Engagement of brush 137 with button 136, however, establishes a new energizing circuit for field winding 133 as follows: hot line 5, wire 277, wire 335, switch arm 90, contact 92, wire 282, switch arm 158, contact 159, wire 283, button 136, brush 137, wire 281, field winding 133 and ground 8. The main operating shaft 121 therefore continues its clockwise movement. Brush 137 quickly rides off button 136 and back onto track 134 whereupon the field winding 133 remains energized by the circuit first described. Main operating shaft 121 therefore continues its clockwise rotation until brush 137 rides off track 134 and onto button 135 whereupon all circuits for field winding 133 are interrupted. During this movement of the main operating shaft 121 while brush 137 moved from button 136 to button 135, the link 123 was moved downwardly

whereby stack damper is rotated in a clockwise direction.

During this initial movement of main operating shaft 121, the cam follower 140 was moved downwardly by cam 138 so as to engage contacts 142 and 143. With the parts in their new position, the stack damper 12 is completely opened and the mercury switch 252 has been moved to closed position.

Prior to closing of main switch 7, the fuel control damper 21 was in its full open position. It will be noted that with the main switch 7 open, solenoid winding 45 is substantially completely short circuited by the following circuit: wire 100, wire 102, switch arm 97, contact 98, wire 104, wire 77, wire 78, protective resistance 75 and wire 79. Solenoid winding 46 is likewise substantially completely short-circuited by the following circuit: wire 100, wire 101, balancing contact finger 57, wire 81, protective resistance 76 and wire 82. Since these protective resistances 75 and 76 are similar and of a like value, the solenoid windings 45 and 46, while both being substantially completely short circuited, are each energized slightly and to an equal extent so that plunger 47 is in the central position shown in the drawing wherein switch arm 48 is intermediate contacts 50 and 51. Closure of main switch 7, together with closure of mercury switch 269, also caused energization of relay coil 95 of relay 86 by a circuit as follows: main line wire 270, wire 285, wire 286, wire 287, relay coil 95 and ground 8. Switch arm 97 thereupon moved out of engagement with contact 98 so as to interrupt this substantial short circuit of solenoid winding 45. Movement of switch arm 97 into engagement with contact 99 however establishes a second substantially complete short circuit for solenoid winding 46 as follows: wire 100, wire 102, switch arm 97, contact 99, a wire 288, switch arm 89, contact 91, wire 107, rheostat 105, wire 106, wire 80, wire 81, protective resistance 76 and wire 82. Solenoid winding 46 therefore remains substantially completely short-circuited irrespective of the position of balancing contact finger 57 and solenoid winding 45 is no longer substantially completely short circuited so that plunger 47 moves to the left and brings switch arm 48 into engagement with contact 50. Relay winding 37 is thereupon placed in parallel with a small number of turns of solenoid 45 and this full current flow goes through relay coil 38. This circuit is as follows: secondary 64, wire 69, wire 70, relay coil 38, at which point the circuit branches one portion going by way of relay coil 37, the wire 72 to wire 71 and secondary 64 whereas the other portion goes by way of wire 109, protective resistance 108, wire 110, switch arm 48, contact 50, wire 111, the small number of turns of solenoid winding 45, and wire 74 to wire 71 and secondary 64. Plunger 39 therefore moves to the left and brings relay switch arm 40 into engagement with relay contact 43, thereby energizing field winding 35 as follows: line 60, wire 65, relay switch arm 40, relay contact 43, wire 67, field winding 35, and wire 66 to line 61. Motor rotor 33 is therefore rotated in a direction which results in rotation of main operating shaft 26 in a clockwise direction as viewed from the left. Fuel control damper 21 is thereby moved towards closed position and balancing contact finger 57 travels along balancing resistance 58 towards the left hand end thereof. When main operating shaft 26 has moved through a quarter revolution, balancing contact

finger 57 engages the left hand end of balancing resistance 58 whereupon solenoid winding 45 is again substantially completely short-circuited. This circuit is as follows: wire 100, wire 101, balancing contact finger 57, wire 78, protective resistance 75 and wire 79. Solenoid windings 45 and 46 now again both being substantially short circuited, the plunger 47 returns to its center position moving switch arm 48 from engagement with contact 50. This breaks the circuit through the small number of turns of solenoid 45 which was in parallel with relay coil 37 so that relay coils 37 and 38 are again equally energized, both being connected in series across the secondary 64. Plunger 39 therefore returns to its central position and moves relay switch arm 40 from engagement with relay contact 43 thereby deenergizing field winding 35. This quarter movement of main operating shaft 26 caused fuel control damper 21 to move to closed position and raised cam follower 254 so as to close mercury switch 255. At this time, it should be noted that by manual manipulation of rheostat 105, the short circuiting effect on solenoid winding 46 can be made less complete whereby balancing contact finger 57 will not move to the extreme left end of balancing resistance 58 in order to rebalance the energization of solenoids 45 and 46. In this manner, the minimum flow position of fuel control damper 21 can be made less than completely closed if desired under these initial starting conditions.

Closure of manual switch 7, together with closure of mercury switch 269 also resulted in energization of primary 208 of transformer 201 by a circuit as follows: main line wire 270, wire 285, wire 286, primary 202 and ground 8. Therefore, as soon as both mercury switches 252 and 255 have been moved to closed circuit position, which means that the stack draft 12 is completely open and fuel control damper 21 is completely closed, energizing circuits for relay coil 210 and safety switch heater 209 are established. During half of each cycle of the alternating current produced by the combined secondaries 204 and 205, the relay coil 210 and the safety switch heater 209, in series, will be energized as follows: secondary 204, secondary 205, wire 289, wire 290, mercury switch 252, wire 291, mercury switch 255, wire 292, switch arm 219, contact 222, wire 293, wire 294, safety switch contacts 206 and 207, wire 295, current path 230 of the rectifier, wire 296, relay coil 210, current path 231 of the rectifier, wire 297, switch arm 218, contact 221, wire 298, safety switch heater 209 and wire 299 to secondary 204. During the other half of each of the cycles of alternating current delivered by secondaries 204 and 205, the energizing circuit for relay coil 210 and safety switch heater 209 will be as follows: secondary 205, secondary 204, wire 299, safety switch heater 209, wire 298, contact 221, switch arm 218, wire 297, current path 233 of the rectifier, wire 296, relay coil 210, current path 232 of the rectifier, wire 295, safety switch contacts 207 and 206, wire 294, wire 293, contact 222, switch arm 219, wire 292, mercury switch 255, wire 291, mercury switch 252, wire 290 and wire 289 to secondary 205. Energization of relay coil 210, moves switch arms 212 and 213 into engagement with contacts 214 and 215. Engagement of contact 214 by switch arm 212 establishes holding circuits for relay coil 210 and safety switch heater 209 which are entirely independent of mercury switches 252 and 255. During one half of each cycle of alternating current,

this holding circuit will be as follows: secondary 204, secondary 205, wire 289, wire 300, contact 214, switch arm 212, wire 301, wire 294, safety switch contacts 206 and 207, wire 295, current path 230 of the rectifier, wire 296, relay coil 210, current path 231 of the rectifier, wire 297, switch arm 218, contact 221, wire 298, safety switch heater 209 and wire 299 to secondary 204. During the other half of each alternating cycle, the holding circuit will be as follows: secondary 205, secondary 204, wire 299, safety switch heater 209, wire 298, contact 221, switch arm 218, wire 297, current path 233 of the rectifier, wire 296, relay coil 210, current path 232 of the rectifier, wire 295, safety switch contacts 207 and 206, wire 294, wire 301, switch arm 212, contact 214, wire 300 and wire 289 to secondary 205. Energization of relay coil 210 after it has initially been energized is therefore entirely independent of the mercury switches 252 and 255 so that the motor mechanisms 120 and 125 may be thereafter operated in their proper manners as will soon be described without deenergizing the relay coil 210 and heater 209.

Movement of switch arm 213 into engagement with contact 215 establishes an energizing circuit for relay coil 172 as follows: main line wire 270, wire 285, wire 303, contact 215, switch arm 213, wire 304, wire 305, switch arm 220, contact 223, wire 206, relay coil 172 and ground 8. Energization of relay coil 172 moves switch arm 174 from engagement with contact 175 and into engagement with contacts 176. It will be noted that upon closure of main switch 7, transformer 190 and field winding 180 in series were energized as follows: hot line 5, wire 307, primary 190, wire 308, field winding 180, wire 309 and ground 8. However, with switch arm 174 in engagement with contact 175, the secondary 191 was open circuited, wherefore the current flow through primary 190 and field winding 180 was not sufficient to operatively energize the field winding 180. Movement of switch arm 174 into engagement with contact 176 completes an energizing circuit or short circuit for secondary 191 as follows: secondary 191, wire 310, switch arm 174, contact 176, wire 312, contact button 183, brush 184 and wire 313 to the other side of secondary 191. The current flow to primary 190 is greatly increased upon short circuiting of secondary 191 and this increased current flow traverses field winding 180 and is sufficient to cause rotation of rotor 178. Main operating shaft 177 is thereupon rotated at slow speed in a counter-clockwise direction as viewed from the left. Initial rotation of brush 184 in counter-clockwise direction causes the same to engage track 181 and leave button 183 whereupon a short circuit for secondary 191 is established which is independent of the contact button 183 and is independent of the switch arm 174 and contact 176. This new short circuit for secondary 191 is as follows: secondary 191, wire 310, wire 314, track 181, brush 184 and wire 313 to the other side of secondary 191. Field winding 180 therefore remains energized until the main operating shaft 177 has completed a half cycle or 180° of rotation whereupon brush 184 disengages track 181 and rests completely upon button 182. This movement is relatively slow and consumes a period of about 360 seconds. Initial counter-clockwise rotation of main operating shaft 177 causes the cam follower 187 to ride off of the depressed portion 186 of cam 185 whereupon mercury switch 188 is moved to closed circuit position thereby energiz-

ing ignition valve 167 as follows: main line wire 270, wire 285, wire 303, contact 215, switch arm 213, wire 304, wire 315, mercury switch 188, wire 316, ignition valve 167 and wire 317 to ground 8.

If the pilot flame is out, so that it does not expand, the safety switch will open and render the system inoperative after the safety switch heater 209 has been energized for about 75 seconds. Energization of ignition valve 167 causes the same to open whereupon the pilot flame should expand to the proportions shown in dotted lines and impinge upon or contact the electrode 235. The charge on the grid 237 of grid glow tube 238 thereby drains off by way of wire 239, electrode 235 and the pilot flame whereupon current is permitted to flow from the anode to the cathode of the grid glow tube. A circuit is thereby established as follows: high voltage secondary 203, wire 318, anode 240, cathode 241, wire 319, wire 320, relay coil 216, wire 321 and wire 322 to the other side of secondary 203. It will be noted that the condenser 226 is connected in parallel with the relay coil 216 and thereby serves to smooth out the pulsating direct current which flows to the relay coil 216 from the secondary 203 and through the grid glow tube 238. Energization of relay coil 216 moves switch arm 218 into engagement with contact 224 and then out of engagement with contact 221, moves switch arm 219 from engagement with contact 222 and moves switch arm 220 from engagement with contact 223 and into engagement with contact 225. This disengagement of switch arm 218 from contact 221 interrupts the initial energizing and holding circuits for the safety switch heater 209 and relay coil 210 but engagement of switch arm 218 with contact 224 establishes maintaining circuits for relay coil 210 only as follows: during one half of each cycle from secondary 205, wire 289, wire 300, contact 214, switch arm 212, wire 301, wire 294, safety switch contacts 206 and 207, wire 295, current path 230, wire 296, relay coil 210, current path 231, wire 297, switch arm 218, contact 224 and wire 325 to secondary 205; and during the other half of each cycle from secondary 205, wire 325, contact 224, switch arm 218, wire 297, current path 233, wire 296, relay coil 210, current path 232, wire 295, safety switch contacts 207 and 206, wire 294, wire 301, switch arm 212, contact 214, wire 300 and wire 298 to secondary 205. The safety switch heater 209 is thus deenergized. Movement of switch arm 220 from engagement with contact 223 interrupts the energizing circuit for relay coil 172 whereupon switch arm 174 returns to the position shown in the drawing wherein it is disengaged from contact 176 and is engaged with contact 175. A short circuit for transformer 191 is thereupon established as follows as soon as brush 184 reaches button 182: transformer 191, wire 310, switch arm 174, contact 175, wire 326, contact button 182, brush 184 which is now engaging contact button 182 and wire 313 to secondary 191. Field winding 180 will then be again energized and cause main operating shaft 177 to continue its counter-clockwise rotation. As soon as brush 184 engages track 181, a maintaining short circuit for secondary 191 is established as heretofore described. At this time, the cam follower 187 again rides upon the depressed portion 186 of cam 185 so that mercury switch 188 again opens and the ignition valve 167 is deenergized. The main operating shaft 177 therefore completes another half revolution, bringing the parts to the position shown in the drawing where- in brush 184 engages contact button 183. As

pointed out before, this half revolution requires a period of time of about 360 seconds. Movement of switch arm 230 into engagement with contact 225 energizes relay coil 257 as follows: main line wire 270, wire 285, wire 303, contact 215, switch arm 213, wire 304, wire 305, switch arm 220, contact 225, wire 327 and relay coil 257 to ground 8. Energization of relay coil 257 moves switch arms 259 and 260 into engagement with contacts 261 and 262. Engagement of switch arm 260 with contact 262 energizes pulverizer and blower motor 14 as follows: hot line 5, wire 328, contact 262, switch arm 260, wire 329, motor 14, wire 330 and ground 8. Engagement of switch arm 259 with contact 260 energizes relay coils 87 and 152 as follows: main line wire 270, wire 331, contact 261, switch arm 259, wire 332, relay coil 87 to ground 8 and wire 333 to relay coil 152 and ground 8. Energization of relay coil 87 moves switch arm 89 from engagement with contact 91 and into engagement with contact 93. Movement of switch arm 89 from contact 91 interrupts the short circuit for solenoid coil 46 and its movement into engagement with contact 93 connects the contact finger 54 with the balancing contact finger 57 and the junction of solenoid windings 45 and 46 whereby to place the pressure control potentiometer in control of the motor mechanism 25. The boiler pressure of course is low at this time inasmuch as the system has not been operating so that control contact finger 54 is engaging the extreme left hand of control resistance 53 whereby the solenoid winding 45 is substantially completely short-circuited as follows: solenoid winding 45, wire 100, wire 102, switch arm 97, contact 99, wire 228, switch arm 89, contact 93, wire 103, control contact finger 54, wire 71, wire 78, protective resistance 75 and wire 79 to the other end of solenoid winding 45. Plunger 47 therefore moves to the right and brings switch arm 48 into engagement with contact 51. A small number of turns of solenoid winding 46 is thereby placed in parallel with relay winding 38 the circuit being as follows: secondary 64, wire 71, wire 72, relay winding 37, at which point the circuit splits, one portion going by way of relay coil 38 and wire 70 to wire 69 and secondary 64, whereas the other portion goes by way of wire 109, protective resistance 108, wire 110, switch arm 48, contact 51, wire 112, the small number of turns of solenoid winding 46, and wire 73 to wire 69 and the same side of secondary 64. In this manner, relay winding 37 becomes more highly energized than relay winding 38, whereupon switch arm 40 moves into engagement with relay contact 42 and energizes field winding 36 as follows: line 60, wire 65, relay switch arm 40, relay contact 42, field winding 36 and wire 66 to line 61. The rotor 34 therefore rotates main operating shaft 26 in a counter-clockwise direction as viewed from the left. This counter-clockwise rotation of main operating shaft 26 continues until the parts return to the position shown in the drawing wherein balancing contact finger 57 engages the extreme right hand end of balancing resistance 158 whereby it substantially short circuits the solenoid winding 46 thereby rendering the energizations of the solenoid windings 45 and 46 equal as heretofore explained. The fuel control damper 21 is therefore moved to full open position and since the motor 14 is energized, the coal will be pulverized or powdered and this powdered fuel will be drawn through the duct 19 and discharged into the duct 20 and into the boiler 10 as heretofore pointed out. Energization of relay coil 87

also moved switch arm 90 from engagement with contact 92 and moved the same into engagement with contact 94. Field winding 133 of motor mechanism 120 was thereupon energized as follows: hot line 5, wire 277, wire 335, switch arm 90, contact 94, wire 336, contact button 135 which is now engaged by brush 137, brush 137 and wire 281 to field winding 133 and ground 8. The main operating shaft 121 is thereby rotated in a clockwise direction and the link 123 is moved upwardly until the stack damper 12 is returned to its two-thirds closed position. At that time, brush 137 will be returned to the position shown in the drawing and cam follower 140 will move upwardly to move contact 142 from engagement with contact 133. Field winding 133 will thereupon be deenergized and the draft damper 12 will remain in its two-thirds closed position. This partially closed position of the damper 12 varies with different boilers and the proper adjustment for a particular installation can be obtained by properly positioning the cam 138 on the main operating shaft 121. During this time, the fuel delivered to the boiler should be ignited by the expanded pilot flame. If ignition properly takes place, then when the pilot flame is contracted by the operation of the motor mechanism 170 in the manner just described, the electrode 235 will be contacted by the main burner flame so as to maintain relay coil 216 energized and the safety switch heater 209 deenergized. If flame should not be established at the main burner, contracting of the pilot will result in movement of the pilot flame away from the electrode 233 whereupon a charge will build up on the grid 237 and block the passage of current through the grid glow tube 238 resulting in deenergization of relay coil 216. Safety switch heater 209 will thus be reenergized as soon as motor mechanism 170 starts through its second half revolution and will cause the bimetallic element 208 to open the safety switch contacts in about 75 seconds, which is less than the time required by the motor mechanism to complete such half-revolution. The system is thereby rendered inoperative until manual intervention.

With the system operating normally, as the boiler temperature increases, control contact finger 54 will move across control resistance 53 towards the right hand end thereof. Such movement of the control finger 54 causes the short-circuiting of solenoid coil 45 to be less complete and when the voltage drop across solenoid coil 45 becomes greater than that across solenoid coil 46, the plunger 47 will move to the left bringing contact arm 48 into engagement with contact 50 whereupon plunger 39 will also move to the left to energize field winding 35 as previously pointed out. Main operating shaft 26 will therefore rotate in a clockwise direction moving balancing contact finger 57 along balancing resistance 58 until the voltage drops across solenoid windings 45 and 46 are again equalized. The opposite action takes place on a fall in boiler pressure. Therefore, during normal operation, the position of the fuel control damper 21 is modulated or proportioned in a well known manner to maintain the boiler pressure within prescribed limits to which the range of movement of the pressure operated potentiometer responds. For a more detailed description of this proportioning or modulating action from a control potentiometer, reference may be had to the copending application of Lewis L. Cunningham, Ser. No. 673,236 en-

titled "Remote control system" and filed May 27th, 1933.

The rheostat 105 has been previously set so that the fuel control damper 21 cannot be completely closed whereby to provide a minimum operating condition. It may happen that the load on the boiler is so small that this minimum operating condition or minimum fuel feed causes the boiler pressure to become excessive whereupon bellows 266 will expand, lifting arm 267 and tilting mercury switch 269 to open circuit position. When this happens, the energizing circuits for relay coil 156, for the transformer 201, for relay 257 and for relay 171 will all be interrupted if they have not already been interrupted during normal operation. Deenergization of relay coil 257 results in deenergization of motor 14 and also causes deenergization of relay coils 87 and 152. The parts therefore all assume the position shown in Fig. 1 of the drawing and upon a subsequent reclosure of mercury switch 269, due to a subsequent decrease in boiler pressure, the apparatus will go through the starting cycle previously explained after which control will be returned to the potentiometer pressure controller.

In the event of a failure of flame during normal operation, relay coil 216 will be deenergized due to the absence of flame and the system will be rendered inoperative until manual intervention. If there should be a failure of electrical power during normal operation, the system will completely recycle and go through the starting operations in the manner previously explained.

To recapitulate, with the power off, the parts assume the position shown in the drawing wherein the draft damper is two-thirds closed and the fuel supply is completely open. However, the fuel feeding and draft producing motor is deenergized. Upon closure of the power circuit by manual manipulation of manual switch 7, relay coil 156 is energized, power is supplied to transformer 201, and power is supplied to transformer 189 and relay coil 95 is energized. Energization of relay coil 156 causes the motor mechanism 120 to run to the position in which the stack damper 12 is fully opened and in which the mercury switch 252 is closed. Energization of relay coil 95 operates the motor mechanism 25 to move fuel control damper 21 to its minimum position and closes mercury switch 255. Closure of mercury switches 252 and 255 energizes relay coil 210 which then establishes its own holding circuit independent of these mercury switches and energizes relay 172 that in turn opens the ignition valve and maintains it open for a timed period through the motor mechanism 170. Immediately upon opening of the ignition valve, the relay coil 210 is energized whereupon relay coil 257 is energized and starts the motor 14. This energization of relay coil 257 also energizes relay coils 152 and 87 whereupon the control of the motor mechanism 25 is turned over to the potentiometer controller responsive to pressure conditions and the motor mechanism 120 is operated to position the stack damper 12 in two-thirds closed position. If flame is not produced, deenergization of the ignition means causes deenergization of relay coil 216 whereupon the motor mechanism 120 begins its return to initial position and the safety switch heater is reenergized and causes the safety switch to open during this return movement of motor mechanism 170. In this manner, the system locks up until manual intervention. If, on the other hand, combustion is properly established, the relay coil 216 is maintained energized and the

system is in normal operation. The supply of fuel and air is thereafter modulated or proportioned in accordance with fluctuations in boiler pressure. If the boiler pressure should become too high by reason of a small load, the system is shut down and thereafter goes through the above described sequence when the boiler pressure returns to a desired safe value. If there should be a failure of flame during normal operation, relay coil 210 becomes deenergized and the system will be rendered inoperative until manual intervention.

It will be evident that many changes in the system of the present invention can be made without departing from the spirit thereof and I therefore intend to be limited only by the scope of the appended claims.

I claim:

1. A burner system of the class described, comprising in combination, fuel control means in control of the supply of fuel to a burner, draft control means for the burner having a starting and a running position, a control operative to position the draft control means in starting position upon an initial demand for the feeding of fuel, means operative to institute the feeding of fuel by said fuel control means only after said draft control means has been positioned in starting position, ignition means for the fuel, and means responsive to the ignition means operative to thereafter position said draft control means in running position.

2. In a burner control system, in combination, fuel control means in control of the supply of fuel to a burner, a damper associated with the burner and having a starting position and a running position, a control operative to position the damper in its starting position upon an initial demand for the feeding of fuel to the burner, means operative to initiate the supplying of fuel to the burner only after the damper has been moved to its starting position, means to ignite the fuel and means operated as a result of the feeding of fuel operative to move the damper to its running position and maintain the same therein including means responsive to combustion of the fuel.

3. In combination, a burner, means in control of the flow of fuel to the burner, a control device responsive to the demand for heat associated with said means and operative to vary the supply of fuel to the burner according to such demands, draft control means having a starting position and at least one running position, a limiting control responsive to a heat condition operative to place said draft control means in its starting position upon the heat condition falling to a predetermined value, means operative to place the fuel control means under the control of said control device only after the draft control means reaches its starting position, and means for placing said draft control means in running position after it has been placed in its starting position.

4. In combination with a burner, draft control means having a starting and a running position, limiting control means responsive to a heat condition operative to place the draft control means in starting position upon the heat condition falling to a predetermined value, switching means moved to a new circuit controlling position when the draft control means reaches its starting position, electrically operated fuel control means in control of the supply of fuel to the burner, a circuit operative to place said fuel control means in operation completed by said switching means

when moved to said new circuit controlling position, circuit connections operative to maintain said fuel control means in operation after the same has been initially placed in operation, and means operative to place the draft control means in running position after it has been placed in its starting position.

5. In a burner control system, a control device responsive to the demands for heat, fuel control means normally positioned by said control device to vary the supply of fuel in a plurality of stages upon fluctuations in the demand for heat, a limiting control responsive to a heat condition, fuel delivery means, connections between said limiting control, fuel delivery means and fuel control means operative to stop the supplying of fuel and to position the fuel control means in maximum fuel delivery position when the limiting control is in a first position as a result of an increase in the value of said heat condition and to position the fuel control means in minimum flow position when the limiting control is in a second position as a result of a subsequent lowering of the value of said heat condition, connections between the fuel control means and fuel delivery means operative to place the fuel delivery means in operation only after the fuel control means has been placed in its minimum fuel control position, and means operative to thereafter maintain the fuel delivery means in operation until the limiting control again moves to its first position.

6. In combination, a burner, fuel delivery means, means in control of the volume of fuel delivered to the burner by the fuel delivery means, a heat condition responsive limiting control arranged to prevent operation of the fuel delivery means and to position the fuel volume control means in maximum fuel flow position when the main control is in one position as a result of an increase in the heat condition to which it responds and to position the fuel volume control means in minimum fuel flow position when in a second position as a result of a subsequent decrease in such heat condition, a second control associated with the fuel volume control means and operative to place the same in a plurality of positions, means associated with the fuel delivery means and fuel volume control means operative to place the fuel delivery means in operation and to place the fuel volume control means under the control of the second control only upon movement of the fuel volume control means to its minimum fuel flow position as a result of movement of the limiting control from its first position to its second position and means operative to thereafter maintain operation of the fuel delivery means until the limiting control returns to said first position.

7. In combination, a burner, fuel delivery means, means in control of the volume of fuel delivered to the burner by the fuel delivery means, draft control means having a starting and a running position, a heat condition responsive limiting control operative to place the fuel volume control means in minimum fuel flow position and the draft control means in starting position when the limiting control moves from a first position in response to an excessive heat condition to a second position in response to a decrease in said heat condition, means controlled by the conjoint action of the draft control means and fuel volume control means to place the fuel delivery means in operation only after the draft control means moves to starting position and the

fuel volume control means moves to minimum fuel flow position, a second control operative to position the fuel volume control means in a plurality of positions, means to ignite the fuel, and means responsive to ignition of the fuel operative to maintain operation of the fuel delivery means, place the draft controlling means in running position and place the fuel volume control means under the control of said second control.

8. In combination, a burner, fuel delivery means for delivering fuel to the burner, fuel volume control means in control of the volume of fuel delivered to the burner by the fuel delivery means, a heat condition responsive limiting control having first and second controlling positions, means controlled by the limiting control to place the fuel volume control means in minimum fuel flow position upon movement of the main control from its first position to its second position as a result of decrease of said heat condition below an excessive value, ignition means, means controlled by the fuel volume control means operative to place the ignition means in operation only after the fuel volume control means reaches its minimum fuel flow position, a second control operative to position the fuel volume control means in a plurality of positions, means responsive to proper operation of the ignition means operative to place the fuel delivery means in operation and to place the second control in control of the fuel volume control means, means to terminate operation of the ignition means, and means to maintain operation of the fuel delivery means and to maintain the second control in control of the fuel volume control means until the main control returns to its first position after the ignition means is rendered inoperative.

9. In combination, a burner, fuel delivery means for delivering fuel to the burner, fuel volume control means in control of the volume of fuel delivered to the burner by the fuel delivery means, draft control means having starting and running positions, a heat condition responsive limiting control having first and second controlling positions, means controlled by the limiting control to place the draft control means in starting position and the fuel volume control means in minimum fuel flow position upon movement of the limiting control from its first position to its second position as a result of a decrease in said heat condition, ignition means, means controlled by the draft control means and fuel volume control means operative to place the ignition means in operation only after the draft control means reaches its starting position and the fuel volume control means reaches its minimum fuel flow position, a second control operative to position the fuel volume control means in a plurality of positions, means responsive to proper operation of the ignition means operative to place the draft control means in running position, to place the fuel delivery means in operation and to place the second control in control of the fuel volume control means, means to terminate operation of the ignition means, and means responsive to combustion conditions to maintain the draft control means in running position, to maintain operation of the fuel delivery means and to maintain the second control in control of the fuel volume control means until the limiting control returns to its first position after the ignition means is rendered inoperative.

10. In combination, a burner, fuel delivery means for delivering fuel to the burner, fuel volume control means in control of the volume

of fuel delivered to the burner by the fuel delivery means, a heat condition responsive limiting control having first and second controlling positions, means controlled by the limiting control to place the fuel volume control means in minimum fuel flow position upon movement of the limiting control from its first position to its second position upon a decrease in said heat condition below an excessive value, ignition means, means controlled by the fuel volume control means operative to place the ignition means in operation only after the fuel volume control means reaches its minimum fuel flow position, a second control operative to position the fuel volume control means in a plurality of positions, means responsive to proper operation of the ignition means operative to place the fuel delivery means in operation and to place the second control in control of the fuel volume control means, means to terminate operation of the ignition means, and means to maintain operation of the fuel delivery means and to maintain the second control in control of the fuel volume control means until the limiting control returns to its first position after the ignition means is rendered inoperative, said means responding to combustion conditions.

11. A burner control system, comprising in combination, means in control of the flow of fuel to the burner, a control associated with the fuel control means and operative to position the same in a plurality of fuel flow positions upon changes in the demand for fuel, ignition means, means operative to place the ignition means in operation for a time period upon an initial demand for fuel feed, and a single mechanism responsive to the proper operation of the ignition means and the successful establishment of combustion operative to initially permit and to thereafter continue the supplying of fuel to the burner.

12. A burner control system, comprising in combination, means in control of the flow of fuel to a burner, a control associated with the fuel control means and operative to position the same in a plurality of fuel flow positions upon changes in the demand for fuel, a flame producing ignition means, means operative to place the ignition means in operation for a time period upon an initial demand for heat, and a single flame responsive device responsive both to the ignition flame and the burner flame operative to permit initiation of the supply of fuel to the burner if the ignition flame is properly established and to continue the feeding of fuel after termination of the ignition flame if combustion has been successfully established.

13. In combination with a furnace, a combination fuel pulverizer and feeding mechanism, a motor for driving the same, a fuel control valve in control of the volume of fuel delivered by said combination fuel pulverizer and feeding mechanism, a furnace stack damper having starting and running positions, a first control having first and second control positions, means controlled by the first control and operative to position the stack damper in starting position and to position the fuel control valve in its minimum fuel control position when the first control moves from its first control position to its second control position, a second control for variably positioning the fuel control valve, connections by which the second control is placed in command of the fuel control valve and said motor is operated only after the stack damper has been moved to its starting position and the fuel con-

trol valve has been moved to its minimum fuel flow position, and means operative to place the stack damper in running position, maintain operation of said motor and maintain said second control in control of the fuel control valve after said stack damper is moved to its running position.

14. In combination with a furnace, a combination fuel pulverizer and feeding mechanism, a motor for driving the same, a fuel control valve in control of the volume of fuel delivered by said combination fuel pulverizer and feeding mechanism, a furnace stack damper having starting and running positions, a first control having first and second control positions, means controlled by the first control and operative to position the stack damper in starting position and to position the control valve in its minimum fuel control position when the first control moves from its first control position to its second fuel control position, a second control for variably positioning the fuel control valve, connections by which the second control is placed in command of the fuel control valve and said motor is operated only after the stack damper has been moved to its starting position and the fuel control valve has been moved to its minimum fuel flow position, and means responsive to the establishment of combustion operative to place the stack damper in running position, maintain operation of said motor and maintain said second control in control of the fuel control valve after said stack damper moves to its running position.

15. In combination, a burner, a draft control means, fuel feed control means, a first control, connections by which the first control places the draft control means in starting position upon a call for heat, ignition means, connections by which the ignition means and fuel feed control means are placed in operation only after the draft control means reaches starting position and means responsive to the successful establishment of combustion operative to move the draft control means out of starting position and to maintain operation of the fuel feed control means after the draft control means has been so moved.

16. In combination, a burner, a draft control means, fuel feed control means, a first control, connections by which the first control places the draft control means in starting position upon a call for heat, ignition means, connections by which the ignition means and fuel feed control means are placed in operation only after the draft control means moves to starting position, means responsive to proper operation of the ignition means to place the draft control means in running position, and means to terminate op-

eration of the ignition means, said ignition responsive means also responding to the burner flame to maintain operation of the fuel feed control means after the ignition means is rendered inoperative and the draft control means has been moved to running position.

17. In combination with a burner, a draft damper, control means for moving said damper to a wide open position, switching means moved to a new circuit controlling position when the draft damper reaches its wide open position, electrically operated fuel control means in control of the supply of fuel to the burner, a circuit operative to place the fuel control means in operation completed by said switching means when moved to said new circuit controlling position, circuit connections to maintain said fuel control means in operation after the same has been initially placed in operation, and means operative to move the damper away from its wide open position.

18. In a control system for a furnace having a draft damper and a fuel feeding means, control means responsive to heat conditions operative to move the draft damper to a wide open position when the heat condition falls to a predetermined value, means operative to place the fuel feeding means in operation when the draft damper reaches the wide open position, means for maintaining the fuel feeding means in operation even though the draft damper is subsequently moved away from its wide open position, and means for subsequently moving the draft damper away from its wide open position.

19. In a control system for a furnace having a draft damper and a fuel feeding means, control means for moving the draft damper to a wide open position, means for placing the fuel feeding means in operation when the draft damper reaches a wide open position, means for igniting the fuel supplied by the fuel feeding means, and means operative upon the successful establishment of combustion for moving the draft damper away from the wide open position.

20. In a control system for a furnace having a draft damper and a fuel feeding means, control means for moving the draft damper to a wide open position, means for placing the fuel feeding means in operation when the draft damper reaches a wide open position, means for igniting the fuel supplied by the fuel feeding means, means operative upon the successful establishment of combustion for moving the draft damper away from the wide open position, and means for maintaining the fuel feeding means in operation even though the draft damper is moved away from the wide open position.

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