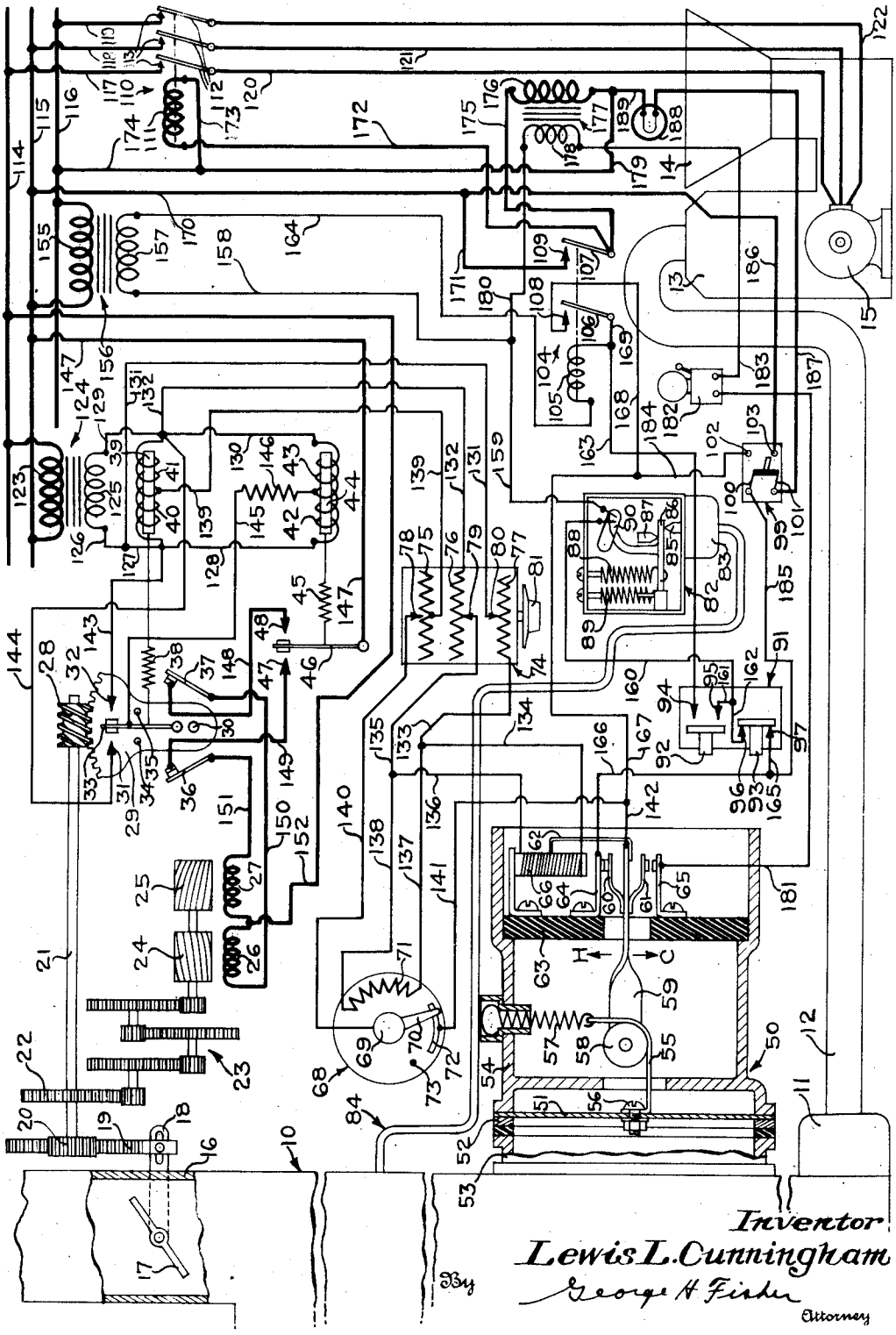
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COMBUSTION CONTROL SYSTEM

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COMBUSTION CONTROL SYSTEM

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4 Claims. (Cl. 177—311)

This invention relates to a combustion control system.

It is an object of this invention to provide a combustion control system wherein the draft through a boiler or furnace is varied in accordance with the fire temperature or furnace temperature.

Another object of this invention is to provide a combustion control system using a draft damper for regulating the draft through a furnace or a boiler wherein thermostatic means responsive to fire or furnace temperatures positions the draft damper so that a given draft may be provided for a given fire condition.

A further object of this invention is to provide a combustion control system of the type described above wherein means are provided for adjusting the controlling effect of the temperature responsive means whereby the draft damper may be adjusted to various positions for a given fire or furnace temperature.

Still another object of this invention is to provide a combustion control system of the class described above wherein means are provided for preventing automatic operation of the draft damper and for placing the draft damper under manual control.

Another object of this invention is to provide a combustion control system for a boiler having fuel supply means and draft regulating means wherein the fuel supply means and the draft regulating means are both controlled in accordance with fire temperature.

Still another object of this invention is to provide a combustion control system having safety devices and signal devices hooked up with a fuel feeding mechanism whereby safe operation of the fuel feeding mechanism is provided.

Other objects and advantages will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawing in which drawing there is diagrammatically illustrated the combustion control system of my invention.

My combustion control system, for purposes of illustration, is shown as being applied to a boiler generally designated at 10. Boiler 10 is shown as being provided with a fuel supply nozzle 11 of the powdered fuel type receiving powdered fuel through a pipe or conduit 12 from a pulverizer 13. The fuel is placed in a hopper 14 and is fed to the pulverizer 13 in a manner known in the art, and the pulverized fuel is then fed from the pulverizer 13 into the boiler 10 through the pipe 12. The pulverizer 13 may be operated by an electric motor designated at 15.

Boiler 10 is shown as being provided with a stack 16 and located in this stack 16 is a draft regulating means which may take the form of a draft damper 17. By positioning the draft damper 17 between its full open and its full closed positions, the draft through the boiler 10 may be accurately regulated. The draft damper 17 is operated by a lever 18 which is connected to a rack bar 19. The rack bar 19 is operated by a pinion 20 mounted on a shaft 21.

The shaft 21 may be operated by a proportioning motor of the type illustrated in my Patent No. 1,989,972 patented on February 5, 1935. For purposes of illustration in this application, I have shown the motor for operating the damper 17 to comprise a gear 22 mounted on the shaft 21 and driven through a reduction gear train 23 by motor rotors 24 and 25. The motor rotors 24 and 25 are operated respectively by field windings 26 and 27 and upon energization of the field winding 27 the draft damper 17 is moved towards a closed position, and upon energization of the field winding 26 the draft damper 17 is moved towards an open position. Also mounted on the shaft 21 is a worm gear 28 in operative engagement with a sector plate 29 pivoted at 30. The sector plate 29 carries contacts 31 and 32. Also carried by the sector plate 29 is a switch arm 33 adapted to engage either contact 31 or 32. The sector plate 29 also carries pins 34 and 35 which are adapted to engage with limit switches 36 and 37 respectively when the sector plate 29 is moved to either extreme position.

The switch arm 33 is operated through a spring 38 by a core or armature 39 which core is moved by oppositely acting coils 40 and 41. When the coil 40 is energized more than the coil 41, the armature 39 is moved to the left and consequently the switch arm 33 is moved into engagement with the contact 31. Likewise, when the coil 41 is energized more than the coil 40, the armature 39 is moved to the right and consequently the switch arm 33 is moved into engagement with the contact 32. Oppositely acting coils 42 and 43 control an armature or core 44 which is connected through a spring 45 to a pivoted switch arm 46. The switch arm 46 is adapted to engage contacts 47 and 48. When coil 42 is energized more than the coil 43, the switch arm 46 moves into engagement with the contact 47, and when the coil 43 is energized more than the coil 42, the switch arm 46 is moved into engagement with the contact 48.

This invention contemplates the use of a controller designated at 50, which responds to fire or furnace temperature and may take the form of the controller shown and described in my Patent No. 1,765,056 patented June 17, 1930. For purposes of illustration in this application I have shown this controller 50 to comprise a diaphragm 51 exposed to the fire within the boiler 10. The diaphragm 51 which may be of spring bronze, engages a ring 52 which may likewise be made of spring bronze and the diaphragm 51 and the ring 52 are clamped between the housings 53 and 54. The controller 50 is suitably secured to the wall of the boiler 10. Secured to the diaphragm 51 by means of a nut and screw arrangement 56, is one end of a ribbon 55. The other end of the ribbon 55 is secured to the housing 54 by means of an adjustable tension spring 57. The ribbon 55 passes over a roller 58 suitably mounted in the housing 54. The ribbon 55 may frictionally engage the roller 58 or it may be secured thereto in any suitable manner as by a pin. The roller 58 carries an arm 59 having contacts 60 and 61 and a slider 62 mounted on the outer end thereof. The arm 59 extends through an opening in an insulating base 63. The insulated base 63 carries contacts 64 and 65 cooperating with the contacts 60 and 61 respectively carried by the arm 59. The insulated base 63 also carries a resistance coil 66 across which the slider 62 is adapted to slide. Upon an increase in fire temperature in the boiler 10 the diaphragm 51 flexes towards the right to move the arm 59 in a counter-clockwise direction as shown by the arrow designated H. Upon a decrease in fire temperature the disc 51 flexes towards the left to move the arm 59 in a clockwise direction as shown by the arrow designated C. The contacts 60, 61, 64 and 65 are overlapping so that in certain positions of the arm 59 contact 60 engages contact 64 and contact 61 engages contact 65. It is therefore seen that when the fire temperature is relatively low, contact 61 is in engagement with contact 65 and the slider 62 is in a down position with respect to the coil 66. Upon an increase in fire temperature the slider 62 moves upwardly and the contact 60 moves into engagement with the contact 64. Upon a further increase in fire temperature the slider 62 continues to move upwardly and the contact 61 is moved out of engagement with the contact 65.

A manual control switch is designated generally at 68 and may comprise a knob or handle 69 for operating a slider 70. In one position of the slider 70 it engages an elongated "automatic" contact 72. In another position the slider 70 engages an "off" contact 73. In still another position the slider 70 engages a resistance coil 71 and is adapted to be manually positioned along this resistance coil 71.

A variable resistance is generally designated at 74 and comprises three resistances 75, 76 and 77. Slidably engaging these resistances 75, 76 and 77 are sliders 78, 79 and 80, respectively. The sliders 78, 79 and 80 are moved with respect to their resistance coils by rotation of a knob or handle 81.

A pressure controller is generally designated at 82 and may take the form of a controller shown and described in application, Serial No. 743,377, filed by S. C. Shipley on September 10, 1934, now Patent No. 2,080,836 of May 18, 1937. For purposes of illustration in this application the pressure controller 82 is shown to comprise a pressure bellows chamber 83 connected by a pipe 84 to a source of steam pressure within the boiler 10. Located in the bellows chamber 83 is a bellows which operates a plunger 85 which engages a lever 86. The lever 86 is pivoted on a knife edge 87 and is urged in a clockwise direction by means of an adjustable tension spring 88. The lever 86 carries a mercury switch 90. Upon an increase in pressure the lever 86 is moved in a counter-clockwise direction against the action of the tension spring 88 to move the mercury switch 90 to a "circuit-breaking" position. Upon a decrease in pressure the tension spring 88 moves the pivoted lever 86 in a clockwise direction to move the mercury switch 90 to a "circuit-making" position. The controller 82 is also provided with a differential spring arrangement 89 whereby the differential in pressure required to move the mercury switch 90 from a circuit-making to a circuit-breaking position and back again, may be varied.

A start and stop switch of usual design is designated at 91 and comprises a start button 92 and an off button 93. The start button when pressed inwardly is adapted to bridge contacts 94 and 95 and the stop button 93 when pushed inwardly is adapted to break contact between contacts 96 and 97.

A single throw double pole switch is designated at 99 and comprises switch arms 100 and 101 which are adapted to engage contacts 102 and 103 respectively.

A relay is generally designated at 104 and comprises a relay coil 105 which is connected in any suitable manner to switch arms 106 and 107. Upon energization of the relay coil 105, the switch arms 106 and 107 are moved into engagement with contacts 108 and 109. Upon de-energization of the relay coil 105, the switch arms 106 and 107 are moved out of engagement with the contacts 108 and 109 by means of springs or gravity or any other means, not shown.

A motor starter is diagrammatically designated at 110 and comprises a coil 111 operatively connected in any suitable manner to switch arms 112. The switch arms 112 are adapted to engage contacts 113 upon energization of the coil 111, and upon de-energization of the coil 111 the switch arms 112 are moved out of engagement with the contacts 113 in any suitable manner.

Line wires 114, 115 and 116 lead from some source of power, not shown. The contacts 113 of the motor starter are connected by wires 117, 118 and 119 to the line wires 114, 115 and 116, respectively. The switch arms 112 are connected by wires 120, 121 and 122 to motor 15 so that upon energization of the coil 111 of the motor starter 110 so as to move the switch arms 112 into engagement with the contacts 113, the motor 15 and consequently the pulverizer 13 are placed in operation and powdered fuel is fed to the boiler 10 through the nozzle 11 and pipe 12.

A primary 123 of a step-down transformer 124, having a secondary 125, is connected across the line wires 114 and 115. One end of the secondary 125 is connected by wires 126, 127 and 128 to the left hand ends of the coils 40 and 42. In a like manner the other end of the secondary 125 is connected by wires 129 and 130 to the right hand ends of the coils 41 and 43. The junction of wires 126 and 127 is connected by a wire 131 to the contact 80 of the variable resistance 74 and the junction of the wires 129 and 130 is connected by a wire 132 to one end of the resistance 76 of the variable resistance 74. One end of the resistance coil 77 is connected by wires 133 and 134 to the bottom end of the resistance coil 66 located in the controller 50. The

contact 79 of the variable resistance 74 is connected by wires 135 and 136 to the upper end of the resistance coil 66. The junction of wires 133 and 134 is connected by a wire 137 to one end of the resistance coil 71 and the junction of wires 135 and 136 is connected by a wire 138 to the other end of the resistance coil 71. The junction of the oppositely acting coils 40 and 41 is connected by a wire 139 to the center of the resistance coil 75. The contact 78 cooperating with the resistance coil 75 is connected by a wire 140 to the slider 70. The "automatic" contact 72 is connected by wires 141 and 142 to the arm 59 of the controller 50. The left hand end of the coil 40 is connected by a wire 143 to the contact 32 carried by the sector plate 29 and the right hand end of the coil 41 is in a like manner connected by a wire 144 to the contact 31 also carried by the sector plate 29. The switch arm 33 is connected by a wire 145 and a resistance 146 to the junction of the oppositely acting coils 42 and 43. The line wire 115 is connected by a wire 147 to the switch arm 46. The contact 48 cooperating with the switch arm 46 is connected by a wire 148 to the limit switch 37 and the contact 47 is likewise connected by a wire 149 to the limit switch 36. The limit switch 37 is also connected by a wire 150 to one end of the field winding 26 and the limit switch 36 is also connected by a wire 151 to one end of the field winding 27. Field windings 26 and 27 are connected together and to a wire 152 which extends to the line wire 114.

From the above wiring connections it is seen that the left hand ends of the secondary 125 and the coils 40 and 42 and the lower end of the resistance coil 66 are connected together and likewise the right hand ends of the secondary 125 and the coils 41 and 43 and the upper end of the resistance coil 66 are connected together. It is also seen that the junction of the coils 40 and 41 are connected to the slider 62 cooperating with the resistance coil 66. Therefore, the secondary 125, the oppositely acting coils 40, 41, 42 and 43 and the resistance coil 66 are connected in parallel.

With the parts in the position shown in the drawing the slider 62 is in engagement with the center of the resistance coil 66 as a result of a normal average fire temperature, the slider 70 is in engagement with the "automatic" contact 72 to position the parts for automatic operation, the variable resistance 74 is adjusted in a mid-position, the oppositely acting coils 40, 41, 42 and 43 are equally energized with the result that neither field winding 26 or 27 is energized and the draft damper 17 is in a mid position causing a normal average draft to exist within the boiler 10.

Upon an increase in fire temperature or furnace temperature, the slider 62 is moved upwardly with respect to the resistance coil 66. This causes shunting or circuiting of the coil 41 to decrease the energization thereof and increase the energization of the coil 40. Due to this unbalanced relationship of the coils 40 and 41, the switch arm 33 is moved into engagement with the contact 31. Movement of the switch arm 33 into engagement with the contact 31 completes a circuit from the secondary 125 through wires 126, 127, 128, coil 42, resistance 146, wire 145, switch arm 33, contact 31 and wires 144 and 129 back to the secondary 125. Completion of this circuit causes short-circuiting of the coil 43 to decrease the energization thereof and increase the energization of the coil 42. This causes movement of the switch arm 46 into engagement with the contact 47 to complete a circuit from the line wire 115, through wire 147, switch arm 46, contact 47, wire 149, limit switch 36, wire 151, field winding 27, and wire 152 back to the line wire 114. Completion of this circuit causes energization of the field winding 27 to operate the rotor 25 to move the damper 17 towards a closed position to retard the draft through the boiler 10. Movement of the damper 17 towards a closed position causes counter-clockwise movement of the sector plate 29. When the draft damper 17 has been moved sufficiently far towards a closed position as determined by the controller 50, the contact 31 carried by the sector plate 29 is moved out of engagement with the switch arm 33 to break the above described circuit through the coil 42 to cause equal energization of the oppositely acting coils 42 and 43. This balancing of the coils 42 and 43 causes movement of the switch arm 46 out of engagement with the contact 47 and into the mid-position shown in the drawing. This causes breaking of the circuit through the field winding 27 and consequently stops operation of the motor to maintain the draft damper 17 in its newly adjusted position.

Upon a decrease in fire or furnace temperature the slider 62 is moved downwardly with respect to the coil 66 which causes short-circuiting or shunting of the coil 40 to decrease the energization thereof and increase the energization of the coil 41. This causes movement of the switch arm 33 into engagement with the contact 32 to complete a circuit from the secondary 125 through wires 129 and 130, coil 43, resistance 146, wire 145, switch arm 33, contact 32, and wires 143, 127 and 126 back to the secondary 125. Completion of this circuit causes short-circuiting of the coil 42 to decrease the energization thereof and increase the energization of the coil 43. This causes movement of the switch arm 46 into engagement with the contact 48 to complete a circuit from the line wire 115 through wire 147, switch arm 46, contact 48, wire 148, limit switch 37, wire 150, field winding 26, and wire 152 back to the line wire 114. Completion of this circuit causes energization of the field winding 26 to operate the rotor 24 to move the draft damper 17 towards an open position. Movement of the draft damper 17 towards an open position causes clockwise movement of the sector plate 29. When the draft damper 17 has been moved sufficiently far towards an open position as determined by the temperature of the fire or furnace, the contact 32 is moved out of engagement with the contact arm 33, to cause breaking of the circuit through the coil 43 to cause equal energization of the coils 42 and 43. Switch arm 46 is thereby moved out of engagement with the contact 48 and to its mid-position as shown in the drawing which breaks the circuit through the field winding 26 and stops operation of the motor controlled thereby. Draft damper 17 is therefore maintained in its newly adjusted position.

If the draft damper 17 should be moved to its full closed position, the pin 34 causes opening of the limit switch 36 to prevent further closing movement of the damper 17. In a like manner, when the draft damper 17 is moved to its full open position, the pin 35 opens the limit switch 37 to prevent further opening movement of the

draft damper 17. In this manner over-travel of the damper 17 is prevented.

The above operation assumes that the variable resistance 74 is adjusted to its mid-position. Assume that the sliders 78, 79 and 80 are moved to the right with respect to their coils 75, 76 and 77, more resistance is placed in circuit with the coil 40 and less resistance is placed in circuit with the coil 41. This has the same effect as moving the slider 62 upwardly with respect to the coil 66 to increase the energization of the coil 40 and decrease the energization of the coil 41, which causes movement of the damper 17 towards a closed position. Therefore, by moving the sliders 78, 79 and 80 towards the right with the slider 62 in a given position with respect to its resistance coil 66, the damper 17 is moved towards a closed position. Likewise, when the sliders 78, 79 and 80 are moved toward the left, more resistance is placed in circuit with the coil 41 and less resistance is placed in circuit with the coil 40, which produces the same effect as if the slider 62 were moved downwardly with respect to its coil 66. This increases the energization of the coil 41 and decreases the energization of the coil 40 to move the damper 17 towards an open position. Therefore with the slider 62 located in a given position with respect to its coil 66, movement of the contacts 78, 79 and 80 towards the left causes opening movement of the damper 17. Movement of contact 78 in either direction with respect to its resistance 75 adds resistance to the circuits through both of the coils 40 and 41 so that in case the sliders 79 and 80 are moved to either extreme position, burning out of the coils 40 and 41 is prevented. In this manner manual means are provided for adjusting the controlling action of the controller 50 with respect to damper 17 so that the damper 17 may be positioned in a given number of different positions when the fire or furnace temperature is at a given value. This provides an easy means for calibrating this portion of the control system.

The above detailed operation was set forth on the assumption that the slider 70 was in engagement with the "automatic" contact 72. Movement of the slider 70 out of engagement with the "automatic" contact 72 breaks the circuit through the slider 62 to prevent operation of the damper 17 by the controller 50. Since the lower end of the resistance coil 71 is connected to the lower end of the resistance coil 66 and the upper end of the coil 71 is connected to the upper end of the coil 66, movement of the slider 70 out of engagement with the contact 72 and into engagement with the resistance coil 71, takes the control of the damper 17 away from the controller 50 and places it under the control of the manual control switch 68. Since the corresponding ends of the coils 71 and 66 are connected together, movement of the slider 70 upwardly with respect to the coil 71, causes closing movement of the damper 17 in the manner above described and movement of the slider 70 downwardly with respect to the resistance coil 71 causes opening movement of the draft damper 17 in exactly the same manner as pointed out above. Movement of slider 70 out of engagement with the resistance coil 71, and out of engagement with the "automatic" contact 72, and into engagement with "off" contact 73, prevents control of the draft damper 17 by either the automatic controller 50 or the manual controller 68. Therefore, manually operable means are provided for rendering the automatic control of the draft damper 17 inoperative, for placing the control of the damper 17 under manual control or for preventing either automatic or manual control of the draft damper 17.

A primary 155 of a step-down transformer 156, having a secondary 157, is connected across the line wires 115 and 116, one end of the secondary 157 is connected by wires 158 and 159 to one of the electrodes of the mercury switch 90 of the pressure controller 82. The other electrode of the mercury switch 90 is connected by wires 160, 161 and 162 to the contacts 95 and 96 of the start and stop switch 91. The start contact 94 is connected by a wire 163 to one end of the relay coil 105. The other end of the relay coil 105 is connected by a wire 164 to the other end of a secondary 157. Stop contact 97 is connected by wires 165 and 166 to the stationary contact 64 of the controller 50. The junction of wire 142 and 141 is connected by wires 167 and 168 to the contact 108 of the relay 104. Switch arm 106 associated with the contact 108 is connected by a wire 169 to the junction of wire 163 and the relay coil 105.

Movement of the start button 92 into engagement with the start contacts 94 and 95 completes a circuit from the secondary 157 through wires 158 and 159, mercury switch 90, wires 160 and 161, contact 95, start button 92, contact 94, wire 163, relay coil 105 and wire 164 back to the secondary 157. Completion of this circuit causes energization of the relay coil 105 to move the switch arms 106 and 107 into engagement with their contacts 108 and 109. Movement of the switch arm 106 into engagement with the contact 108 completes a maintaining circuit from the secondary 157 through wires 158 and 159, mercury switch 90, wires 160 and 162, contact 96, stop button 93, contact 97, wires 165 and 166, contacts 64 and 60, arm 59, wires 142, 167 and 168, contact 108, switch arm 106, wire 169, relay coil 105 and wire 164, back to the secondary 157. This maintaining circuit maintains the relay coil 105 energized regardless of the position of the start button 92. However, included in this maintaining circuit is the pressure controller 82, the contacts 60 and 64 of the controller 50 and the stop button 93 of the start and stop switch 91. If the boiler pressure should become too high so as to move the mercury switch 90 to a "circuit breaking" position, or if the fire or furnace temperature should decrease below a given value so as to move the contact 60 out of engagement with the contact 64, or if the stop button 93 should be pressed to break contact between the contacts 96 and 97, the maintaining circuit through the relay coil 105 would be broken to cause de-energization of the same to move the switch arms 106 and 107 out of engagement with the contacts 108 and 109. Since the starting circuit for the relay coil 105 is completed through the starting button 92, start button 92 must again be moved into engagement with the start contacts 94 and 95 to again cause energization of the relay coil 105. Therefore, the relay coil 105 may only be initially energized upon manipulation of the start button 92 and will only be maintained in an energized condition when the boiler pressure is normal and when the condition of the fire is normal.

The contact 109 of the relay 104 is connected by wires 170 and 171 to the line wire 115. The switch arm 107 cooperating with the contact 109 is connected by a wire 172 to one end of the coil

111 of the motor starter 110. The other end of the coil 111 is connected by wires 173 and 174 to the line wire 116. Therefore, upon energization of the relay coil 105 in the manner above described, to move the switch arm 107 into engagement with the contact 109, the coil 111 is energized to move the switch arms 112 into engagement with contacts 113 to cause operation of the motor 15 and the fuel pulverizer 13 to supply fuel to the boiler 10.

The switch arm 107 is connected by a wire 175 to one end of a primary 176 of a step-down transformer 177, having a secondary 178. The other end of the primary 176 is connected by a wire 179 to the junction of wires 173 and 174. Therefore, when the relay coil 105 is energized to move the switch arm 107 into engagement with the contact 109, the transformer 177 is energized simultaneously with the motor starter 110. One end of the secondary 178 is connected by a wire 180 to the junction of wires 158 and 159. The stationary contact 65 of the controller 50 is connected by a wire 181 to an indicating device 182 which may take the form of an alarm or bell of usual design. The indicating device 182 is connected by a wire 183 to the other end of the secondary 178. When the fire temperature decreases to a given value so as to cause simultaneous engagement of overlapping contacts 60, 64 and 61 and 65, a circuit is completed from the secondary 178 through wires 180 and 159, mercury switch 90, wires 160 and 162, contact 96, stop button 93, contact 97, wires 165 and 166, contacts 64, 60, 61 and 65, wire 181, alarm 182 and wire 183 back to the secondary 178. Completion of this circuit causes sounding of the alarm 182 to notify the attendant in charge of the combustion control system that the condition of the fire within the boiler 10 is abnormal.

Summarizing briefly that portion of the combustion control system relating to the fuel feeding mechanism, when the fire within the boiler 10 is extinguished, the arm 59 is in a down position whereby contacts 60 and 64 are broken and contacts 61 and 65 are made. To start operation of the fuel supplying means, start button 92 is pressed inwardly to complete the above referred to starting circuit which causes starting of the fuel pulverizer 13 with consequent delivery of pulverized fuel from the boiler 10. This pulverized fuel is ignited in any suitable manner, not shown, and from that point the fire temperature will tend to increase. An increase in fire temperature causes upward movement of arm 59 to move the contact into engagement with the contact 64, it being remembered that the contact 61 is still in engagement with the contact 65. Therefore, when the contact 60 moves into engagement with the contact 64, the circuit through the alarm is completed and the alarm is sounded to notify the engineer in charge of the combustion control system that contact has been established between the contacts 60 and 64. The engineer in response to this alarm releases the start button 92 and since the contact between the contacts 60 and 64 is established, the maintaining circuit is completed to maintain the fuel feeding means in operation. Continued rise in fire temperature causes positioning of the draft damper 17. If by reason of clogging of the nozzle 11 or by any other reason, the fire within the boiler 10 should decrease through a predetermined low value, the arm 59 is moved downwardly to make contact between the contacts 61 and 65 to sound the alarm 182 to notify the engineer of faulty operation of the fuel feeding means. If the faulty operation is not corrected, the arm 59 continues to move downwardly to break contact between the contacts 60 and 64 to break the above referred to maintaining circuit to shut down the fuel feeding means, which can only be started again after manual manipulation of the start button 92.

The contact 102 of the single throw double pole manual switch 99 is connected by a wire 184 to the junction of wires 167 and 168. The switch arm 100 is connected by a wire 185 to the junction of wires 165 and 166. By reason of these connections it is seen that the manual switch 99 is connected in parallel with the contacts 60 and 64 so that when the switch arm 100 is moved into engagement with the contact 102, the contacts 60 and 64 are rendered inoperative to control the fuel pulverizer 13. In this manner the safety function of the controller 50 may be eliminated. As a safeguard to notify the engineer in charge that the safety function of the controller 50 is rendered inoperative, the switch arm 101 is connected by a wire 187 to a light 188 which in turn is connected by a wire 189 to the junction of wire 179 and the primary 176. The contact 103 cooperating with the switch arm 101 is connected by a wire 186 to the junction of wires 170 and 171. By reason of these connections when the switch arm 100 is moved into engagement with contact 102 to render the safety function of the controller 50 inoperative, the light 188 is lit to notify the engineer of this fact.

From the above it is seen that I have invented a novel combustion control system wherein a draft regulating means is positioned in accordance with fire or furnace temperatures, wherein a fuel supplying means is manually placed in operation and is under the control of safety devices so that if the fire should assume an abnormal condition or if the boiler pressure should exceed a given amount, the fuel supplying means will be rendered inoperative, wherein the draft regulating means may be adjustably positioned with respect to the fire or furnace temperature, wherein means are provided for rendering the automatic control means for the draft regulating means inoperative and placing the draft regulating means under manual control, and wherein an alarm system is provided for notifying the engineer when the condition of the fire is abnormal.

Although for purposes of illustration I have disclosed one form of my invention, changes and modifications thereof may become apparent to those skilled in the art, and consequently the scope of this invention is to be limited only by the scope of the appended claims and prior art.

I claim as my invention:

1. In a combustion control system, in combination, means forming a combustion chamber, means for supplying fuel to said combustion chamber, means comprising a manually depressible switch device for initiating operation of said fuel supplying means, said switch being closed only when held in depressed position, means responsive to a condition indicative of the presence of combustion in the combustion chamber, said last means being operable to cause continued operation of said fuel supplying means independently of said switch when proper combustion occurs in the combustion chamber, signal means for automatically indicating when operation of said fuel supplying means is independent of said switch whereby upon starting of the system the

presence of a human operative is required until proper combustion is assured by the signal whereupon the manually depressible switch may be released.

2. In a combustion control system, in combination, means forming a combustion chamber, means for supplying fuel to said combustion chamber, means comprising a manually depressible switch device for initiating operation of said fuel supplying means, said switch being closed only when held in depressed position, means responsive to a condition indicative of the presence of combustion in the combustion chamber, said last means being operable to cause continued operation of said fuel supplying means independently of said switch when proper combustion occurs in the combustion chamber, signal means for automatically indicating when operation of said fuel supplying means is independent of said switch whereby an operative may then release the switch, and said condition responsive means comprising means operative upon an increase of combustion to terminate the signal given by said signal means whereby the operative is apprised of the establishment of combustion and of the satisfactory progress of combustion thereafter.

3. In a combustion control system, in combination, means forming a combustion chamber, means for supplying fuel to said combustion chamber, means comprising a manually depressible switch device for initiating operation of said fuel supplying means, said switch being closed only when held in depressed position, means responsive to a condition indicative of the presence of combustion in the combustion chamber, said last means being operable to cause continued operation of said fuel supplying means independently of said switch when proper combustion occurs in the combustion chamber, signal means for automatically indicating when operation of said fuel supplying means is independent of said switch whereby an operative may then release the switch, and said condition responsive means comprising means operative upon an increase of combustion to terminate the signal given by said signal means whereby the operative is apprised of the establishment of combustion and of the satisfactory progress of combustion thereafter, and said condition responsive means being arranged to cause said signal means to give a signal and to terminate said signal to indicate substantial termination of combustion in said combustion chamber.

4. In a combustion control system, in combination, means forming a combustion chamber, means for supplying fuel to said combustion chamber, draft regulating means for said combustion chamber, means comprising a manually depressible switch device for initiating operation of said fuel supplying means, said switch being closed only when held in depressed position, means responsive to the fire condition in said combustion chamber, said last means being operable to cause continued operation of said fuel supplying means independently of said switch when proper combustion occurs in the combustion chamber whereby said switch may be released, said condition responsive means including means operable to assume control of the draft regulating means when operation of said fuel supplying means becomes independent of said switch, signal means for automatically indicating when operation of said fuel supplying means is independent of said switch and said condition responsive means is controlling said draft regulating means, said condition responsive means causing the signal given by said signal means to be terminated after an increase in combustion in said combustion chamber, said condition responsive means relinquishing control of said draft regulating means substantially upon the termination of combustion, and said condition responsive means causing said signal means to indicate when said condition responsive means relinquishes control of said draft regulating means.

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