April 22, 1924. 1,491,157

R. F. METCALFE.

METHOD OF CONTROLLING BURNERS AND APPARATUS THEREFOR

Filed Oct. 2, 1922 5 Sheets-Sheet 1

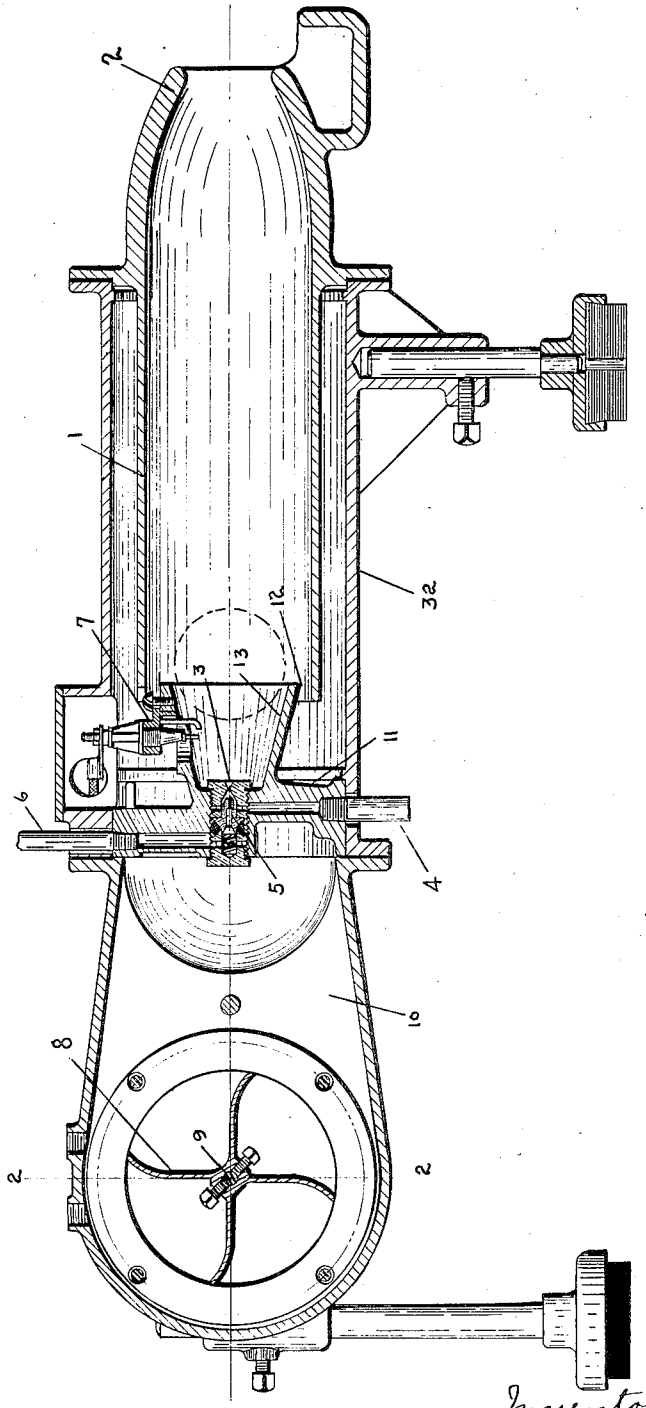


FIG. 1

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Filed Oct. 2 1922 5 Sheets-Sheet 2

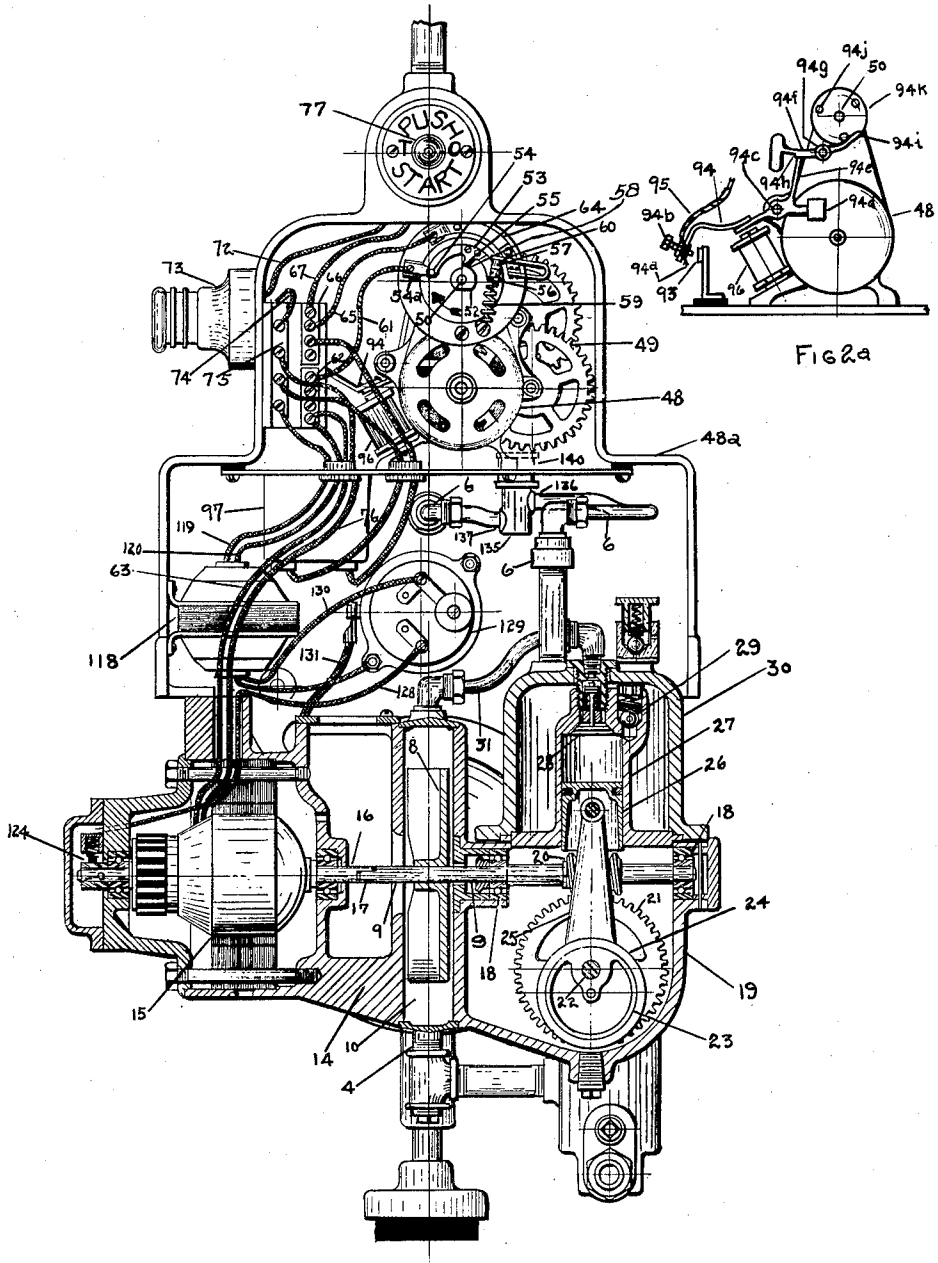


Fig 2a

Fig 2

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METHOD OF CONTROLLING BURNERS AND APPARATUS THEREFOR

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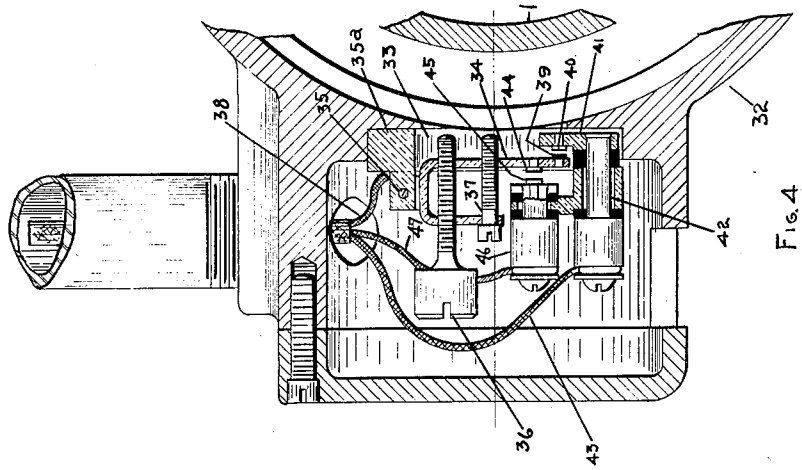


Fig. 4

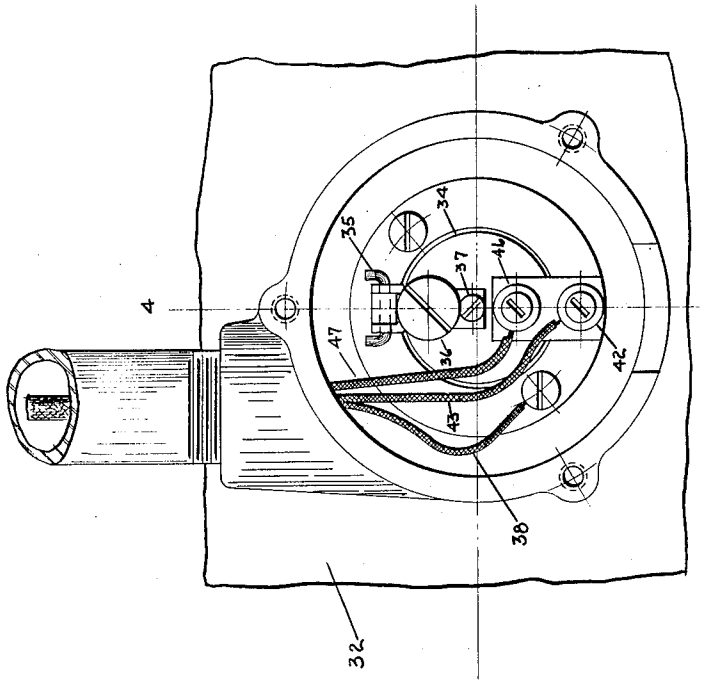


Fig. 3.

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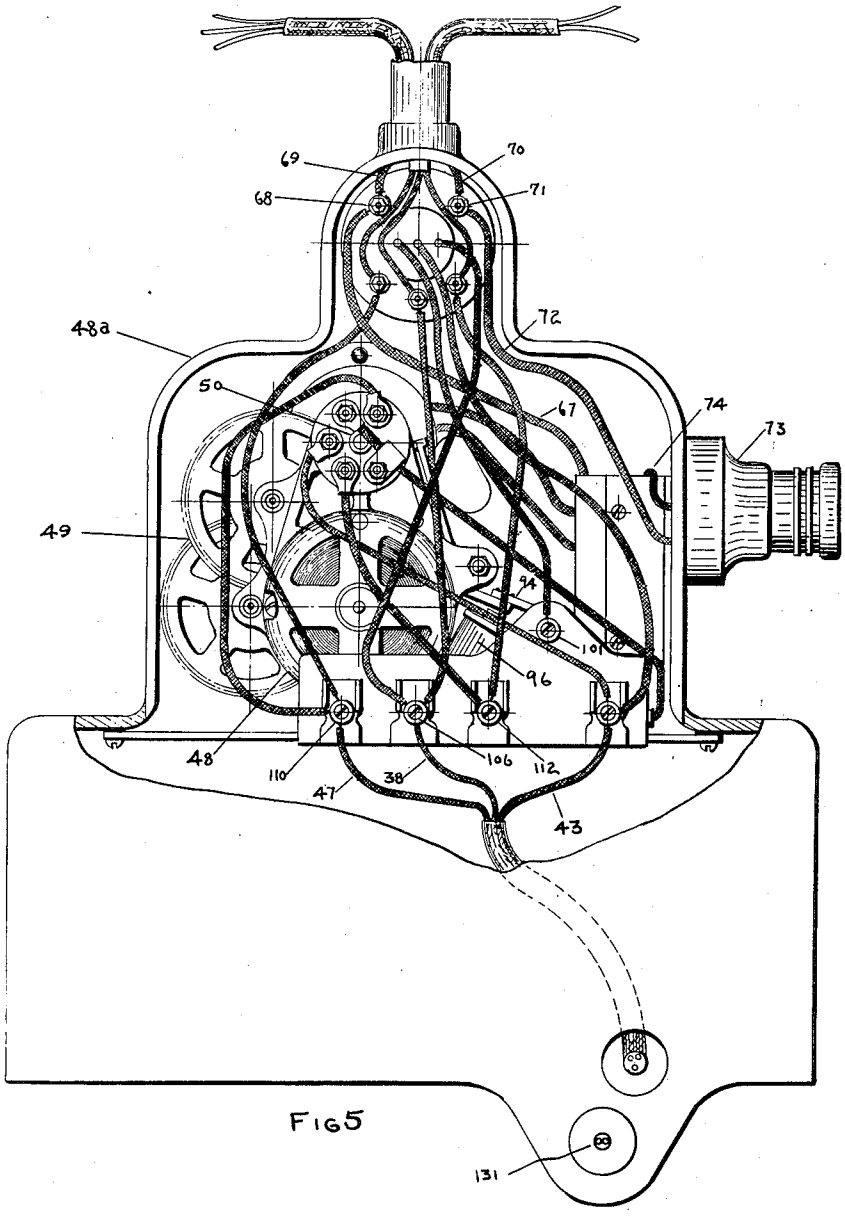


FIG5

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METHOD OF CONTROLLING BURNERS AND APPARATUS THEREFOR

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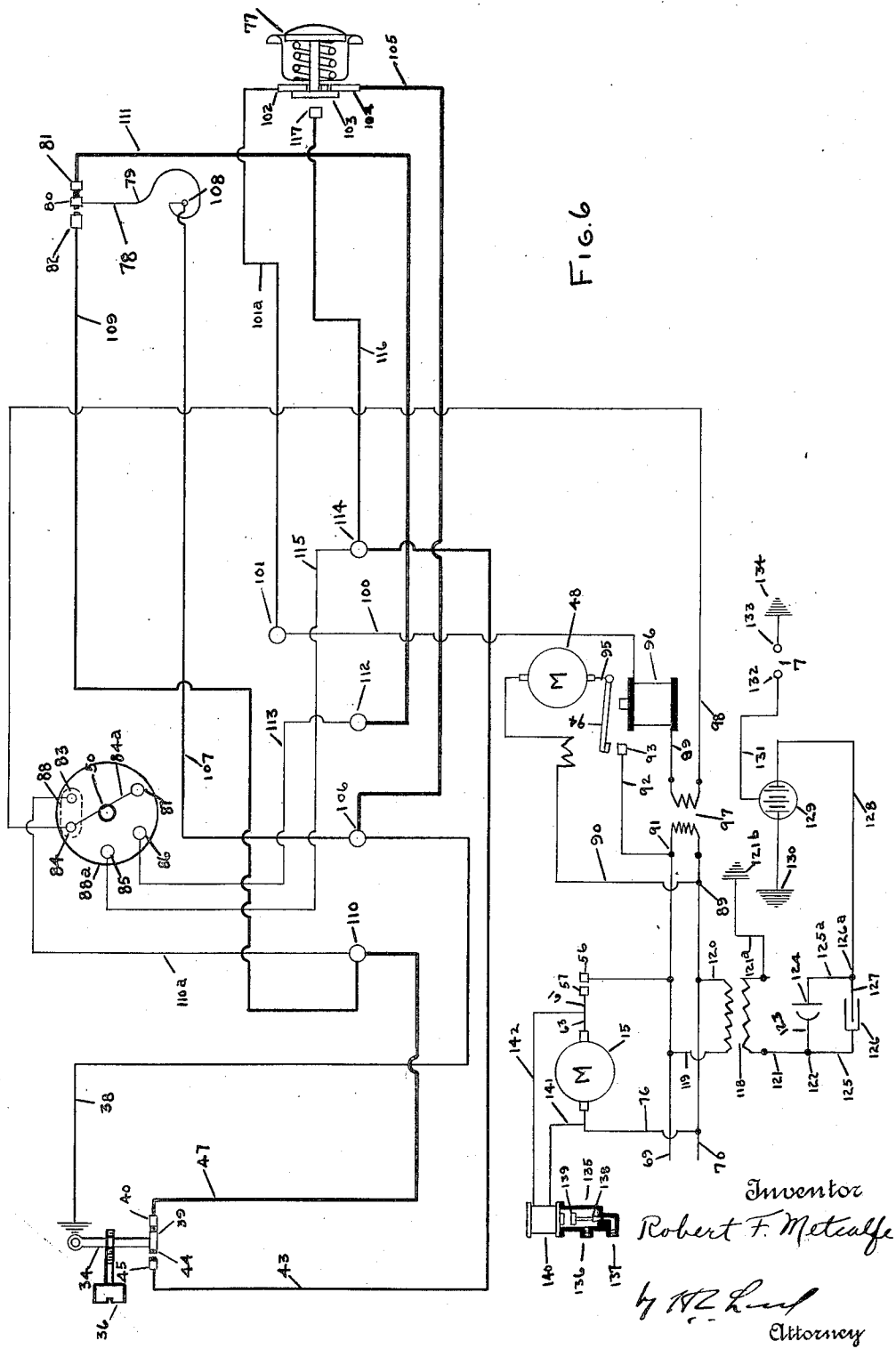


FIG. 6

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Patented Apr. 22, 1924. 1,491,157

UNITED STATES PATENT OFFICE.

ROBERT F. METCALFE, OF ERIE, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO SOCONY BURNER CORPORATION, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

METHOD OF CONTROLLING BURNERS AND APPARATUS THEREFOR.

Application filed October 2, 1922. Serial No. 591,768.

To all whom it may concern:

Be it known that I, ROBERT F. METCALFE, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in Methods of Controlling Burners and Apparatus Therefor, of which the following is a specification.

This invention is designed to provide a method and means for automatically shutting off the burner when the burner fails for any reason. It is of particular advantage in connection with liquid fuel burners in which the motors are used for introducing the fuel and air for combustion to the burner. It is further of advantage in connection with automatic controls for such a burner. The invention is, therefore, exemplified with a power-actuated burner and thermostatic control, the burner motor being controlled by a controlling motor to make its action more complete. Other features of the invention will appear from the specification and claims.

The apparatus forming the subject matter of the invention and with which the method may be practiced is illustrated as follows:—

Fig. 1 shows a central sectional view through the burner.

Fig. 2 a section of the burner operating mechanism, the section being along on the line 2—2 in Fig. 1.

Fig. 2ª a detail view of the control motor controlling switch.

Fig. 3 an elevation of the burner control safety switch.

Fig. 4 a section on the line 4—4 in Fig. 3.

Fig. 5 a rear view of the controlling motor and its connections.

Fig. 6 a diagram of the wires.

1 marks the burner chamber. This has a confined nozzle 2. 3 marks the fuel jet, 4 the supply passage leading to the fuel jet, and 5 the air jet by which the fuel is sprayed and drawn to the fuel jet. The air under pressure is conveyed through a pipe 6. Ignition is accomplished by the use of a spark plug 7. Added air for combustion is delivered through the action of a fan 8 which is fixed on a shaft 9. A passage 10 connects the fan with the rear end of the burner, the air passing by a spider 11 through a space 12 around the ignition cone 13. There is a preliminary combustion of rich mixture at the center of the burner which is enveloped by the air entering at 12 and a very rapid intense combustion at the issuance of the nozzle 2. These particular features do not form a part of the invention of this application except as they may be connected with the features hereinafter described. The fan is carried in a frame 14 on which the driving motor 15 is mounted, the motor shaft 16 being connected by a coupling 17 with the shaft 9. The shaft 9 is carried in bearings 18 in a frame extension 19. A worm 20 on the shaft 9 operates in a worm gear 21 arranged on a shaft 22. An eccentric 23 is fixed on the shaft 22. A strap 24 operates on the eccentric. A connecting rod 25 extends from the strap to the piston 26 of the air pump. The piston operates in a cylinder 27. The cylinder has an inlet valve 28 and a discharge valve 29 and discharges to a receiver 30 arranged over the cylinder. A pipe 31 leads from the fan chamber to the inlet valve 28 so that it retains air from the same source as the fan if desired. The pipe 6 leads from the receiver 30. A shell 32 is arranged around the burner 1 forming an air space. This air space, however, is in communication with the burner and subjected to its variations in pressure. An opening 33 (see dotted lines in Fig. 1 and Figs. 3 and 4) leads from this air space and is closed by a swinging plate 34. The plate 34 is hinged at 35 in a fitting 35ª. The plate is provided with an adjustable weight 36 in the form of an enlarged head of a screw which is screwed through the plate. The screw is locked in adjustment by a second screw 37 which springs the part of the plate through which the screw 36 extends. A wire 38 leads to a fitting 35ª and consequently to the plate 34. A contact point 39 is carried by the plate 34 and operates in connection with a contact 40 carried by a plate 41 on a post 42, the post 42 being supported by but insulated from the fitting 35ª. A wire 43 extends from the post 42. A contact point 44 is also carried by the plate 35 and is adapted to swing into contact with the point 45 on a post 46, the post being mounted on but insulated from the fitting 35ª. A wire 47 extends from the post 46.

This safety device simply exemplifies a

form of safety device which will respond to a failure of the burner. If when the burner motor starts there is a failure of ignition the pressure on the swinging plate 34 will not be sufficient to carry the point 39 out of contact with the point 40 and through a controlling motor controlling the controlling apparatus hereinafter described the burner motor will be shut down after a fixed interval. If, however, there is a proper ignition the expansion due to temperature in the burner creates a decided back pressure which communicated to the plate 34 swings the point 39 out of contact with the point 40 and the contact 39 into contact with the point 45 which position will so operate on the controlling apparatus as to permit a continuation of the operation of the burner motor.

A controlling motor 48 is mounted in a case 48ª supported on the frame 14. It drives a series of gears 49 which drive the switch shaft 50. A cam 52 is fixed on the shaft 50. A switch arm 53 is hinged at 54 on a plate 54ª supported by but insulated from the frame. This has a riding wheel 55 which rides on the cam 52. A contact point 56 is carried by the switch arm 53 and is adapted to be brought into contact with a point 57 when the cam roller 55 is on a raised portion 58 of the cam 52. The point 57 is carried by a spring arm 60 and a spring 59 operates on the arm 53 and tends to separate the points 56 and 57 when the roller 55 drops for the raise 58 of the cam. A wire 61 leads from the plate 54ª to a plate 62. A wire 63 leads from the plate 62 to the motor 15. The spring support 60 is mounted on a conductor plate 64. A wire 65 leads from the plate 64 to a plate 66 and a wire 67 leads from the plate 66 to a post 68. The line wire 69 connects the post 68. The other line wire 70 leads to a post 71. A wire 72 leads from the post 71 to a fuse block 73. A wire 74 leads from the fuse block to a plate 75 and a wire 76 leads from the plate 75 to the other wire of the motor 15. It will readily be seen, therefore, that when the points 56 and 57 are open the motor is stopped. When these points are together current is on the motor so as to drive the fan and air pump.

The wiring can be better understood from an observation of the diagram in Fig. 6 from which the purpose of the connections on the regular apparatus will be readily apparent. In order to operate the controlling motor so as to control the burner motor there are three points of control. First, the safety switch which we have described which responds to different pressures in the burner and consequently takes care of a failure at the burner. A switch operated by a thermostat so as to automatically control the temperature of whatever may be heated by the pressure, and a manually controlled switch which must be operated in order to start the apparatus after there has been a failure and a stoppage through the action of the safety switch. The manually operated device is taken care of by a push button switch 77. The thermostat is indicated at 78 and the safety switch has the plate 34 shown diagrammatically and the contacts 39, 40 and 44 indicated.

The thermostat operates the thermally movable sensitive element 79 carrying the movable point 80 of the switch. It operates against a point 81 when the thermostat is subjected to cold temperature and this is commonly called the cold side and contacts a point 82 when the thermostat is subjected to a warmer temperature and this is ordinarily referred to as the warm side.

A series of contact posts 83, 84, 85, 86 and 87 are grouped around the switch shaft 50 and are in position to be wiped and bridged by a bridge 88 which bridge is carried on a stop disc 88ª on the shaft. With the bridge over the posts 83 and 84 the controlling apparatus is so set as to continue the operation of the burner motor. When the bridge is over the posts 86 and 87 the apparatus is in position to stop or open the circuit through the burner motor. Otherwise this is the normal stopped position. When the bridge is crossing the posts 84 and 85 this will stop the burner motor and may be termed the emergency stop position. The stoppage here takes place only when there is a failure of ignition and an operation of the safety switch. To start the motor again requires the operation of the push button 77.

The line wire 70 leads to a post 89 from which a wire 90 leads to the control motor 48. The wire 69 leads to a post 91 from which a wire 92 leads to a contact post 93 of a magnetic switch, the switch being provided with the usual swinging arm 94 which is connected by a wire 95 with the motor 48. A coil 96 controls the arm 94.

A transformer 97 is provided, a wire 98 in the low tension side running directly to the post 84 of the control switch. The other side has a wire 99 running to the coil 96, from the coil 96 by a wire 100 to a post 101, from the post 101 by a wire 101ª to a contact plate 102 forming one side of the switch controlled by the push button 77. A bridge 103 operates on the plate 102 and a plate 104. A wire 105 leads from the plate 104 to a post 106. A wire 107 extends from the post 106 to a post 108 which is connected with the movable element 79 of the thermostat. A wire 109 leads from the plate 82 at the warm side of the thermostatic switch to a post 110 and the wire 47 leads to this post. A wire 110ª leads from the post 110 to the post 83 of the controlling switch. A wire 111

leads from the plate 81 at the cold side of the thermostatic switch to a post 112 and a wire 113 leads from the post 112 to the post 86 of the control switch. The wire 43 leads to a post 114. A wire 115 leads from the post 114 to the post 85 of the control switch. A wire 116 also leads from the post 114 to a contact plate 117 adapted to be connected with the bridge plate 103 while the stem of the push button remains in contact with the plate 102 thus bridging the wires 101^a and 116. A wire 84^a permanently bridges the posts 84 and 87.

In order to lock the switch 93—94 in closed position as the stop disc 88^a rotates bringing the bridge plate from one set of contacts to another I provide the following mechanism:—The switch arm 94 is provided with an insulated block 94^a through which the contact screw 94^b extends forming the immediate contact with the point 93. The flexible wire 95 extends from the screw 94^b. The arm 94 is pivoted at 94^c and is provided with a weight 94^d which throws the switch open when the circuit through the coil 96 is broken. The arm 94 has a catch extension 94^e. A catch lever 94^f is pivoted at 94^g on the frame and carries a catch shoulder 94^h which is adapted to swing down back of the extension 94^e when the arm 94 is drawn down by the magnetic coil. The lever 94^f has a cam extension 94^i which is in the path of studs 94^j carried by a disc 94^k, the disc 94^k being mounted on the switch shaft 50. The lugs 94^j are so positioned as to lift the lever 94^f out of engaging position when the switch plate 88 is in position to bridge the contacts 83—84, or the contacts 84—85, or the contacts 86—87. At all other positions the lever is released from the pins 94^j and drops under the influence of the weight of the lever in position to lock the switch lever in closed position providing it has been brought to closed position, the lever freely permitting the closing movement of the lever 94 to take place at any time.

The operation of the controlling apparatus through these controlling circuits is as follows:—As shown the control shaft is stopped with the bridge plate 88 bridging the posts 83 and 84 and this is in the normal running position, in other words, the control motor is at what may be termed the running position. Under these conditions the thermostatic switch would either be closed on the cold side or be in an intermediate position. As shown it is on the cold side and the safety switch 34 initially would be swung outwardly under the pressure of the flame closing the points 44 and 45. Under these conditions following the circuit through the magnetic switch coil 96 we find that this circuit is open and consequently the switch 93—94 open and the controlling motor closed. Tracing this circuit the wire 99—98 leads to the contact 94, across the bridge 88, post 83, by the wire 110^a to the post 110, by the wire 109 to the warm side of the thermostat where we find the points 82 and 80 separated and consequently a break in the circuit. Under these conditions also the contacts 44—45 are closed under pressure from the burner and there is a break between the points 39—40 so that there is nothing at the safety switch that will change this condition. If anything, however, should happen to the burner such as failure in ignition, or failure in fuel immediately the pressure incident to the burning gas in the burner would be relieved and the safety switch would reverse due to the weight bringing the points 39—40 together. Following the circuit thus established through the magnetic coil 96 the wire 99—98 leads to the point 34, by the bridge 88 to the point 83, by the wire 110^a to the post 110, by the wire 47 through the points 40—39, by the swinging plate 34, wire 38 to the post 106, by the wire 105 past the push button switch by way of the point 104, bridge plate 103 and point 107, thence by the wire 104^a to the wire 101^a to the post 101, thence by the wire 100 to the coil 96. It will be seen, therefore, that the magnetic switch will be immediately closed and the controlling motor is started advancing the switch plate 88 counter-clockwise. Immediately this starts as before stated the lever 94 being in its lower position the catch lever 94^f locks the lever 94 in closed position until the bridge plate 88 bridges the contacts 84—85. At this point the lock lever 94^f is lifted by the pin 94^j and if the other conditions remain the same permits the opening of the controlling switch 93—94. That this is so is evident by following the line through the controlling coil 96 of the magnetic switch. The wire 99—98 will lead to the post 84, by the bridge 88 to the post 85, by the wire 115 to the post 114, by the wire 43 to the point 45, the switch 45—44 being open. This opening breaking the circuit the magnetic switch is opened and the controlling motor stops with the bridge plate 88 bridging the posts 85—84 and remains in that position until the apparatus is started by a manual operation of the push button 77. With the push button moved inwardly so as to bring the plate 103 into contact with the point 117 a circuit is established through the coil 96 as follows: By the wire 99—98 to the point 84, by the bridge plate 88 to the point 85, by the wire 115 to the post 114, by the wire 116, point 117, bridge plate 103, stem of the push button, plate 102, wire 101^a, post 101, wire 100 to the coil. The controlling switch, therefore, is immediately

closed by a movement of the push button and as soon as the control motor starts the lock lever operates and locks the switch 93—94 in closed position until it reaches a position over the points 86—87. When the plate reaches this position it will stop at this position, or continue to running position depending on the condition of the thermostatic switch. It will be understood that with the switch plate 88 over the posts 84—85, or over the posts 86—87, the points 56—57 are separated and the burner motor has been stopped.

If the thermostat is at the cold side a circuit will be established through the coil 96 of the magnetic switch so as to hold this switch in closed position through the influence of the coil and the controlling motor will continue. Following this circuit it will be seen that it will pass from the coil 96 by the wire 99—98, post 84, bridge wire 84ª, post 87, bridge plate 88, post 86, wire 113 to the post 112, wire 111 to the point 81, across to the point 80 by way of the thermal element 79, terminal mounting of the thermal element 108, wire 107 to the post 106 by wire 105, and with the pressure on the push button released by way of the plates 104, 103, 102, wire 101ª, post 101, wire 100 to the coil. If the push button is retained in depressed position then, of course, the bridge plate will remain stationary on the posts 86—87 until the release of the push button. If, however, the thermostatic movable element 79 has the switch point 80 away from the cold side, or on the warm side, then the circuit will be broken with the plate 88 on the posts 86—87 and then will remain in the stopped position until the reversal of the thermostatic element. That this is evident will be seen by following the circuit from the controlling coil 96 to the wire 99—98, post 84, bridge wire 84ª, post 87, bridge plate 88, post 86, wire 113, post 112, wire 111 to the point 81 where there will be a break in the circuit and this break will continue until the point 80 is brought to the cold side and in contact with the point 81. If, however, the point 80 is brought to the warm side so that this circuit is closed and the controlling motor is started by the closing of the circuit just traced the contact between the points 56—57 is made by the cam 52 with the initial movement away from the posts 86—87 and the burner motor is started. The controlling motor has the usual retarding device so that by the time the plate 88 reaches a position to bridge the points 83—84 there will have been a sufficient interval for the burner to start and the expansion due to the burning gases to have acted on the safety switch to close the points 44—45. If due to the failure of ignition a circuit is established through the coil 96 of the magnetic switch by way of the points 39—40 it will continue the operation of the controlling motor to run it over to the safety stop position over the posts 84—85. That this is so is evident by tracing the circuits through the coil 96 by way of the wire 99—98 to the post 84, by plate 88, post 83, wire 110ª, point 40, point 39, safety switch plate 34, wire 38, post 106, wire 105, plates 104, 103, 102, wire 101ª, post 101, and wire 100 to the coil. Under these conditions the controlling motor switch will remain closed and the plate 88 will be brought forward, the locking lever immediately operating and locking it in position until the plate bridges the contact 84—85 where the locking lever is released and the circuit through the coil 96 being broken the controlling switch 93—94 controlling the motor is stopped and the points 57—56 being open at this position the burner motor is stopped. That this is true will be seen by following the circuit from the coil 96 by way of the wires 99—98, post 84, plate 88, post 85, wire 115, post 114, wire 43, point 45 where there is a break in the circuit between the point 45 and point 44. As before stated the parts will remain in this position until the push button is operated and the circuit again closed and the controlling motor put in motion.

Auxiliary devices are shown in diagram in Fig. 6. A transformer 118 is connected with the line wires 69—70 by wires 119 and 120. The low tension side wire 121ª leads to ground and a wire 121 to a post 122 where it is connected through a wire 123 with a circuit breaker 124. Wires 125 lead from the post 122 to a condenser 126. The circuit breaker is connected to the wire 125 and the condenser with a wire 127 by a post 126ª. A wire 128 leads from the post 126ª to a spark coil 129 which is grounded at 130 and connected by a wire 131 with one side 132 of the spark plug 7. The other side 133 is grounded at 134.

It is desirable to immediately stop the flow of fuel when the burner motor circuit is broken in order that there may be no leakage to the burner, or any unconsumed oil delivered to the burner. This is accomplished automatically in the following mechanism: The air pipe 6 leads to and from a chamber 135 having an inlet 136 and outlet 137. A valve 138 closes the passage from the chamber 135 to the outlet by gravity. An armature 139 is mounted on the stem of the valve 138 in position to be actuated by the coil 140. The coil 140 is connected by a wire 141 with the wire 76 and a wire 142 with the wire 61—63, in other words, the coil 140 is in a shunt line with the burner motor circuit. When the burner motor is shut off, therefore, the valve 138 drops im-

mediately closing the air passage 6 and thus immediately cutting off any after-flow of fuel by reason of any residual pressure there may be in the receiver or otherwise.

The confined nozzle is desirable with this safety valve in that it not only improves the combustion by bringing the air and gases which are formed from the fuel into more intimate relation but increases the difference in pressure between that existing when there is a failure of the burner and when there is combustion in the burner.

What I claim as new is:—

1. The method of controlling burners which consists in restricting the flow of gases from the burner and applying as a control medium differences of pressure in the burner.

2. The method of controlling burners which consists in restricting the flow of gases from the burner and applying as a control medium differences of pressure in the burner incident to the presence or absence of ignition.

3. The method of controlling burners which consists in applying through electrically responsive devices comprising a rotary control motor as a control medium differences of pressure in the burner.

4. In an apparatus for controlling burners, the combination of a burner chamber in which flame is produced, said chamber having a restricted discharge; a device responsive to pressures in the chamber; and mechanism controlling the burner controlled by said device.

5. In an apparatus for controlling burners, the combination of a burner chamber in which flame is produced; a device responsive to pressures in the chamber; mechanism comprising a burner motor delivering fuel to the burner; and a rotary control motor controlling the burner motor controlled by said device.

6. In an apparatus for controlling burners, the combination of a burner chamber; a pressure actuated member subjected to burner pressure; two switches controlled by said member, one switch being closed with pressure on the burner and the other switch being closed with a less pressure on the burner; mechanism controlled by the first-mentioned switch for delivering fuel to the burner and stopping the delivery on the opening of said switch; and manually actuated mechanism for re-starting the burner when the second-mentioned switch is closed.

7. In an apparatus for controlling burners, the combination of a burner chamber having an opening therein; a movable plate closing the opening; a switch controlled by the plate; and means controlling the burner controlled by the switch.

8. In an apparatus for controlling burners, the combination of a burner chamber having an opening therein; a movable plate in the opening; switches at opposite sides of the plate, one being closed at a higher pressure and the other being closed at a lower pressure; means for feeding fuel to the burner with the switch closed with the higher pressure closed, the feeding of fuel being stopped through said means by the opening of said switch; and means permitting the re-starting of said means with the switch closed with the lower pressure in closed position.

9. In an apparatus for controlling burners, the combination of an interior flame chamber; an insulating chamber around the flame chamber and communicating therewith and having an opening therefrom; a pressure actuated plate in the opening; and means controlled by the movement of the plate controlling the burner.

10. In an apparatus for controlling burners, the combination of a burner chamber having an opening therein; a movable plate in the opening moving with variations of pressure in the burner; means for adjusting the resistance to movement of the plate; and means actuated by the movement of the plate controlling the burner.

11. In an apparatus for controlling burners, the combination of a burner chamber having an opening therein; a swinging plate in the opening; an adjustable weight on the plate and offset from a vertical plane through the axis on which the plate swings; and means controlling the burner actuated by the movement of said plate.

12. In an apparatus for controlling burners, the combination of a burner chamber having an opening therein; a swinging plate in the opening; a weighted screw in the plate; and means actuated by the plate controlling the burner.

In testimony whereof I have hereunto set my hand.

ROBERT F. METCALFE.