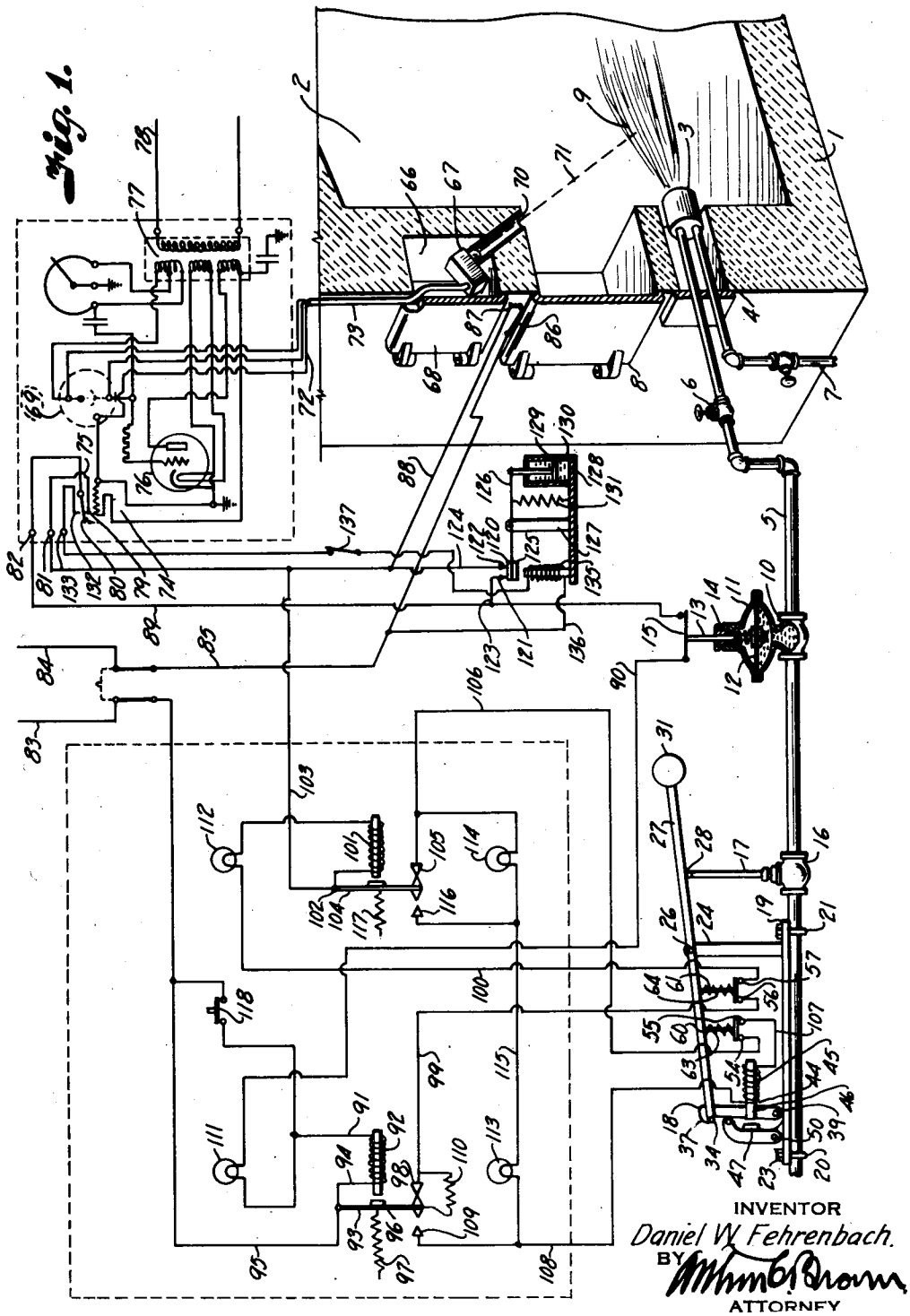
June 7, 1938. D. W. FEHRENBACH 2,120,053

APPARATUS FOR SHUTTING-OFF FUEL SUPPLY TO A FURNACE OR THE LIKE

Filed June 26, 1936 2 Sheets-Sheet 1

Fig. 1.



INVENTOR
Daniel W. Fehrenbach.
BY
Wm. G. Brown
ATTORNEY

June 7, 1938. D. W. FEHRENBACH 2,120,053

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Fig. 2.

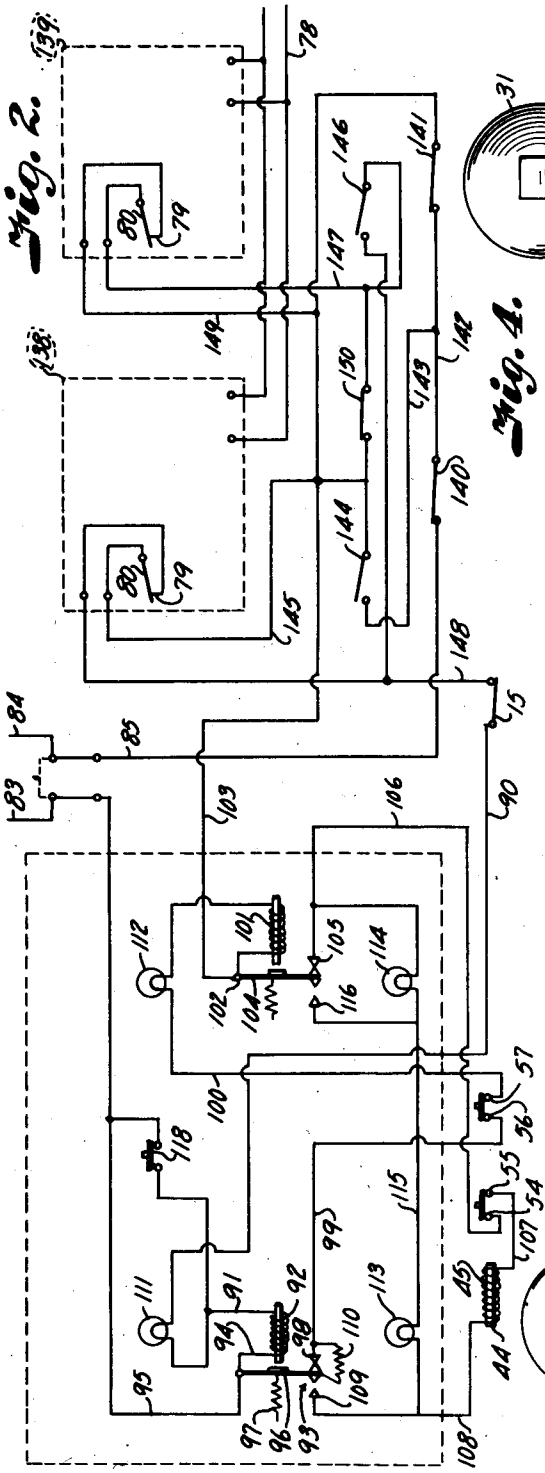


Fig. 4.

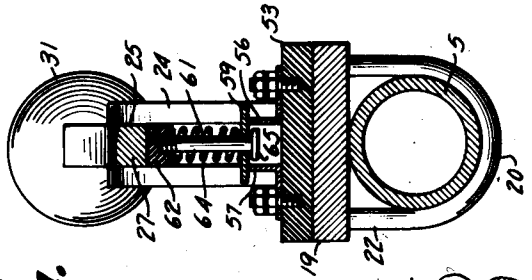
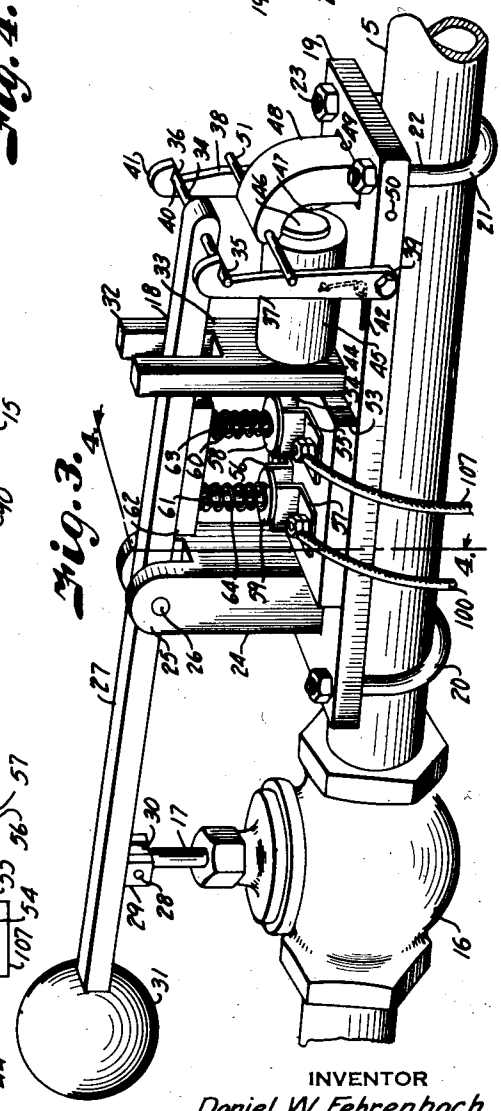


Fig. 3.



INVENTOR
Daniel W. Fehrenbach.
BY
ATTORNEY

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UNITED STATES PATENT OFFICE

2,120,053

APPARATUS FOR SHUTTING OFF FUEL SUPPLY TO A FURNACE OR THE LIKE

Daniel William Fehrenbach, Kansas City, Mo., assignor to Kansas City Journal-Post Company, Kansas City, Mo., a corporation of Missouri

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4 Claims. (Cl. 158—28)

This invention relates to an apparatus for shutting off the fuel supply to a furnace or the like, particularly to those operating on liquid or gaseous fuels of explosive character. In furnaces of this type the flame for various reasons often becomes extinguished with the result that the fuel continues to flow and soon fills the combustion chamber with a highly explosive mixture. The fuel is, therefore, not only wasted but the combustible mixture is apt to cause a serious explosion particularly if attempt is made to relight the fuel before the combustion chamber has time to be scavenged.

Other important objects of the invention are to provide an apparatus of this character which may be operated remotely from the place of shutting off the fuel; to provide for shutting off the fuel in case the burner is not operating efficiently; to prevent admission of fuel to the combustion chamber when the furnace door is open; and to provide signals for indicating when the burner is operating satisfactorily, when the burner is out of operation, and when the fuel supply has been turned on preparatory to lighting the burner.

It is also an important object of the invention to prevent functioning of the shut-off mechanism when the burner is operating with a low flame that has been purposely set to maintain lower furnace temperatures, but which will cause function of the shut-off in case the flame should become extinguished.

In accomplishing these and other objects of the invention, as hereinafter pointed out, I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is a sectional perspective view of a part of a furnace combustion chamber having a burner supplied with a liquid or gaseous fuel and equipped with a shut-off mechanism and control apparatus embodying the features of the present invention.

Fig. 2 is a diagrammatic view of a control system used in connection with a battery of furnaces.

Fig. 3 is a detail perspective view of the shut-off valve and trip mechanism therefor.

Fig. 4 is a cross-section on the line 4—4 of Fig. 3.

Referring more in detail to the drawings:

1 designates a conventional type furnace having a combustion chamber 2 equipped with a burner 3 adapted for burning a liquid or gaseous fuel. The burner 3 is mounted in an opening 4 in the front wall of the furnace and is supplied through a pipe line 5 having a manually operated control valve 6. In the case of a liquid fuel, such as heavy oils, the burner is provided with a steam connection 7 for effecting vaporization of the fuel as in conventional practice. Located in the front wall of the furnace at a point above the burner is a fire-door 8 through which access is had to the burner in the combustion chamber.

The construction thus far described is conventional to apparatus of this character and specifically forms no part of the present invention, which provides means for automatically shutting off the fuel supply in case the flame 9 from the burner should become extinguished.

In carrying out the present invention, the supply line 5 is provided with a pressure operated switch 10 including a diaphragm housing 11 having a diaphragm 12 that is responsive to pressure of the fuel moving through the line. The diaphragm 12 operates a rod 13 that extends through a suitable packing gland 14 in the top of the housing 11 to connect with a switch 15. The supply line is also provided with an automatic shut-off valve 16 having a reciprocatory actuating stem 17 that is connected with a suitable trip mechanism generally designated 18. The trip mechanism 18 is best illustrated in Fig. 3 and includes a base 19 that is supported on the pipe 5 at a point adjacent the valve by means of U-clamps 20 and 21 extending thereunder and having their shanks 22 projecting through suitable openings in the base for mounting nuts 23 whereby the base is clamped to the pipe and retained in horizontal position.

Projecting upwardly from the base, at the end adjacent the valve 16, is a bracket 24 having spaced ears 25 to mount a fulcrum pin 26 on which a rock lever 27 is pivotally mounted. The rock lever has one end projecting over the stem 17 and is pivotally connected therewith by means of a cross pin 28 extending through depending ears 29 on the lever and through a head 30 on the stem. The lever extends beyond the valve and carries a weight 31 whereby the valve is normally retained in closed position to shut off flow through the line. The opposite end of the lever extends through the forked end 32 of a guide bracket 33 and carries a cross bar 34 extending therethrough and having its ends 35 and 36 arranged for latched engagement with latches 37 and 38 pivotally mounted on the sides of the base, as shown at 39.

The free ends of the latches terminate in hooks 40 having rounded upper ends 41 for guiding the bar 34 into latched engagement with the

hooks when the valve stem 17 is moved to position for opening the valve. The latches 37 are normally retained in latching position relatively to the bar 34 by suitable springs 42 having one of their ends engaging the base and their other ends engaging against the respective latches.

Carried on the bracket 33, and projecting between the latches 37, is a magnet 44 having a winding 45 and a metallic core 46 adapted to attract an armature 47 when the coil is energized, as later described. The armature 47 has its lower end 48 pivotally mounted in a recess 49 of the base on a pin 50. The upper end of the armature terminates in a gooseneck bend and carries a cross pin 51 having its ends normally engaging the latches 37 and 38 incidental to the overbalancing weight thereof in the direction of the magnet.

Supported on the base, intermediate the brackets 24 and 33, is an insulator 53 carrying spaced pairs of contacts 54—55 and 56—57 adapted to be respectively engaged by circuit closing plates 58 and 59 loosely carried on headed pins 60 and 61 depending from an insulating block 62 on the under side of the lever 27. When the valve is open and the rock lever is in latched position, the plates 58 and 59 are yieldingly held in engagement with the pairs of contacts by coil springs 63 and 64 having their ends engaged against the insulating block 62 and against the contact plates respectively. The pins are of such length that when the valve is closed the heads 65 of the pins will carry the contact plates away from engagement with the pairs of contacts to break circuit therethrough as later described.

Formed in the front wall of the furnace, at a point above the fire-door 8, is a recess 66 for a phototube holder 67 to which access is had through a door 68 covering the recess 66. The holder carries a phototube 69 located in focusing alignment with a tube 70 extending downwardly through the furnace wall and at such an angle that the axis thereof intersects the flame 9 at its hottest point, as indicated by the dotted line 71, so that the tube is rendered active incidental to the intensity of the flame. The circuit wires for the tube are indicated at 72 and extend from the housing 67 through a conduit 73 having connection with a photoelectric relay 74 that is of any standard design but which includes a relay switch 75, an amplifying tube 76, and a transformer 77 that is adapted to convert a current from a supply line 78 to that suitable for operating the relay. The switch 75 includes fixed and movable contacts 79 and 80 that are normally closed when the fire is burning properly and which are ordinarily opened in response to control by the phototube when the fire becomes extinguished. The contacts 79 and 80 are respectively connected with terminals 81 and 82 for connection of the relay with the valve operating circuit now to be described.

83 and 84 designate the respective line wires of a suitable current supply for furnishing current to actuate the valve shut-off part of the circuit as well as the signal circuits whereby the conditions of operation are visibly indicated at a point remote from the shut-off valve 16.

The line 84 connects with a conductor 85 leading to the arm 86 of a switch that is caused to engage a fixed contact 87 when the fire-door 8 is closed to pass current through a conductor 88 leading to the terminal 81 of the relay switch 75. The other terminal 82 is connected by a conductor 89 leading to one of the contacts of the switch 15. The other contact of the switch 15 is connected by a conductor 90 with one of the leads 91 of the winding 92 for a solenoid switch 93. The other lead 94 of the solenoid winding is connected by a conductor 95 with the other line wire 83, thus completing circuit through the switch on the fire-door through the photoelectric relay switch 75, through the pressure actuated switch 15 and the winding of the magnetic switch 93, when the burner is operating.

The switch 93 includes an armature 96 that is normally influenced by the solenoid winding 92 against action of a spring 97 to normally close circuit to the pairs of contacts 56 and 57, previously described, the armature of the switch also being connected with the conductor 95. The contact 98, with which the armature is retained in engagement upon energization of the solenoid coil, is connected by a conductor 99 with the contact 56. The other contact 57 is connected by a conductor 100 with one end of a solenoid winding 101 of a second magnetically operated switch 102, the other end of which is connected by a conductor 103 with the conductor 88. It is thus obvious that when the switch 15 and the contacts 86 and 87 are closed current flows through the conductor 95, switch arm 93, contact 98, conductor 99, switch contacts 56 and 57, conductor 100, solenoid winding 101, conductor 103, conductor 88, switch contacts 87 and 86 and conductor 85 thereby energizing the magnetic switches 93 and 102.

The switch 102 includes an armature 104 engageable with a contact 105 when the solenoid winding 101 is energized. The contact 105 is connected to the contact 54 by a conductor 106 and the other contact 55 is connected by a conductor 107 with one of the terminals of the solenoid 45. The other terminal of the solenoid is connected by a conductor 108 with a second contact 109 of the relay switch 93 that is adapted to be engaged by the armature 96 thereof when the spring 97 becomes effective in opening the circuit between the switch arm and the contact 98. The armature 96 is connected with the conductor 99 by means of a resistance 110 for a purpose later described.

Connected in the conductors 90 and 100 are signal lights 111 and 112 respectively, which are preferably green in color. Red and amber signal lights 113 and 114 are connected in series by a conductor 115 with the conductors 108 and 106. The conductor 115 is connected with a contact 116 for the switch 102 corresponding to the contact 109 of the switch 93. The armature 104 of the switch 102 is normally retained in engagement with the contact 116 by a spring 117 when the solenoid winding 107 thereof is deenergized. In order to effect manual closure of the circuit to the solenoid 45 a normally opened switch 118 is connected across conductors 95 and 91.

With an apparatus constructed and assembled as thus far described, the furnace is set in operation as follows:

The valve 6 is first opened and then the valve 16 by lifting the weighted end of the rock lever 27 so that the hooked end of the latches 37 and 38 engage over the ends of the cross bar 34 to normally hold the valve 16 in open position. Since the burner has not yet been ignited the photoelectric relay switch will, of course, be open, consequently no current can flow through the coil 92 and the spring 97 will retain the armature in engagement with the contact 109 so that there is a current flowing through the coil 45, contacts 54 and 55, conductor 106, lamp 114, contact

116 and conductors 103, 88 and 85, but due to the fact that the resistance of the lamp 114 is of high value and in series with the coil 45 there is not enough current flowing through the coil to effect unlatching of the lever 27. Also since the resistance 110 is in series with the coil 101 sufficient current cannot flow therethrough to cause movement of the armature away from the contact 116. Since the contact 109 is engaged by the armature 96, current will flow through the signals 113 and 114, the red signal 113 indicating that the burner is out of operation and the amber signal 114 that the fuel is turned on and ready to be lighted.

When the door 8 is opened to light the burner it will, of course, be necessary to hold the valve 16 open for the reason that opening of the door breaks the circuit through the switch 86. However, when the switch is again closed, the circuit is reestablished and the valve 16 will be kept open.

After lighting the burner, the phototube is effective to cause closing of the relay contacts 79 and 80 so that current can then flow from the line wire 83, conductor 95, solenoid winding 92, signal light 111, conductor 90, switch 15, conductor 89, contacts 79 and 80, conductor 88, switch contacts 87 and 86, conductor 85, back to the line 84, thereby energizing coil 92 and causing the armature 96 to be drawn into engagement with the contact 98. Current then flows from the line 83, conductor 95, armature 96, contact 98, conductor 99, contacts 56 and 57, conductor 100, signal light 112, solenoid 101, conductor 103, conductor 88, switch contacts 87 and 86 and conductor 85. The green light 111 is now illuminated to indicate that the burner is in operation. When the electrical circuit through the contact 109 is broken the red signal light 113 is extinguished and current is broken through the solenoid 45. Since the resistance 110 is now out of circuit sufficient current flows to the coil 101 to break the circuit through the amber signal light 114 and to establish a direct circuit through the trip magnet 44 by way of the contact 105, but no current will flow therethrough since the circuit to the contact 109 has been opened.

Now, assuming that the flame should become extinguished for some reason, the phototube will become effective in breaking the relay circuit through the contacts 79 and 80. When this occurs circuit is broken through the coil 92 so that the spring 97 comes into action to break contact of the armature with the contact 98 and establish engagement with the contact 109.

When this occurs current will flow from the line wire 83 through the conductor 95, armature 96, contact 109, conductor 108, solenoid 45, conductor 107, contacts 54 and 55, conductor 106, contact 105, armature 104, conductor 103, conductors 88 and 85 back to the line wire 84 thereby energizing the coil 45 to effect unlatching of the lever arm whereupon the lever is free to tilt under influence of the weight 31 to close the valve 16, thereby shutting off flow of fuel to the burner. Attention is here directed to the fact that the current flowing to the magnet when the resistance 110 is in series is such as to hold the armature 104 in contact with 105 thereby maintaining the circuit through the magnet 44 closed; however, the current is not sufficient to close the circuit after it has been open as in the instance above noted when the valve 16 is initially opened preparatory to lighting of the burner.

When current is established through the coil 45, current also flows through the red light 113, to indicate that the burner is out of service. Immediately upon tilting of the lever the circuits through the pairs of contacts 56—57 and 54—55 are broken to interrupt current flow through the coil 101. When this occurs the spring 117 comes into play to cause the armature 104 to engage the contact 116 so that the red light is kept in circuit but all of the other signal lights are extinguished. The system may then be put back in service by opening the valve 16 and lighting the burner 3 as above described.

Should pressure drop in the supply line the diaphragm will cause opening of the switch 15 to break circuit through the magnet winding 92 and cause shutting of the valve in the same manner as if the relay operated responsive to the phototube. If the burner is not operating efficiently, or should the flame not maintain the intensity to which the phototube has been adjusted, then the phototube will again come into play to shut off the supply of fuel to the burner in the same manner as if the flame were extinguished. Opening of the door 8 will also effect breaking of the circuit through the contacts 86 and 87 to shut off flow of oil to the burner. Attention is directed to the fact that the oil supply to the burner may also be shut off manually at a remote point by closing the switch 118 which shorts the current to the coil 92 so it becomes deenergized and allows the armature of the switch 93 to move into position for establishing circuit through the coil 45, which then operates to shut off the valve 16 in the same manner as described in connection with its operation incidental to actuation of the phototube.

At times it may be desirable to operate the burner with a low flame and in such cases the flame does not operate with the same intensity but tends to flicker which would cause the phototube to effect shutting off the fuel supply when it is not desired. In order to overcome this difficulty and yet provide for shut-off of the fuel supply in case the flame should become extinguished, I provide an automatic switch 120 adapted to keep the circuit which includes the contacts 79 and 80 closed when the photocell relay is opened under flickering tendency of the flame.

The switch 120 includes a pair of fixed contacts 121 and 122 that are respectively connected by conductors 123 and 124 with the conductors 89 and 88. The contacts are normally closed by a bridging contact 125 carried on a lever 126 that is pivotally mounted on a bracket 127 carried by a base 128. The other end of the lever is connected with a piston 129 operable in a dash-pot 130 whereby movement of the lever 126 is retarded. The bridging contact is normally retained in engagement with the fixed contacts 121 and 122 by means of a spring 131 connected with the lever and with the base 128. It is thus obvious that as long as the bridging contact is engaged with the contacts 121 and 122 the relay switch 75 is normally out of circuit and has no effect upon the coil 92.

In order to make the relay switch 75 effective in case the flame should become extinguished, it is provided with a second fixed contact 132 connected with a terminal 133 to which a conductor 134 is connected for supplying current to a solenoid 135 having its other end connected by a conductor 136 with the conductor 85, the solenoid 135 being effective to break circuit through the contacts 121 and 122 under regulating control of the dashpot 130. In order that the solenoid

92 remains sufficiently energized when the solenoid 135 is included in series therewith, the latter solenoid is of relatively low impedance.

With this arrangement, flickering of the flame will continue to operate the phototube to open the relay switch 75, but mere flickering of the flame has no effect on the control circuit since the contacts 121 and 122 are kept closed by the bridging contact 125 even though the switch arm of the relay momentarily engages the contact 132 to cause current to flow through the coil 135, for the reason that the dash-pot prevents the coil from being immediately effective in breaking circuit through the contacts 121 and 122. Therefore, before the circuit can be broken, the phototube has again closed circuit through the photocell relay; however, should the flame become extinguished the relay switch arm retains engagement with the contact 132 to energize the coil a sufficient length of time to effect breaking of the circuit through the contacts 121 and 122 to effect shutting of the valve 16 and stopping flow of fuel to the burner. When the furnace is operating under normal conditions the switch mechanism 120 is taken out of the circuit upon opening of a switch 137 in the conductor 134.

In Fig. 2 is shown a wiring diagram of my improved circuits connected with a battery of two furnaces, each having a photocell circuit, designated 138 and 139 respectively, that are connected in parallel with the circuit to the solenoid winding 92.

In this instance the fire-door switches 140 and 141 are connected by a conductor 142 having a branch conductor 143 connected with a manually operated switch 144 which is connected by a conductor 145 to the relay terminal 81 as is conductor 88 in Fig. 1, for making the relay switch 138 effective. The relay circuit 139 is made effective independently of the relay circuit 138 upon closing a switch 146 that is connected between the conductors 147 and 148 respectively, corresponding to the conductor 89 of the circuit illustrated in Fig. 1. The relay circuit 139 is also connected to the conductor 147 and to the conductor 142 by a conductor 149. The relay circuits are both made effective by wiring them in series by connecting them with a conductor 145 to a switch 150 which is in turn connected to the conductor 147. When it is desired to make the circuit 138 effective exclusive of the circuit 139, the switch 144 is closed and the switches 146 and 150 opened. When it is desired to operate the relay 139 exclusive of 138, then the switches 144 and 150 are opened and the switch 146 is closed. Both relay circuits can be made effective by closing the switch 150 and opening switches 144 and 146 so that either relay circuit can operate the shut-off mechanism.

From the foregoing, it is obvious that I have provided an automatic apparatus that will function responsive upon failure of the combustion of the fuel in the fire-box so that the fuel is automatically shut off the instant that the failure occurs, thereby preventing the fire-box from filling with explosive gases and oil. The signals also advise the operator of the conditions occurring both at the time the supply to the burner is shut off and when the burner is being put back into service.

What I claim and desire to secure by Letters Patent is:

1. In combination with a furnace having a burner, a door for access to the burner and means for supplying fuel to the burner of means for controlling said fuel supply, including a valve, a magnet for closing the valve, an electrical circuit for energizing the magnet, a magnetic switch in the magnet circuit, a relay circuit connected with the magnetic switch, means responsive to presence of combustion in the furnace for closing the relay circuit to energize the magnetic switch for opening the magnet circuit and operable upon absence of combustion to open the relay circuit and effect closure of the magnetic switch for closing the valve, and a switch in said magnet circuit having connection with the door for breaking said magnet circuit to permit closing the valve upon opening the door.

2. In combination with a furnace having a burner and means for supplying fuel to the burner of means for controlling said fuel supply including a valve, a magnet for closing the valve, an electrical circuit for energizing the magnet, a magnetic switch in the magnet circuit, a relay circuit connected with the magnetic switch, means responsive to presence of combustion in the furnace for closing the relay circuit to energize the magnetic switch for opening the magnet circuit and operable upon absence of combustion to open the relay circuit and effect closure of the magnetic switch for closing the valve, a signal circuit connected with the magnet circuit and energized upon closure of the magnetic switch to indicate closing of the valve, a second magnetic switch in the magnet circuit for controlling the signal circuit, a second circuit connected with the first named magnetic switch for energizing the second magnetic switch, and a switch in said second circuit and having connection with the valve for closing said circuit to energize the second magnetic switch for opening the signal circuit when the valve is opened.

3. In combination with a furnace having a burner and means for supplying fuel to the burner of means for controlling said fuel supply including a valve, a magnet for closing the valve, an electrical circuit for energizing the magnet, a magnetic switch in the magnet circuit, a relay circuit connected with the magnetic switch, means responsive to presence of combustion in the furnace for closing the relay circuit to energize the magnetic switch for opening the magnet circuit and operable upon absence of combustion to open the relay circuit and effect closure of the magnetic switch for closing the valve, a signal circuit connected with the magnet circuit and energized upon closure of the magnetic switch to indicate closing of the valve, a second magnetic switch in the magnet circuit for controlling the signal circuit, a second circuit connected with the first named magnetic switch for energizing the second magnetic switch, a switch in said second circuit and having connection with the valve for closing said circuit to energize the second magnetic switch to open the signal circuit when the valve is opened, a signal circuit controlled by the second magnetic switch for indicating open position of the valve, and a switch in the magnet circuit and having connection with the valve to close the last named signal circuit.

4. In combination with a furnace having a burner and means for supplying fuel to the burner of means for controlling said fuel supply including a valve, a magnet for closing the valve, an electrical circuit for energizing the magnet, a magnetic switch in the magnet circuit, a relay circuit connected with the magnetic switch, means responsive to presence of combustion in the fur-

nace for closing the relay circuit to energize the magnetic switch for opening the magnet circuit and operable upon absence of combustion to open the relay circuit and effect closure of the magnetic switch for closing the valve, a signal circuit connected with the magnet circuit and energized upon closure of the magnetic switch to indicate closing of the valve, a second magnetic switch in the magnet circuit for controlling the signal circuit, a second circuit connected with the first named magnetic switch for energizing the second magnetic switch, a switch in said second circuit and having connection with the valve for closing said circuit to energize the second magnetic switch for opening the signal circuit when the valve is opened, a signal circuit controlled by the second magnetic switch for indicating open position of the valve, a switch in the magnet circuit and having connection with the valve to close the last named signal circuit, and a resistance in said second circuit including a resistance bypassing the first named magnetic switch to prevent deenergization of said second magnetic switch when the relay circuit is broken and until the circuit through the second magnetic switch is opened by way of the switch in the second circuit.

DANIEL WILLIAM FEHRENBACH.