Sept. 29, 1964 L. N. BOLMGREN 3,150,709

BURNER CONTROL APPARATUS

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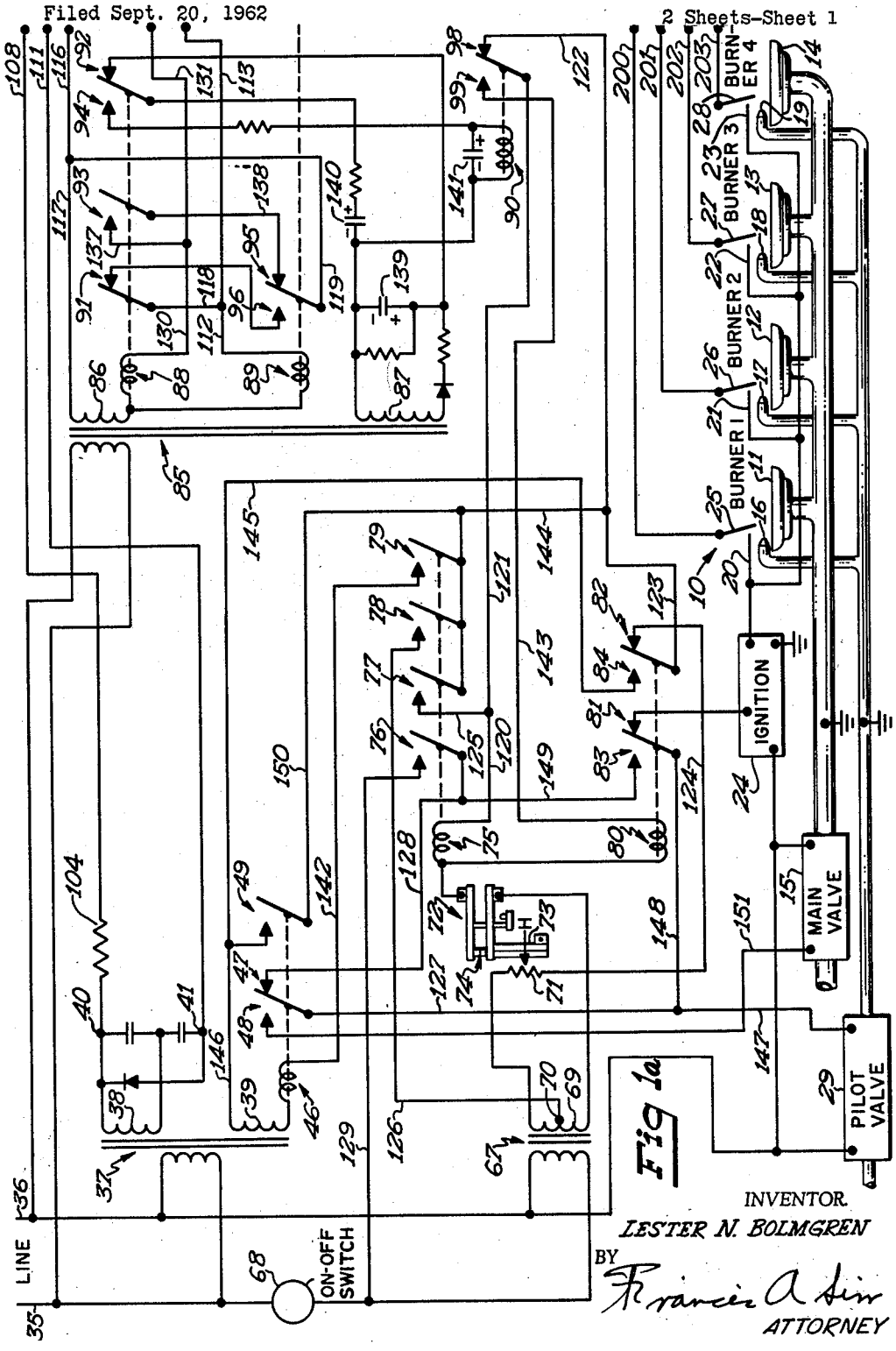


Fig 1a

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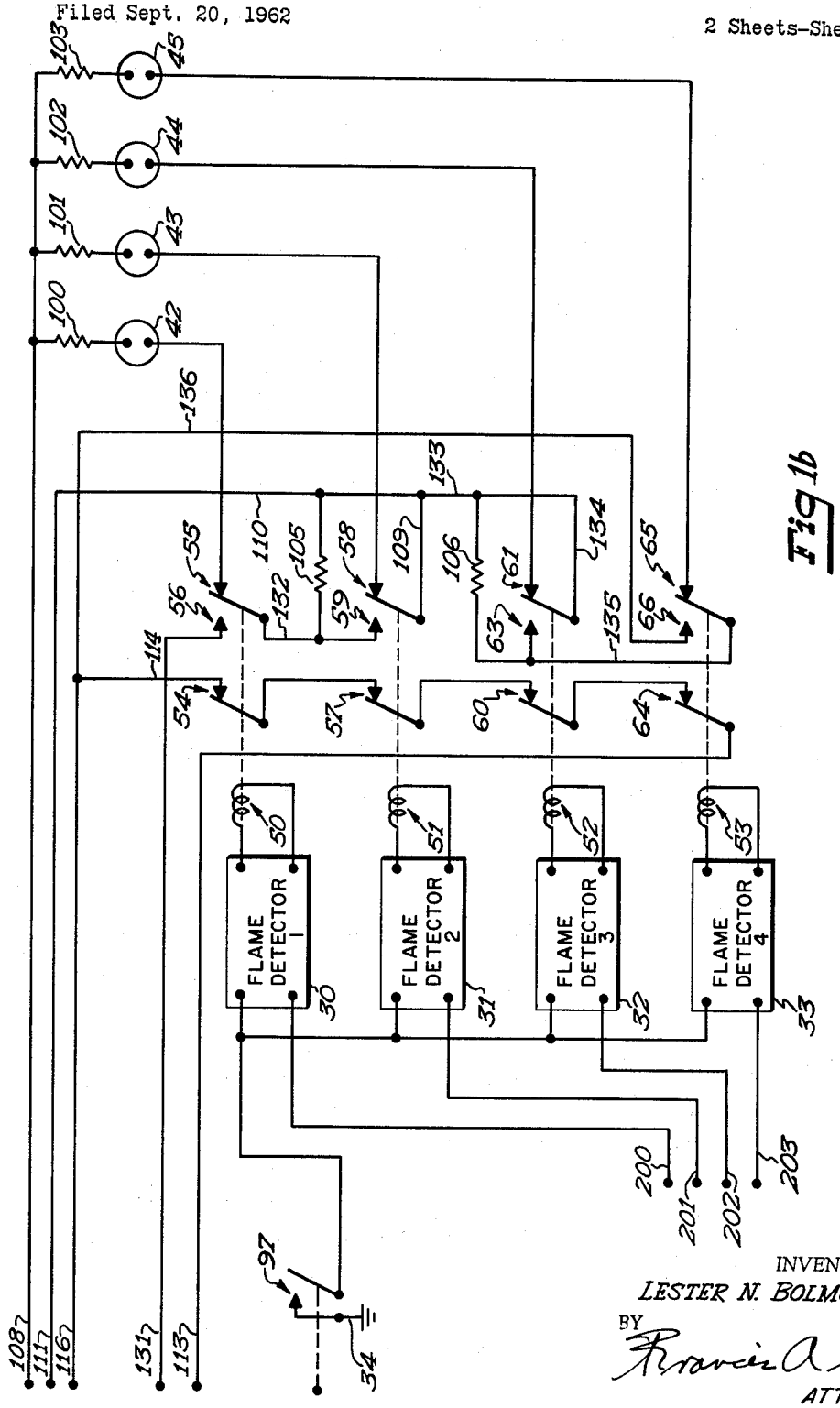


Fig 1b

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3,150,709

BURNER CONTROL APPARATUS

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7 Claims. (Cl. 158—28)

The present invention is concerned with an improved burner control apparatus and particularly with such an apparatus which is adapted for use with a multiple fuel burner installation.

Multiple fuel burner installations provide a plurality of individual fuel burner units having a main fuel valve controlling the flow of fuel to all the burners, having a pilot valve controlling the flow of fuel to individual pilot burners associated with each of the main burners, and having ignition means to ignite the pilot burners. With such an arrangement, it is conventional to provide separate and individual flame detectors, one of which is associated with each of the individual burners and is responsive to the presence or absence of flame at this particular burner. A flame failure, experienced at any one of the burners, is effective, through the medium of its individual flame detector, to shut the main valve connected to all of the burners and thereby turn off all the burners, even though a flame failure has been experienced at only one of the burners.

One aspect of the present invention provides a plurality of indication or monitor means, one of which is associated with each of the flame detectors and is effective, through a unique electrical circuit, to provide an indication of that flame detector which first experienced a flame failure. Such an indication is of utility in that the first indication of a flame failure results in the turning off of all the burners and thus all the flame detectors indicate the absence of flame. Without the provision of such an indicator, it is not possible to determine which of the burners was the burner which malfunctioned to cause the shutdown.

As a further feature of the invention, the same plurality of electronic flame detectors which produce the unique monitor or indication function also cooperate to provide continuous component checking through the medium of a cycling relay construction. Specifically, this cycling relay construction provides a first relay which is energized upon all of the flame detectors sensing the presence of flame and, once energized, is maintained energized through a holding circuit including one of its own switches and the switch of a second relay. This second relay, de-energized at this time, is connected to be energized upon all of the flame detectors detecting the absence of flame at the fuel burner.

Energization of the first-mentioned relay is effective to simulate the absence of flame at all the fuel burners to this cause all the flame detectors to move to a position corresponding to the sensing of the simulated absence of flame at all the fuel burners. In response thereto, the second-mentioned relay is energized to de-energize the first-mentioned relay. Energization of the second-mentioned relay completes a holding circuit for this relay through one of its own switches and through a switch of the first relay which is completed when the first relay drops out in response to energization of the second relay.

De-energization of the first relay is effective to interrupt the simulated absence of flame and thus all the flame detectors again move to the condition of detecting the actual presence of flame. In this manner, the cycling relay construction continues to cycle, and a further relay is provided to be maintained continuously energized so long as the cycling relay construction continues to cycle.

The cycling relay construction is effective to cause the flame detectors to (1) cyclically sense the actual presence of flame at all the fuel burners, and (2) to sense the simulated absence of flame at all the fuel burners. Thus, the cycling relay construction is effective to check the operativeness of each of the flame detectors during the running period of the multiple fuel burner unit. If any of the flame detectors becomes inoperative to either sense the actual presence of flame or to sense the simulated absence of flame, the associated indicator or monitor means is energized to indicate that a fault has occurred in connection with this specific burner or flame detector. At the same time, the main valve is closed to shut off fuel to all the burners.

The present invention will be apparent to those skilled in the art upon reference to the following specification, claims, and drawing, of which the FIGURES 1*a* and 1*b* are a schematic representation of my invention.

Referring to the FIGURE 1*a*, reference numeral **10** designates generally a multiple fuel burner installation having four individual main fuel burners **11**, **12**, **13** and **14**, also designated "Burner 1" etc. The four burners **11–14** are connected to receive fuel through a main fuel valve **15**, which is normally in a closed position and moves to an open position upon energization of an electrical operator. Thus, closing or opening of the main valve controls the supply of fuel to all of the burners **11–14**.

Associated with each of the main burners is a pilot burner, identified by reference numerals **16–19**. Each of these pilot burners is cooperatively associated with its respective main burner to ignite fuel flowing from the main burner. Associated with each of the pilot burners is an ignition electrode **20–23**, the ignition electrodes in turn being connected to an ignition means in the form of a transformer **24**.

Also associated with each of the individual fuel burners of the multiple fuel burner installation are flame detecting means including flame rods **25–28**. The flame rods are shown only by way of example. It is within the teachings of the present invention to use means such as photocells or other radiation sensitive devices to sense the presence or absence of flame at the individual fuel burners.

The individual pilot burners **16–19** are connected to a common fuel conduit and receive fuel through a normally closed pilot valve **29**, the pilot valve having an electrical operator which, when energized, opens the pilot valve to allow fuel to flow to the pilot burners.

The flame rods **25–28** are connected to the input circuits of individual flame detectors **30–33**, see FIGURE 1*b*. These flame detectors have also been designated by means of the legend indicating flame detectors **1**, **2**, **3** and **4**, this designation corresponding to the legend for the main burners of FIGURE 1*a*. As can be seen, the individual flame rods for each of the burners are connected by means of electrical conductors **200–203** to an input terminal of its respective flame detector. The other input terminal of each of the flame detectors is adapted to be connected through relay switch means **97** to a ground connection at conductor **34** and then by way of further ground connections to the fuel conduits of the pilot and main burners of the fuel burner installation **10**. The significance of this connection by which the input terminal of each of the flame detectors is connected to ground will be apparent later in the specification when dealing with the cycling relay construction.

By way of specific example, each of the flame detectors **30—33** may be of the type disclosed in the United States Patent 2,556,961.

Operating electrical voltage for the apparatus of FIGURES 1*a* and 1*b* is provided by a pair of power line

conductors 35 and 36 (FIGURE 1*a*) which are adapted to be connected to a source of alternating voltage, not shown.

A transformer 37 (FIGURE 1*a*) is provided and has its primary winding directly connected to the power line conductors 35 and 36. Transformer 37 includes a pair of secondary windings 38 and 39. Secondary winding 38, in conjunction with a voltage doubler rectification system, provides a D.C. source of potential at the terminals 40 and 41, this source of potential to be utilized in the monitor or indication network including indicators in the form of normally de-energized neon indicator lights 42, 43, 44 and 45, see FIGURE 1*b*. As will be apparent, one of the neon indicator lights 42–45 is associated with each of the flame detectors 30–33 in a particular manner and functions to indicate the first flame detector to experience a flame failure.

The secondary winding 39 of transformer 37 (FIGURE 1*a*) is connected to supply operating voltage to the winding of a relay 46, the function of relay 46 being to prevent recycling operation of the multiple fuel burner installation in the event that a flame failure is experienced. Relay 46 includes a normally closed switch 47 and a pair of normally open switches 48 and 49.

Each of the flame detectors 30–33 includes an output flame relay 50, 51, 52 and 53, associated with the flame detectors 30–33 respectively. Each of the flame relays 50–53 includes a pair of normally closed switches and a normally open switch. For flame relay 50, the normally closed switches are identified by means of reference numerals 54 and 55 while the normally open switch is identified by means of reference numeral 56. For flame relay 51, the normally closed switches are identified by means of reference numerals 57 and 58 while the normally open switch is identified by means of reference numeral 59. For flame relay 52, the normally closed switches are identified by means of reference numerals 60 and 61, while the normally open switch is identified by means of reference numeral 63. For flame relay 53, the normally closed switches are identified by means of reference numerals 64 and 65 while the normally open switch is identified by means of reference numeral 66.

Transformer 67 is provided with a primary winding which is connected to power line conductors 35 and 36 through on-off switch 68. The secondary winding 69 of transformer 67, having a tap 70, is connected to energize the actuating heater 71 of a safety cutout means 72 having a bimetal operator 73 and a normally closed switch 74 which is adapted to open after a time period of energization of the heater 71 to heat bimetal 73 and cause the upper end thereof to move in a lefthand direction, as indicated by the arrow labeled "H." The secondary winding 69 of transformer 67 is also connected to provide operating voltage for a relay 75 having normally open switches 76, 77, 78 and 79. The secondary winding 69 of transformer 67 also provides operating voltage for a further relay 80, this relay being adapted, as will be apparent, to be energized in accordance with the presence or absence of flame at all of the fuel burner units. Relay 80 includes a pair of normally closed switches 81 and 82 and a pair of normally open switches 83 and 84.

Transformer 85 has its primary winding directly connected to the power line conductors 35 and 36 and includes first and second secondary windings 86 and 87. Transformer 85, and particularly secondary windings 86 and 87, supply operating voltage to the cycling relay structure including the cycling relays 88 and 89 and the normally continuously energized relay 90. As will be apparent, relay 90 is normally continuously energized, to thus maintain relay 80 continuously energized, so long as relays 88 and 89 continue to cycle.

Relay 88 is provided with a pair of normally closed switches 91 and 92, as well as a pair of normally open switches 93 and 94.

Relay 89 is provided with a normally closed switch 95 and a pair of normally open switches 96 (FIGURE 1*a*) and 97 (FIGURE 1*b*).

Relay 90 is provided with a normally closed switch 98 and a normally open switch 99.

The description thus far has dealt with a general description of the major components of the preferred embodiment of my invention, dealing only briefly with the over-all operation of the invention. Prir to a detailed description it would be well to briefly describe the over-all operation of the apparatus, now that the major components thereof have been identified.

With the apparatus as shown in FIGURES 1*a* and 1*b*, the control of the multiple fuel burner installation 10 is achieved by means of the normally open switch 68. Also, operating voltage is not applied to conductors 35 and 36.

Upon initial application of voltage to the power line conductors 35 and 36, the primary windings of transformers 37 and 85 are energized. Relay 89 is first energized to thereby close its switch 97 to place the flame detectors 30–33 in a condition to subsequently detect the actual presence of flame at the various fuel burners.

Closing of switch 68, to indicate a need for operation of the multiple fuel burner unit, is first effective to energize relay 75 and this relay in turn institutes energization of the pilot valve 29 and ignition transformer 24 to establish a pilot flame.

The detection of flame at all of the pilot burners 16–19 is effective, through the medium of the flame detectors 30–33, to energize the respective flame relays 50–53. Energization of all of the flame relays completes an energizing circuit for cycling relay 88 to energize this relay. Relay 88 in turn is effective, when energized, to cause de-energization of relay 89 and thus, by virtue of switch 97 which then opens, to simulate the absence of flame at all of the fuel burner units. Subsequent thereto, all of the flame relays 50–53 move to a de-energized position in response to the simulated absence of flame at all of the fuel burner units.

In response thereto, cycling relay 89 is again energized to in turn cause de-energization of cycling relay 88. In this manner, relays 88 and 89 continue to cycle between energized and de-energized states. Relay 90 is thus maintained continuously energized.

Energization of relay 90 is effective to energize relay 80 and to in turn de-energize the ignition transformer 24 and to energize relay 46. Relay 46 is effective to energize the main valve 15 to supply fuel to main fuel burners 11–14 where it is ignited by the pilot flame now present at the pilot burners 16–19.

As has been described, the neon indicator lights 42–45 are connected to receive operating voltage from the D.C. power supply existing at terminals 40 and 41. The energizing circuits by which the neon indicator lights 42–45 are interconnected to the terminals 40 and 41 include switch means controlled by the flame relays 50–53 and likewise include resistors 100–105.

The interconnection of the various switch means of the flame relays 50–53, the neon indicator lights 42–45, and the resistors 100–105 to the terminals 40 and 41 is such that the first flame relay 50–53 to drop out is effective to complete an energizing circuit for its associated neon indicator light and this light then fires or is energized. Subsequent de-energization of the other flame relays does not provide energization of their associated neon indicator lights by virtue of the fact that the majority of the voltage present across terminals 40–41 is dropped across the voltage dropping resistor 104. Thus, this one indicator light remains energized to indicate to the operator the particular fuel burner unit or flame detector which has malfunctioned to cause a complete shutdown of the multiple fuel burner installation.

Referring now to a detailed description of the operation of the apparatus, it should first be noted that the apparatus is shown as it exists with no voltage applied to power line conductors 35 and 36. Upon application of

voltage to the power line conductors 35 and 36, the primary windings of transformers 37 and 85 are initially energized. It will be assumed at this point that switch 68 is in an open condition, signifying that there is no need for operation of the multiple fuel burner installation 10.

As a result of energization of the primary winding of transformer 37, a D.C. voltage is provided at the terminals 40 and 41. At this time, the flame relays 50–53 are all in a de-energized condition and thus energizing circuits are completed for all of the neon indicator lights 42–45 to the terminals 40 and 41. One or the other of these neon indicator lights will become energized at this time. Since there is no call for operation of the multiple fuel burner 10 at this time, the energization of a particular neon indicator light is of no significance. However, to aid in the understanding of the operation of the neon indicator light monitor system, it will be assumed that neon indicator light 42 is the first to become energized. This energizing circuit can be traced from terminal 40 through a resistor 104, conductor 108, resistor 100, neon indicator light 42, switch 55 of flame relay 50, conductor 132, resistor 105, conductor 110, and conductor 111 to terminal 41. As a result of this energizing circuit, voltage is dropped across the resistors in the above traced circuit and thus, even though the energizing circuits are completed at switch 58 for neon indicator light 43, at switch 61 for neon indicator light 44 and at switch 65 for neon indicator light 45, the voltage applied to the neon indicator lights 43, 44 and 45, by virtue of these circuits, is insufficient to energize these lights.

Energization of the primary winding of transformer 85 is effective to complete an energizing circuit for cycling relay 89 and this energizing circuit can be traced from the lower terminal of secondary winding 86 through the winding of relay 89, conductors 112 and 113, switches 64, 60, 57 and 54 of flame relays 53, 52, 51 and 50 respectively (FIGURE 1*b*) and conductors 114, 116 and 117 to the upper terminal of secondary winding 86. By virtue of this energizing circuit, switch 95 of relay 89 is opened and switches 96 and 97 are closed. The closing of switch 97 (FIGURE 1*b*) completes the input circuit of the individual flame detectors 30–33 to thus connect the flame rods 25–28 through the input circuits of the flame detectors to ground at connection 34. The flame detectors are thus rendered operative to sense the presence or absence of flame at the respective fuel burners.

The closing of switch 96 of relay 89 completes a holding circuit for this relay which can be traced from the lower terminal of secondary winding 86 through the winding of relay 89, conductors 112 and 118, switch 91, switch 96, and conductors 119 and 117 to the upper terminal of this secondary winding.

The apparatus is now in a standby condition. Subsequent need for operation of the multiple fuel burner installation 10 is indicated by closing of switch 68. The closing of this switch connects the primary winding of transformer 67 to the power line conductors 35 and 36. Energization of transformer 67 completes an energizing circuit for relay 75 which can be traced from the lower terminal of secondary winding 69 through the closed switch 74 of safety cutout means 72, the winding of relay 75, conductors 120 and 121, switch 98 of relay 90, conductors 122 and 123, switch 82 of relay 80, conductor 124, and heater 71 of safety cutout means 72 to the upper terminal of secondary winding 69.

By virtue of this circuit, it can be seen that relay 75 is operatively energized only in the event that safety cutout means 72 has not been operated and, as a result, switch 74 is closed; only in the event that relay 90 is in a de-energized condition; only in the event that relay 80 is in a de-energized condition; and only in the event that the heater 71 of the safety switch 82 has electrical continuity, indicating that the heater is operative.

Energization of relay 75 is effective to cause its switches 76–79 to move to a closed condition. The closing of switches 77 and 78 is effective to complete a holding energizing circuit for relay 75 which can be traced from the lower terminal of secondary winding 69 through switch 74, the winding of relay 75, conductors 120 and 125, switches 77 and 78, and conductor 126 to the tap 70 of secondary winding 69. Thus, continued energization of relay 75 is dependent only upon switch 74 remaining in a closed condition, and no longer depends upon the relays 90 and 80 being in a de-energized condition. Heater 71 of safety cutout means 72 continues to be energized by means of a circuit which can be traced from the upper terminal of secondary winding 69 through heater 71, conductor 124, switch 82, conductors 123 and 122, switch 98, conductor 121, switches 77 and 78, and conductor 126 to the tap 70 of secondary winding 69.

The closing of switch 76, closed by energization of relay 75, completes an energizing circuit for pilot valve 29 and ignition transformer 24. This circuit can be traced from power line conductor 36 through the pilot valve and the ignition transformer to a conductor 127, the circuit to conductor 127 including switch 81 in series with the ignition transformer 24. The circuit from conductor 127 continues through switch 47, conductor 128, switch 76, conductor 129 and switch 68 to power line conductor 35. Thus, fuel is admitted to the individual pilot burners 16–19 and this fuel is ignited by means of the ignition transformer 24, including ignition electrodes 20–23.

As has been pointed out, relay 89 is at this time energized and thus switch 97 is closed to render the flame detectors 30–33 operative to sense the presence of flame at the individual fuel burners. As pilot flame is established at each of the individual burners, the flame relays 50–53 are energized. Energization of any one of the individual flame relays is effective to interrupt the initial energizing circuit for relay 89. However, it will be remembered that relay 89 continues to be held energized through the closed switch 91 of relay 88 and the switch 96 of relay 89.

Upon all of the flame relays 50–53 being energized, an energizing circuit is completed for relay 88 and this energizing circuit can be traced from the lower terminal of secondary winding 86 through the winding of relay 88, conductors 130 and 131, switch 56, conductor 132, switch 59, conductors 109, 133 and 134, switch 63, conductor 135, switch 66, and conductors 136, 116 and 117 to the upper terminal of secondary winding 86. Resistors 100, 101, 102, 103, 105 and 106 are to prevent relay 88 from closing due to any sneak circuit through certain combinations of contacts 55, 56, 58, 59, 61, 63, 65 and 66. These resistors would not be necessary if the contacts of relays 50–53 were completely isolated rather than single pole double throw. Energization of relay 88 is effective to break the above mentioned holding circuit for relay 89 to thus cause this relay to be de-energized. De-energization of relay 89 closes its switch 95 and opens its switches 96 and 97.

The closing of switch 95 completes a holding circuit for relay 88 which can be traced from the lower terminal of secondary winding 86 through the winding of relay 88, conductors 130 and 137, switch 93, conductor 138, switch 95 and conductors 119 and 117 to the upper terminal of this secondary winding. Thus, relay 88 is maintained energized independent of subsequent de-energization of any one of the flame relays 50–53. However, as will be apparent, the de-energization of all of the flame relays 50–53 is effective to again energize relay 89 to thus cause relay 88 to be de-energized.

The de-energization of relay 89 also opens its switch 97, as above mentioned. The opening of this switch opens the flame rod circuit from all of the flame rods 25–28 to the input of the flame detectors 30–33. Thus, the absence of flame is simulated at all of the fuel burners. If the flame detectors 30–33 are operating properly, as is normal, all of the flame relays 50–53

now drop out to again close the switches 54, 57, 60 and 64 connected in the energizing circuit of relay 89. Thus, relay 89 is again energized to open its switch 95 and close its switches 96 and 97.

The opening of switch 95 causes de-energization of relay 88. The closing of switch 96 completes a holding circuit for relay 89 including in series therewith switch 91 of relay 88 and the switch 96 of relay 89. The closing of switch 97 again connects the flame rods 25–28 to the input circuits of flame detectors 30–33 to once again render these flame detectors operative to sense the presence or absence of flame at the fuel burner unit.

Thus, so long as flame detectors 30–33 remain operative, the flame relays 50–53 and the relays 88 and 89 continuously cycle between energized and de-energized states. In this manner, the operativeness of the flame detectors 30–33 is cyclically checked, first to check the ability of the flame detectors to sense the actual presence of flame at the fuel burners, and to then check the operativeness of the flame detectors to detect the simulated absence of flame at the fuel burners.

Continued cycling of relays 88 and 89 is effective to energize relay 90 and to maintain it continuously energized so long as these relays 88 and 89 continue to cycle. Relay 90 is energized from a capacitor charge-and-discharge circuit including transformer secondary winding 87 which is connected by means of a half wave rectifier, to charge a capacitor 139. The charge on capacitor 139 is transferred to a further capacitor 140 during those times in which relay 88 is de-energized to close its switch 92. Subsequent energization of relay 88 is effective to connect the charged capacitor 140 to a further capacitor 141 connected in parallel with the winding of relay 90, this connection being completed by switch 94 of relay 88. Thus, as relay 88 continues to cycle, capacitor 140 is cyclically charged and then discharged into capacitor 141 to maintain relay 90 continuously energized, the energization of relay 90 being indicative of the operativeness of the flame detectors 30–31 and indicative of the presence of flame at all of the individual fuel burners.

Energization of relay 90 is effective to complete an energizing circuit for relay 80, this circuit being traced from the lower terminal of secondary winding 69 through safety switch 74, relay 80, conductor 143, switch 99, conductors 121 and 125, switches 77 and 78 and conductor 126 to tap 70 of secondary winding 69.

Energization of relay 80 is effective to produce energization of relay 46, to produce de-energization of the heater 71 of the safety cutout means 72, to produce de-energization of the ignition transformer 24, and to provide a holding circuit for pilot valve 29.

Upon energization of relay 80, switch 84 closes to complete an energizing circuit for relay 46 which can be traced from the lower terminal of secondary winding 39 through the winding of relay 46, conductor 142, switch 79, conductors 144 and 123, switch 84, and conductors 145 and 146 to the upper terminal of secondary winding 39.

Furthermore, the energization of relay 80 is effective to open its switch 82, this switch being in series with the heater 71 of safety cutout means 72. Hence, the safety switch heater is de-energized.

The opening of switch 81 by virtue of the energization of relay 80 is effective to de-energize ignition transformer 24.

The closing of switch 83, controlled by relay 80, completes a holding circuit for pilot valve 29 which can be traced from power line conductor 36 through pilot valve 29, conductors 147 and 148, switch 83, conductor 149, switch 76, conductor 129, and switch 68 to power line conductor 35.

Energization of relay 46, by means of the circuit above traced is effective to complete a holding circuit for this relay which can be traced from the lower terminal of secondary winding 39 through the winding of relay 46, conductor 142, switch 79, conductor 150, switch 49, and conductor 146 to the upper terminal of secondary winding 39.

Also, the energization of relay 46 is effective to complete an energizing circuit for main valve 15 to thus admit fuel to the main burners 11–14, whereupon this fuel is ignited by the pilot flame now present at the pilot burners 16–19. The energizing circuit for main valve 15 can be traced from power line conductor 36 through main valve 15, conductor 151, switch 48, conductors 127 and 148, switch 83, conductor 149, switch 76, conductor 129 and switch 68 to power line conductor 35.

Energization of relay 46 and the resulting opening of its switch 47 is effective to open the initial energizing circuit for pilot valve 29 and to complete the above mentioned holding circuit which is now dependent upon continued energization of relay 80, this relay being, in effect, a flame relay since its continued energization is dependent upon energization of relay 90.

The above detailed description of my invention has dealt with the initial startup of the multiple fuel burner installation. The running period of the fuel burner installation is determined by switch 68. Subsequent opening of this switch is effective to de-energize the various components of the apparatus to again place the apparatus in the standby condition, as above described. In this standby condition, relay 89 is the only one of the various relays which is in an energized condition.

A further feature of my invention, as above described, involves a monitor or indication arrangement whereby the plurality of neon indicators 42–45 is effective to indicate the burner to first experience a flame failure or to indicate the flame detector to first experience a component failure.

Assume that during the running period a flame failure is experienced at burner 2, this being main burner 12 and pilot burner 17. As a result of this flame failure, flame detector 31 either (1) senses the absence of such a flame by causing its relay 51 to become de-energized during that portion of the cycling of relays 88 and 89 in which switch 97 is closed, or (2) relay 51 fails to become again energized if the flame failure at burner 2 occurs during the simulated absence of flame at all of the fuel burners, this being during the time in which switch 97 is open. In any event, relay 51 causes its switch 58 to close or to remain closed when the switches 55, 61 and 65 controlled by flame relays 50, 52 and 53 respectively move to an open position in response to the flame detectors 30, 31 and 33 sensing the presence of flame at their respective burners. As a result, neon indicator 43 is energized by means of a circuit which can be traced from terminal 40 through resistor 104, conductor 103, resistor 101, neon indicator light 43, switch 58, conductors 109 and 110, and conductor 111 to terminal 41.

The failure of all of the flame relays 50–53 to move to an energized condition stops the cycling of relays 88 and 89 and thus causes relay 90 and relay 80 to become de-energized. The de-energization of relay 80 is effective to immediately open the circuit to both the pilot valve and the main valve by virtue of the opening of switch 83. As a result thereof, fuel no longer flows to the pilot burners or the main burners of the multiple fuel burner installation 10 and the flame relays 50, 52 and 53 are also de-energized. However, due to the prior de-energization of relay 51, and the resulting energization of its neon indicator light 43, the neon indicator lights 42, 44 and 45 are not energized by virtue of the abnormally low voltage existing across these neon lights, this low voltage resulting from conduction or firing of neon 43. Thus, the attendant at the multiple fuel burner installation 10, upon becoming aware of a complete shutdown of the installation, may view the neon indicator lights 42–45 and determine that the fault is concerned with burner 2 or flame detector 2. Thus, the correction of the fault is

greatly simplified since the location of the fault is readily determined.

From the above description it can be seen that I have provided an improved burner control apparatus which is particularly adapted for use with a multiple fuel burner installation and in which a plurality of flame detectors is associated, one with each of the individual burners of the multiple fuel burner installation, to provide continuous component checking of the flame detectors by virtue of the cycling means 88–89 and to likewise provide monitor or indication of flame failure or component failure within any one of the flame detectors, this monitor or indication being achieved by means of indicators 42–45 which are constructed and arranged such that the first to be energized indicates the location of the fault and the other indicators then cannot be subsequently energized, even though flame is subsequently extinguished at all of the individual burners.

Other modifications of the present invention will be apparent to those skilled in the art and it is thus intended that the scope of the present invention be limited solely by the scope of the appended claims.

I claim as my invention:

1. Burner control apparatus for use with a multiple fuel burner installation, comprising;

a plurality of flame detectors each of which is associated with one of the fuel burners to supervise the presence of flame at its fuel burner,

fuel burner monitor means having a plurality of indicator means one for each of the fuel burners,

means controlled by said flame detectors, responsive to a flame failure at any one of the fuel burners, and connected in controlling relation to said fuel burner monitor means to cause operation of one of said indicator means to indicate which one of the fuel burners has experienced a flame failure,

component checking means including first control means adapted to continuously cycle between first and second conditions of operation and including second control means,

means interconnecting said first and second control means to maintain said second control means in a first condition of operation only upon said first control means continuously cycling between said first and second conditions of operation,

and means interconnecting said first control means and said plurality of flame detectors to cause said first control means to assume said first condition of operation upon all of said flame detectors sensing the presence of flame at the fuel burners, said first control means when in said first condition of operation being effective to simulate the absence of flame at all of the fuel burners so that said first control means subsequently assumes said second condition of operation upon all of said flame detectors sensing the simulated absence of flame at the fuel burners.

2. Burner control apparatus for use with a multiple burner installation, to allow fuel to be supplied to all the burners only when a flame is detected at all the burners, to provide indication of the particular burner which experiences a flame failure, and to provide continuous component check of the flame detecting means, the apparatus comprising:

a plurality of flame detectors, one of which is associated with each of the burners, and each of which includes output means,

continuous component check means having output means and cycling means with said output means adapted to be maintained in a first state of operation so long as said cycling means alternately changes between a first and a second state of operation,

means connecting said flame detectors in controlling relation to said component check means to cause said cycling means to assume a first state of operation upon all of said flame detectors detecting the presence of flame,

means connecting said cycling means in controlling relation to all of said flame detectors to simulate the absence of flame upon said cycling means assuming said first state of operation to cause said cycling means to assume a second state of operation upon all of said flame detectors detecting the simulated absence of flame to thereby cause said cycling means to cycle between said first and said second states of operation,

a plurality of indicating means one of which is associated with each of the burners,

means connecting said indicating means to said flame detectors to provide indication of the burner to experience a flame failure,

and further means controlled by the output means of said component check means and adapted to control the flow of fuel to the burners to stop the flow of fuel upon one of the burners experiencing a flame failure.

3. Burner control apparatus for use with a multiple fuel burner installation, comprising:

a plurality of flame detectors, each of which is provided with input means adapted to be associated with one of the fuel burners to sense the presence or absence of flame at its respective fuel burner, and having output means including switch means assuming a first or a second condition of operation as the flame detector senses the presence or absence of flame at its fuel burner,

cycling relay means having a first and a second condition of operation,

circuit means connecting said cycling relay means to be controlled by the switch means of said flame detectors to assume a first condition of operation upon all of said flame detectors detecting the presence of flame at their respective fuel burners,

circuit means controlled by said cycling relay means when in said first condition of operation to simulate the absence of flame at all of the fuel burners to thereby cause all of the switch means of said flame detectors to assume a second condition of operation so that said cycling relay means assumes a second condition of operation,

a further relay connected to be controlled by said cycling relay means and to assume a first condition of operation only upon said cycling relay means continuing to cycle between said first and second conditions of operation,

safety means adapted to be connected in controlling relation to the fuel burners to interrupt the supply of fuel to the fuel burners upon actuation of said safety means,

means connecting said further relay in controlling relation to said safety means to operate the same and thus interrupt the supply of fuel to the fuel burners upon said further relay assuming a second condition of operation as a result of failure of said cycling relay means to cycle between its first and second conditions of operation,

a plurality of electrically energizable indicator means one of which is associated with each of the flame detectors and is operative upon energization thereof to indicate a flame failure at one of the fuel burners,

and circuit means controlled by the switch means of said flame detectors and effective to energize only the indicator associated with the first of the flame detectors to detect the absence of flame and its associated fuel burner.

4. In combination:

a multiple fuel burner unit having a plurality of individual burners and a fuel valve controlling the flow of fuel to the burners,

a plurality of electronic flame detectors, one of which

is associated with each of the burners, having output switching means,

cycling means connected to be controlled by said flame detector switching means to assume a first condition upon all of the flame detectors detecting flame;

means controlled by said cycling means when in said first condition to simulate the absence of flame at all the burners so that all of the said flame detectors detect the simulated absence of flame to thereupon cause said cycling means to assume a second condition in which the flame failure is not simulated,

means controlled by said cycling means connected to said fuel valve to interrupt the flow of fuel to all of the burners in the event that one of said flame detectors fails to either detect a flame or to detect the simulated absence of flame,

and indicator means connected to be controlled by said flame detector switching means to indicate the the individual one of the flame detectors which so failed.

5. In a fuel burner installation having a plurality of burners with means controlling the flow of fuel to all of the burners, and having a plurality of electronic flame detectors, one of which is associated with each of the burners; a control apparatus providing means to cyclically check the operativeness of each of the flame detectors and to stop the flow of fuel in response to inoperativeness of any of the flame detectors or in response to flame failure at any of the burners, and having means to indicate which one of the flame detectors is inoperative or which one of the burners experienced a flame failure; the control apparatus comprising:

cycling control means having an output connected in controlling relation to the flame detectors and having an input connected to be controlled by the flame detectors, the connection of said input and output being such that a flame failure is simulated upon all of the flame detectors detecting the presence of flame so that all of the flame detectors detect the simulated absence of flame to thereby remove the flame failure simulation to cause cycling of said cycling control means as the operativeness of each of the flame detectors is cyclically checked.

means responsive to failure of said cycling means to so cycle connected to stop the flow of fuel,

a plurality of indicator means one of which corresponds to each of the burners,

and means controlled by the flame detectors operative to render that one of the indicator means operative corresponding to the burner to experience inoperativeness of the flame detector or a flame failure.

6. In combination,

a plurality of electronic flame detectors, each having a flame relay with switch means controlled thereby,

a plurality of neon indicator lights, one of which is associated with each of said flame detectors,

a source of voltage including series connected impedance means,

means interconnecting said neon indicator lights and said flame relay switch means to said source of voltage to apply a firing voltage to the neon indicator light associated with the first flame detector to experience a flame failure, the current rating of each neon indicator light and the magnitude of said impedance means being chosen so that sufficient voltage is developed across said impedance means to prevent

other of the nean indicator lights from subsequently firing,

a first cycling relay including switch means,

circuit means controlled by the switch means of all of said flame relays connecting said first cycling relay to a source of voltage to energize the same upon all of said flame detectors detecting flame,

a second cycling relay including switch means,

circuit means controlled by the switch means of said first and second cycling relays maintaining said first cycling relay connected to the source of voltage until said second cycling relay is energized,

circuit means controlled by the switch means of said first cycling relay, when energized, to simulate the absence of flame at all of said flame detectors,

circuit means controlled by the switch means of all of said flame relays connecting said second cycling relay to a source of voltage to energize the same, upon all of said flame detectors detecting the simulated absence of flame to thereupon deenergize said first cycling relay to interrupt the simulation of the absence of flame,

and circuit means controlled by the switch means of said first and second cycling relays maintaining said second cycling relay connected to the source of voltage until said first cycling relay is energized to thus cause said first and second cycling relays to cycle between energized and de-energized states so long as each of the flame detectors is capable of detecting both the presence of flame and the simulated absence of flame.

7. Burner control apparatus for use with a multiple fuel burner unit to provide indication of the first of the multiple burners to experience a flame failure, comprising:

a plurality of flame detectors, one of which is associated with each of the burners to sense the presence or absence of flame at its respective burner, and each of which includes an output flame relay including switch means,

a plurality of electrically energizable indicators, one of which is associated with each of said flame detectors,

a source of voltage,

impedance means connected in series therewith,

a plurality of parallel circuit means, each of which includes one of said indicators and the switch means of one of said flame relays, said switch means being closed in the absence of flame,

and circuit means connecting said parallel circuit means to said source of voltage through said impedance means, the current rating of each indicator and the magnitude of said impedance means being chosen so that a flame failure at one of the burners is effective to cause its flame detector to sense such failure and to operatively energize its indicator to produce a voltage drop across said impedance means of sufficient magnitude to prevent subsequent operative energization of other indicators.

References Cited in the file of this patent

UNITED STATES PATENTS

2,304,200	Plein et al.	Dec. 8, 1942
2,825,012	Consoliver et al.	Feb. 25, 1958

FOREIGN PATENTS

695,863	Great Britain	Aug. 19, 1953