July 13, 1965 R. W. BROWN 3,194,296

CONTROL APPARATUS

Filed July 26, 1963 3 Sheets-Sheet 1

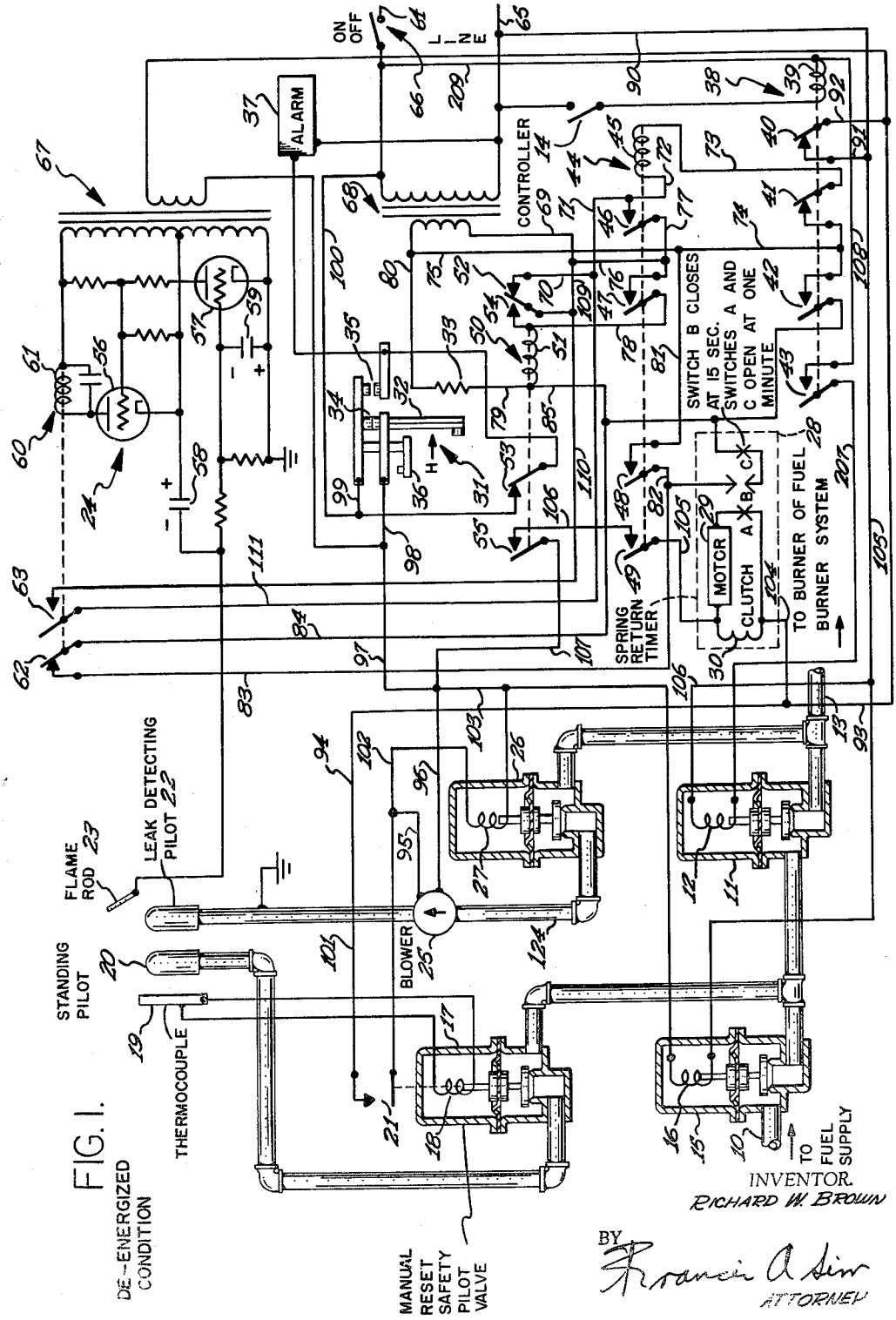

FIG. 1.

DE-ENERGIZED CONDITION

INVENTOR.
RICHARD W. BROWN

BY Francis A Sim
ATTORNEY

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CONTROL APPARATUS

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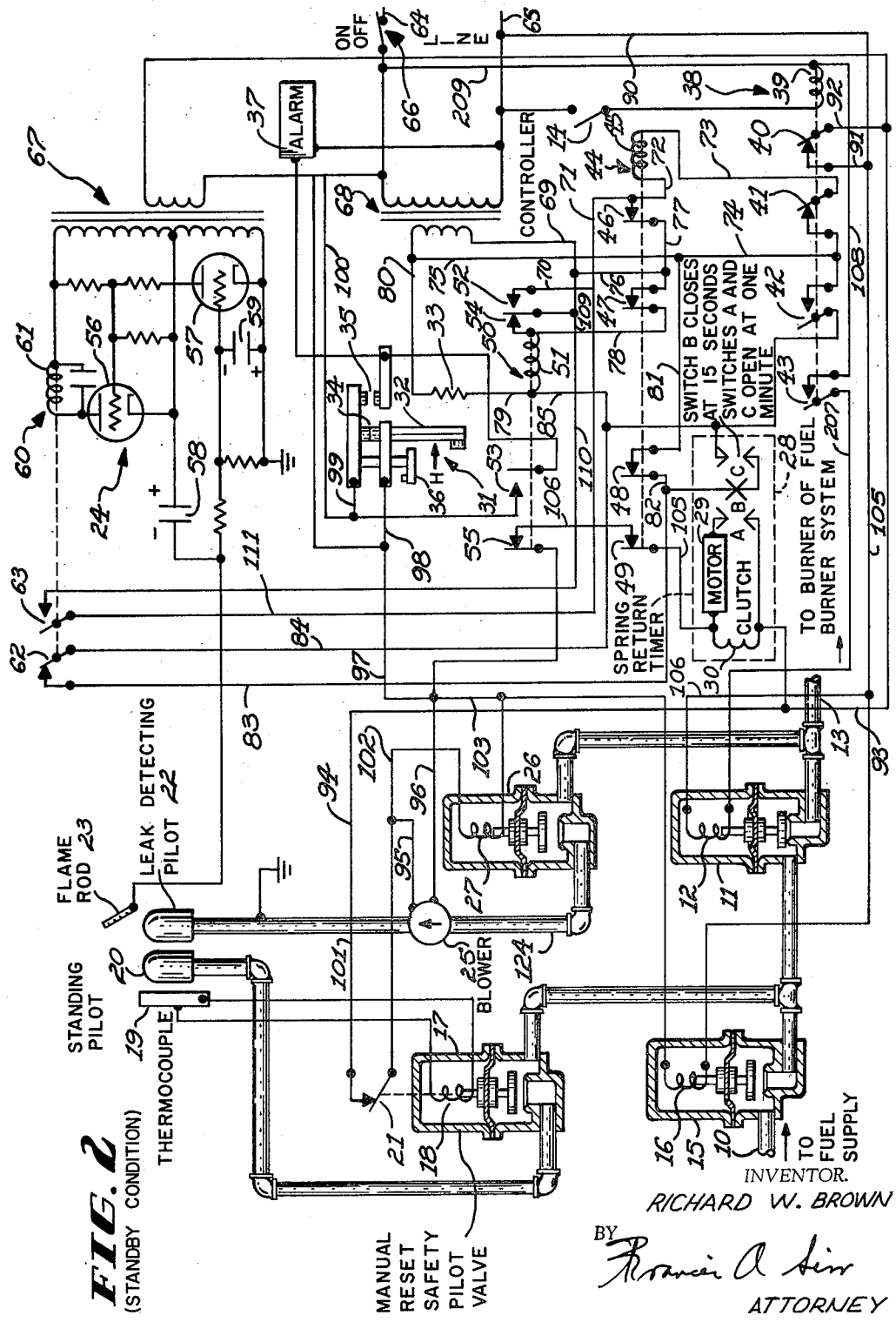

FIG. 2
(STANDBY CONDITION)

INVENTOR.
RICHARD W. BROWN
BY Francis A. Sirr
ATTORNEY

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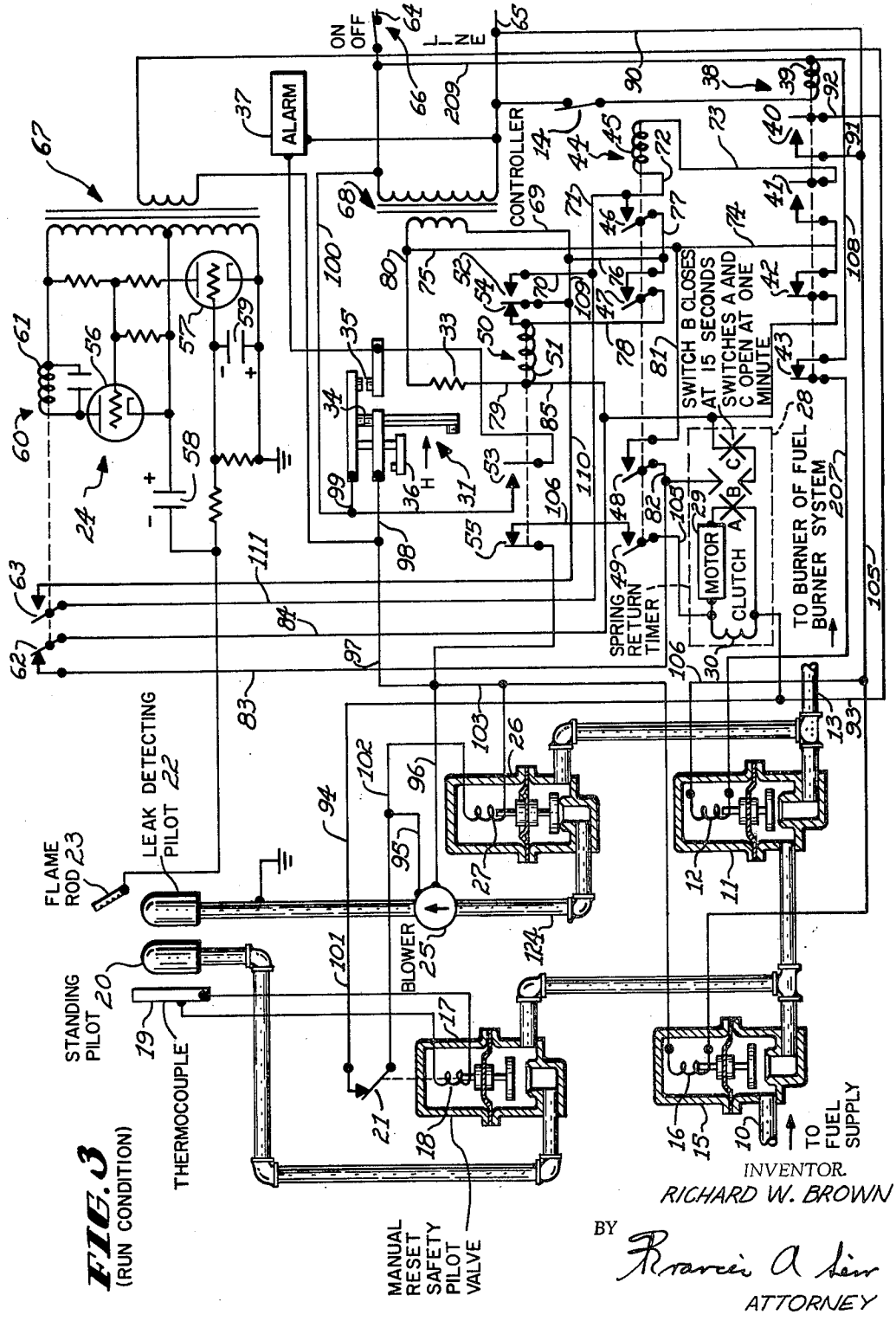

FIG. 3
(RUN CONDITION)

INVENTOR.
RICHARD W. BROWN

BY Francis A. Lee
ATTORNEY

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3,194,296

CONTROL APPARATUS

Richard W. Brown, Excelsior, Minn., assignor to Honeywell Inc., a corporation of Delaware

Filed July 26, 1963, Ser. No. 297,910
8 Claims. (Cl. 158—122)

My invention is concerned with an improved control apparatus and particularly a control apparatus which is adapted for use with a fuel burner installation to check and supervise a fuel valve of a fuel burner installation and to sound an alarm or the like if a leak should occur at this valve.

As is well known, fuel burner installations may utilize various arrangements of ignition means, pilot means, main burners and blower to provide safe lightoff and operation of the main burner, under the control of a controlling device responsive to the need for operation of the fuel burner. This control may be derived either as a result of a predetermined process requirement or as a result of the need for heat in an area to be maintained in a given temperature by operation of the fuel burner installation. Combustion safeguard means are provided to supervise operation of the main burner, under the direct control of a main fuel valve which, when open, allows fuel to flow from a main fuel supply pipe or conduit to the main burner where it is then ignited by ignition means, for example a pilot burner. During the standby period of operation, when heat is not required from the fuel burner installation, the main valve is conditioned to be closed. Various failures may occur at this fuel valve, such as small particles of dirt lodging at the seat of the valve, to result in a fuel leak.

The apparatus of my invention provides improved control apparatus to detect such a fuel leak. I recognize that fuel leak detectors are generally old in the prior art. However, prior art fuel leak detectors do not function to provide the improved supervisory features which my invention incorporates.

Specifically, the structure of my invention provides an arrangement whereby a fuel valve leak detecting apparatus includes a standing pilot which is associated with a thermo-couple, a thermo-couple providing a safety pilot means to maintain flow of fuel to the standing pilot so long as flame is continuously detected at the standing pilot. Operatively associated with the standing pilot I provide a leak detecting pilot which is to be ignited by the standing pilot in the event a leak occurs. The leak detecting pilot is connected at the end of a fuel flow circuit or pipe with a valve conditioned to be opened only when the thermo-couple safety pilot detects flame at the standing pilot and only when the main fuel valve of the burner installation is conditioned to be closed. Thus, I allow the leak detecting pilot to be operative only if two conditions exist. The first condition is that the standing pilot must be present to ignite the leak detecting pilot in the event a leak occurs. The second condition is that the main fuel valve must be conditioned to be closed.

As a further feature of my invention I provide flame detecting means which is associated with the leak detecting pilot to detect flame only at this leak detecting pilot. Furthermore, I provide an arrangement whereby proper operation of my improved apparatus requires that this flame detecting means detect the presence of residual fuel which is downstream of the main valve immediately subsequent to the closing of this main valve.

In other words, it is recognized that a residual amount of fuel will always remain at a position downstream of the main valve immediately after the valve is conditioned to be closed, and after it in fact does close. This residual fuel is supplied to the leak detecting pilot where a momentary flame is produced. The structure of my apparatus requires that the flame detecting means associated with the leak detecting pilot must detect this momentary flame to insure that the flame detecting means is in fact operative and is capable of detecting a flame.

Furthermore, I provide a timer which is energized only after the flame detecting means detects this residual amount of fuel downstream of the main valve, the timer being conditioned to provide a timing period for burnoff of this residual fuel. As a result the apparatus of my invention indicates a leaky valve, sounds an alarm, or closes a further safety valve which is upstream of the main valve, only when a sustained flame exists at the leak detecting pilot after this timing period.

With these general observations in mind, my invention will be apparent to those skilled in the art upon reference to the following specification, claims, and drawing, of which:

FIGURE 1 is a showing of a preferred embodiment of my invention shown in the de-energized condition,

FIGURE 2 is the same embodiment shown in the standby condition, and

FIGURE 3 is the same embodiment shown in the run condition.

Referring to FIGURE 1, reference numeral **10** designates a fuel supply conduit which is connected to a source of fuel which is to be supplied to a fuel burner installation, the components of which are not shown.

The flow of fuel to the fuel burner installation is under the control of a main supply valve **11**, having a winding **12** which, when energized, is effective to open the valve and to allow fuel to flow to a conduit **13** which is connected to the burners of the fuel burner installation. Energization of winding **12** of valve **11** is under the control of a controller **14**, shown as an open switch.

I have chosen not to show the components of the fuel burner installation, and the manner in which controller **14** energizes these components since the exact manner and structure to accomplish this may take many forms. Controller **14** may in fact be pressure responsive or temperature responsive, and may be an automatic actuator to cycle the fuel burner installation automatically, to satisfy a condition to which the controller is responsive. It suffices to say that there are many ways in which controller **14** may operate a fuel burner installation to establish flame at the burner installation. Furthermore, combustion safeguard apparatus may be provided, and is usually provided, to supervise the proper maintenance of flame at the fuel burner installation.

My invention is concerned with detecting a fuel leak at valve **11** and it is intended that my invention be in addition to the normal combustion safeguard devices provided at a fuel burner installation.

Reference numeral **15** designates a safety valve having a winding **16**. Safety valve **15** is connected in fuel-flow series with valve **11** and, as will be apparent, safety valve **15** is normally open and is closed only upon the detecting of a fuel leak, or upon a failure of a component of the fuel leak detecting system.

Reference numeral **17** designates a manual reset safety pilot valve having a winding **18** which is connected to be energized from a thermo-couple **19** associated with a standing pilot burner **20**. As will be apparent, not only is valve **15** normally open, but valve **17** is also normally open to establish a standing pilot flame at pilot burner **20** to thus maintain thermo-couple **19** heated to hold valve **17** open and to maintain a switch **21** in a closed condition. Valve **17** is of the general type in which means are provided to manually open the valve. However, switch **21** is closed, and valve **17** is maintained open only if thermo-couple **19** is heated.

I have chosen first my apparatus in a de-energized con-

dition, to facilitate the explanation of the initial sequence of operation of my invention. Normally, however the apparatus is continuously energized during both the standby (FIGURE 2) and the running (FIGURE 3) period of operation of an associated fuel burner installation.

Reference numeral 22 designates a leak detecting pilot which is associated with standing pilot 20, standing pilot 20 being the ignition means for fuel which is present at leak detecting pilot 22. Flame detecting means, in the form of a flame rod 23 connected to an electronic flame detector 24, is associated with leak detecting pilot 22 and is responsive only to flame at leak detecting pilot 22. Means may be provided to shield flame rod 23 from flame at standing pilot 20 to insure that the flame rod does not detect a flame at the standing pilot.

Leak detecting pilot 22 is connected at the end of a fuel conduit 124, having a blower 25 which, when energized, is effective to cause the medium within conduit 124 to move in the direction of the arrow, toward leak detecting pilot 22. Also connected in conduit 124 is a valve 26 having a winding 27 which is connected to be energized when winding 12 of main fuel valve 11 is de-energized. As will be apparent, blower 25 and winding 27 of valve 26 are energized when the main fuel valve 11 is conditioned to be closed and thus leak detecting pilot 22 samples the medium downstream of main fuel valve 11 only during periods in which valve 11 is conditioned to be closed.

Also, as is apparent, immediately after de-energization of winding 12 of valve 11, to condition this valve to close, a residual amount of fuel remains in fuel conduit 13 downstream of valve 11. This residual fuel causes a momentary flame to be established at leak detecting pilot 22. This flame is detected by the flame detecting means including flame rod 23 and electronic flame detector 24.

The detection of residual fuel is necessary to establish the energization of a timer 28 having a timer motor 29, a clutch 30, and switches A, B, and C. The function of timer 28 is to time a given time period during which burnoff of residual fuel takes place, and to render the fuel leak detecting apparatus effective at the end of this time period.

In the event of a fuel leak, I provide safety cutoff means 31, in the form of a bimetal operated safety switch, having a bimetal actuator 32, a heater 33 therefor, a normally closed switch 34, a normally open switch 35, and a manual reset button 36. Closed switch 34 of safety cutoff means 31 is connected in series with winding 16 of valve 15 and closes this valve upon actuation of the safety cutoff means. The open switch 35 of safety cutoff means 31 is connected in series with an alarm 37 which, when energized, indicates the presence of a fuel leak.

Other major components of my apparatus include a relay 38 having a winding 39 connected in circuit with controller 14, having closed switches 40 and 41, and having open switches 42 and 43. A relay 44, having a winding 45 and open switches 46, 47, 48 and 49, is provided to be maintained energized only during the standby condition of an associated fuel burner installation, and to be first energized during the detection of the burnoff of residual fuel immediately at the end of a period of operation of the main fuel burner installation as a check for the operability of flame detecting means 23–24. Relay 50, having a winding 51, normally closed switches 52 and 53, and normally open switches 54 and 55, is provided to sense a momentary power failure and to also check electrical continuity of heater 33 to insure that safety cutoff means 31 is in fact operative. Furthermore, de-energization of winding 50 is effective, by means of switch 53, to provide a second energizing circuit for alarm 37 to insure that this alarm will be energized at the appropriate time.

Referring to electronic flame detector 24, this flame detector is of conventional design and includes a pair of electron discharge devices 56 and 57 operating as a rectification type flame detector. The output of flame rod 23, when a flame is present at leak detecting pilot 22, is effective to charge a capacitor 58 to the polarity shown. This charge

is transferred to a capacitor 59 to bias discharge device 57 to be non-conductive. The nonconduction of discharge device 57 allows conduction of discharge device 56 to energize a flame relay 60, having a winding 61, a normally closed switch 62, and a normally open switch 63, such energization taking place upon the presence of flame.

Having described the basic components of my apparatus, a detailed description of the operation will now be given.

Energizing voltage for the apparatus is provided from a pair of power line conductors 64 and 65. I have shown in FIGURE 1 a switch 66 as being in the off condition such that the entire apparatus is de-energized. This switch is normally closed and closing of this switch connects the primary windings of transformers 67 and 68 to power line conductors 64 and 65, it being assumed at this time that there is no call for operation of an associated fuel burner installation, and that controller 14 is open.

The closing of switch 66 completes an energizing circuit for valve 15 which can be traced from power line conductor 65 through conductors 90 and 105, valve winding 16, conductors 103, 97 and 98, switch 34, and conductors 99 and 100 to power line conductor 64. Fuel now flows to the upstream side of valves 11 and 17.

Valve 17 is then opened manually (without closing switch 21) and standing pilot 20 is ignited, to heat thermo-couple 19. When thermo-couple 19 is heated sufficiently, manual opening of valve 17 can then be released and the valve remains open, with switch 21 closed, so long as thermo-couple 19 continues to detect flame at standing pilot 20.

The energization of transformer 67 renders flame detector 24 operative, the cathode heaters of the discharge devices 56 and 57 not being shown.

Energization of transformer 68 completes an initial energizing circuit for winding 45 of relay 44 by way of a circuit which can be traced from the bottom terminal of the secondary winding of transformer 68 through conductor 69, switch 52 of relay 50, conductors 70, 71 and 72, winding 45 of relay 44, conductor 73, switch 41 of relay 38, and conductors 74 and 75 to the upper terminal of this secondary winding. Energization of the winding 45 of relay 44 is effective to actuate the switches of this relay. The closing of switch 46 completes a holding circuit to energize the winding of relay 44, this circuit being traced from the lower terminal of the secondary winding of transformer through conductors 69, 76 and 77, switch 46, conductor 72, winding 45, conductor 73, switch 41, and conductors 74 and 75 to the upper terminal of this secondary winding.

The closing of switch 47 completes an energizing circuit for winding 51 of relay 50, which can be traced from the lower terminal of the secondary winding of transformer 68 through conductors 69 and 76, switch 47, conductor 78, winding 51, conductor 79, heater 33, and conductor 80 to the upper terminal of this secondary winding.

The closing of switch 48 completes a circuit which shunts heater 33 during the standby condition of the fuel burner installation, but only so long as flame detector 24 does not detect the presence of flame at leak detecting pilot 22. This shunt circuit can be traced from the upper terminal of heater 33 through conductors 80, 75 and 81, switch 48, conductors 82 and 83, switch 62, and conductors 84, 85 and 79 to the lower terminal of heater 33.

Energization of blower 25 is achieved by means of a circuit which can be traced from power line conductor 65 through conductors 90 and 91, switch 40, conductors 92, 93, and 101, switch 21, conductor 95, blower 25, conductors 96, 97 and 98, switch 34, and conductors 99 and 100 to power line conductor 64.

An energizing circuit for winding 27 of valve 26 can be traced from the above mentioned conductor 94 through conductor 101, switch 21, conductor 102, valve winding 27, conductors 103, 97 and 98, switch 34, and conductors

99 and 100 to power line conductor 64. Thus, valve 26 is conditioned to open and blower 25 is energized.

With both relays 44 and 50 energized, an energizing circuit is completed for timer 28. This energizing circuit can be traced from power line conductor 65 through conductors 90 and 91, switch 40, conductors 92, 93 and 104, clutch 30 and motor 29, conductor 105, switch 49, conductor 106, switch 55, conductors 107, 97 and 98, switch 34, and conductors 99 and 100 to power line conductor 64.

The energization of motor 29 and clutch 30 is effective to cause rotation of the motor, and as indicated, switch B closes at 15 seconds after energization of motor 29 and clutch 30. Switches B and C, in series, form a circuit which shunts the closed switch 62 of flame relay 60 to allow frame relay 60 to respond to the residual fuel downstream of valve 11 immediately after the closing of this valve without causing the energization of heater 33.

At the one minute interval, switches A and C open. The opening of switch C again places flame relay 60 in a condition to supervise energization of heater 33 of cutoff device 31 such that this heater is energized as flame is detected as a result of an actual fuel leak. The opening of switch A de-energizes motor 29. The switches A, B and C are maintained in their actuated positions by virtue of continued energization of clutch 30. Timer 28 is a spring return timer and subsequent de-energization of clutch 30 causes switches A, B and C to return to the position shown in FIGURE 1.

The apparatus is now in a standby condition as shown in FIGURE 2 wherein valves 15 and 17 are open, valve 11 is closed, valve 26 is open, blower 25 is energized, timer 28 is in its actuated position with switch A open, switch B closed and switch C open, relay 38 is de-energized, and relays 44 and 50 are energized.

The medium downstream of main valve 11 is drawn through open valve 26, by means of blower 25 and is presented to leak detecting pilot 22. If this medium, or atmosphere, contains fuel, this fuel is ignited by standing pilot 20 and is detected as a fuel leak by flame detecting means which includes flame rod 23 and electronic flame detector 24.

I will now describe the sequence of operation which takes place upon a need for operation of the associated fuel burner unit, as is evidenced by the closing of controller 14. The closing of this controller effects energization of winding 39 of relay 38, to actuate its associated switches. The opening of switch 40 is effective to de-energize the primary winding of transformer 67 associated with flame detector 24, this primary winding being connected to power line conductor 65 through switch 40. The opening of switch 40 is also effective to de-energize winding 27 of valve 26, blower 25, and timer clutch 30. Switch 42 shorts heater 33 of safety cutoff device 31 during the run cycle of the associated fuel burner installation. The opening of switch 41 is effective to de-energize winding 45 of relay 44.

The closing of switch 43 is effective to complete an energizing circuit for winding 12 of valve 11. This energizing circuit can be traced from power line conductor 65 through conductors 90, 105 and 106 to winding 12, conductor 207, switch 43, and conductors 108 and 209 to power line conductor 64. Thus, valve 11 is conditioned to open and fuel flows to the associated fuel burner unit.

The de-energization of relay 44, as a result of the opening of switch 41, is effective to cause its switches 46 and 47 to open. The opening of switch 46 opens the above traced holding circuit for winding 45 of relay 44. The opening of switch 47 opens the circuit which previously shunted the closed switch 54 of relay 50 and thus relay 50 is maintained energized by way of a circuit which includes only its closed switch 54.

In the event of a power failure at this time, it is necessary that the starting cycle be repeated to energize relay 50.

The apparatus is now in the run condition as shown in FIGURE 3 where valves 15 and 18 are open, valve 11 is open to allow fuel to flow to the fuel burner installation, valve 26 is closed, blower 25 is deenergized, flame detector 24 is inoperative, timer 28 has reset so that switches A and C are closed and switch B is open, relays 38 and 50 are energized, and relay 44 is de-energized. This condition remains until the end of the period of need for operation of the associated fuel burner unit.

At the end of a call for operation of the associated fuel burner unit, as evidenced by the opening of controller 14, relay 38 is again de-energized. The de-energization of this relay connects the primary winding of transformer 67 to power line conductors 64 and 65 to render the electronic flame detector 24 operative. Furthermore, main valve 11 is closed and the fuel leak detecting apparatus, including valve 26 and blower 25, is actuated. At this time there is residual fuel in fuel conduit 13 downstream of main valve 11. This residual fuel produces a flame at leak detecting pilot 22. This flame is detected by means 23–24 and as a result flame relay 60 is energized.

The energization of flame relay 60 causes switch 63 to close. The closing of this switch is effective to complete an energizing circuit for relay 44. This energizing circuit can be traced from the lower terminal of the secondary winding of transformer 68 through conductors 69, 109 and 110, switch 63, conductors 111, 71 and 72, winding 45, conductor 73, switch 41, and conductors 74 and 75 to the upper terminal of this secondary winding. Thus, energization of relay 44 is evidence of the operability of means 23–24 to detect the presence of flame.

As soon as relay 44 is energized, the above traced energizing circuit for motor 29 and clutch 30 of timer 28 is completed to institute a fuel burnoff period, but to institute this period only if flame detecting means 23–24 has proven to be operative.

After a short interval of 15 seconds, switch B of the timer closes to shunt heater 33 of safety cutoff means 31. In the event that flame detector 24 had failed and did not detect the presence of flame which is known to exist as a result of the residual fuel downstream of main valve 11, heater 33 of safety cutoff means 31 would have remained energized and, after a time period of energization, safety cutoff means 31 is actuated to open switch 34 and to close switch 35. As has been mentioned, the opening of switch 34 is effective to close valve 15 as an additional safety feature and to energize alarm 37.

Normally however flame detector 24 is operative and as a result timer 28 is energized. However my apparatus first checks the operability of the flame detector and institutes the residual fuel burnoff timing only after the flame detector operability has been proven.

Timer 28 allows a one minute period for burnoff of the residual fuel which is known to exist downstream of valve 11. After this one minute interval, switch C is opened and heater 33 of safety cutoff means 31 is again placed under the supervision of flame relay 60. In the event that valve 11 has failed to close, and that a leak thus exists at the valve, leak detecting pilot 22 continues to sustain a flame and flame relay 60 remains energized. So long as this relay remains energized, heater 33 of safety cutoff means 31 is also energized and after an additional time period (the timing period of means 31) valve 15 is closed and alarm 37 is energized.

Furthermore, if at any time during the standby period of the associated fuel burner installation (the period of which controller 14 is open) a fuel leak develops at valve 11, flame relay 60 is energized and heater 33 is then energized. After the timing period of safety cutoff means 31, valve 15 will close and alarm 37 will be energized.

From the above description it can be seen that I have provided an improved control apparatus of a type to detect a leak at a fuel valve, and that my apparatus is constructed and arranged to utilize a standing pilot such that

the leak detecting apparatus is operative only if the standing pilot is proven. The timing period, to time burnoff of residual fuel which is known to exist, is instituted only after the residual fuel has been detected by an associated flame detector. Thus, I provide an arrangement whereby the various components are checked, one against the other, to insure that various possible component failures do not result in unsafe operation and reliance on the operability of the control apparatus, when such operability does not in fact exist.

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

I claim as my invention:

1. Fuel leak detecting apparatus comprising:
a fuel burner unit,
a fuel conduit connected between the fuel burner unit and a source of fuel,
a main fuel valve connected in the fuel conduit and adapted to admit fuel to the fuel burner unit only during periods of a need for operation of the fuel burner unit,
a controller operable to determine the periods of a need for operation of the fuel burner unit,
a first pilot burner having first flame sensing means cooperating therewith to sense the presence or absence of flame,
a safety pilot valve connected between the fuel conduit and said first pilot burner, controlled by said first flame sensing means to allow fuel to flow to said first pilot burner so long as flame is sensed thereat,
a second pilot burner having second flame sensing means cooperating therewith to sense the presence or absence of flame, said second pilot burner being adapted to be mounted in cooperating relation to said first pilot burner so that fuel at said second pilot burner is ignited by flame at said first pilot burner,
means including a further valve adapted to be connected to the fuel conduit at a position downstream from the main valve and to be connected to said second pilot burner to admit fuel at said position downstream to said second pilot burner,
means adapted to be controlled by the controller and by said first flame sensing means to cause said further valve to open only when flame is sensed at said first pilot burner during a period when there is no need for operation of the fuel burner unit,
and means controlled by said second flame sensing means to prevent fuel flow to the fuel burner unit in the event of a fuel leak at the main valve as evidenced by the presence of flame at said second pilot burner.

2. Control apparatus for use in detecting a fuel leak at a fuel valve which is connected in a fuel supply conduit to control the flow of fuel therethrough, the apparatus comprising:
a continuously burner pilot burner,
a fuel supply conduit,
a fuel valve connected in said fuel supply conduit to control the flow of fuel therethrough,
flame sensing means responsive to a flame at said pilot burner,
controllable fuel flow means adapted to be connected to the fuel supply conduit at a position downstream of the fuel valve to selectively sample for fuel within the fuel supply conduit at said position downstream,
a second pilot burner operatively associated with said controllable fuel flow means and with said continuously burner pilot burner so that fuel supplied to said second pilot burner by said fuel flow means is ignited by said continuously burning pilot burner,
means including said flame sensing means adapted to control said fuel flow means to connect said second pilot burner in fuel flow relation to said position downstream of the fuel valve only when the fuel valve is conditioned to be closed at a time when a flame is sensed at said continuously burning pilot burner,
and means including second flame sensing means responsive only to a flame at said second pilot burner for preventing fuel flow through said fuel supply conduit in the event of flame being present at said second pilot burner.

3. Fuel leak detecting apparatus for use with a fuel burner system comprising:
a fuel burner,
a fuel supply conduit connected between said fuel burner and a source of fuel,
a main valve in said fuel supply conduit to control the fuel to said fuel burner,
a continuously burning pilot burner and first flame sensing means responsive to the presence of flame thereat,
a second pilot burner associated with said continuously burning pilot burner so that said continuously burning pilot burner constitutes igniting means for said second pilot burner,
sampling means including a normally closed valve and a fuel conduit adapted to be connected to said second pilot burner and to the fuel supply conduit at a position intermediate the fuel burner and the main fuel valve,
means including said first flame sensing means to energize said normally closed valve only when the main fuel valve is conditioned to be closed at a time when a flame is sensed at said continuously burning pilot burner,
second flame sensing means responsive to flame at said second pilot burner,
checking means controlled by said second flame sensing means and operative upon the momentary establishment of flame at said second pilot burner due to residual fuel at the position intermediate the fuel burner and the main fuel valve as fuel normally exists immediately after closing of the main fuel valve,
and safety means controlled by said second flame sensing means and operative upon the presence of a prolonged flame at said second pilot after the closing of the main valve to prevent fuel flow through said fuel supply conduit.

4. Fuel leak detecting apparatus for use with a fuel burner system, operative to detect a fuel leak at a main fuel valve, the apparatus comprising:
a fuel burner system,
a fuel supply conduit connected between said fuel burner system and a source of fuel,
a main fuel valve having an operator, said main fuel valve connected in said fuel supply conduit to control the fuel flow therethrough,
a continuously burning pilot burner and first flame sensing means responsive to the presence of flame thereat to maintain fuel flow to said continuously burning pilot burner,
a second pilot burner associated with said continuously buring pilot burner, said continuously buring pilot burner constituting ignition means for said second pilot burner,
sampling means including a normally closed valve and a sampling fuel conduit adapted to be connected to said second pilot burner and to the fuel supply conduit at a position which is intermediate the fuel burner system and the main fuel valve,
means including said first flame sensing means arranged to open said normally closed valve only when the main fuel valve operator is conditioned to close the main fuel valve at a time when a flame is sensed at said continuously burning pilot burner,

second flame sensing means responsive to flame at said second pilot burner,

timing means,

checking means controlled by said second flame sensing means and operative upon the establishment of flame at said second pilot burner due to the presence of residual fuel which exists at the position intermediate the fuel burner system and the main fuel valve immediately after the closing of the main fuel valve,

means including said checking means to energize said timing means to begin a timing interval for burning off of the residual fuel upon operation of said checking means,

and safety means controlled by said second flame sensing means and by said timing means and operative upon the presence of flame at said second pilot burner after the expiration of said timing interval to prevent fuel flow to said fuel burner system.

5. In combination:

a fuel burner unit having a main valve to control the flow of fuel to a main burner,

a controller operative to selectively control said main valve to be open or to be closed,

a continuously burning first pilot burner having first flame detecting means associated therewith to maintain fuel flow to said first pilot burner so long as flame is detected thereat,

a second pilot burner, arranged to be ignited by said first pilot burner, having second flame detecting means associated therewith to be responsive only to a flame at said second pilot burner,

a fuel flow conduit connecting said second pilot burner to the downstream side of said main valve, said fuel flow conduit including means controlled by said controller and by said first flame detecting means to allow said second pilot burner to sample for fuel at the downstream side of said main valve only when said main valve is controlled to be closed at a time when flame is detected at said first pilot burner,

time delayed safety cutout means having an actuator and switch means to be actuated after a time period of energization of said actuator,

means to render said safety cutout means actuator inoperative when said main valve is controlled to be open,

a relay having a winding and switch means controlled thereby, checking means to check the operating of said second flame detecting means and including said relay winding to initially energize said relay winding when said main valve is initially controlled to be closed and a flame detected at second pilot burner, means including said relay switch means to subsequently maintain said relay winding energized so long as said main valve is controlled to be closed,

a timer, including switch means, to time for a given interval the burnoff of residual fuel at the downstream side of said main valve subsequent to said main valve being controlled to be closed, means including said relay switch means to energize said timer upon energization of said relay winding,

means including said timer switch means and said relay switch means to render said safety cutout means actuator inoperative during said given interval,

and means including said second flame detecting means to render said safety cutout means actuator operative if flame is detected at said second pilot burner subsequent to said given time interval.

6. Control apparatus for use with a fuel burner unit comprising:

a main burner,

a main valve adapted to control the flow of fuel to said main burner,

a controller operative to selectively control said main valve to be open or closed,

a continuously burning first pilot burner having first flame detecting means associated therewith to maintain fuel flow to said first pilot burner so long as flame is detected thereat,

a second pilot burner, arranged to be ignited by said first pilot burner, and having second flame detecting means associated therewith to be responsive only to a flame at said second pilot burner,

a fuel flow conduit adapted to connect said second pilot burner to the downstream side of the main valve, said fuel flow conduit including means adapted to be controlled by the controller and by said first flame detecting means to sample for fuel at the downstream side of the main valve only when the main valve is controlled to be closed at a time when flame is detected at said first pilot burner,

time delayed safety cutout means having an actuator and switch means to be actuated after a time period of energization of said actuator,

a relay having a winding and switch means controlled thereby, checking means to check the operation of said second flame detecting means and including said relay winding to initially energize said relay winding when the main valve is initially controlled to be closed and the residual fuel downstream of the main valve causes a flame to be detected at said second pilot burner, means including said relay switch means to subsequently maintain said relay winding energized,

a timer, including switch means adapted to time for a given time interval the burnoff of the residual fuel at the downstream side of the main valve subsequent to the main valve being controlled to be closed, means including said relay switch means to energize said timer upon energization of said relay winding,

means including said timer switch means and said relay switch means to render said safety cutout means actuator inoperative during said given time interval,

and means including said second flame detecting means to render said safety cutout means actuator operative if flame is detected at said second pilot burner subsequent to said given time interval.

7. Control apparatus for use with a fuel burner unit comprising:

a main burner,

a main valve adapted to control the flow of fuel to said main burner,

a controller operative to selectively control said main valve to be open or closed,

a continuously burning first pilot burner having first flame detecting means associated therewith,

a second pilot burner, arranged to be ignited by said first pilot burner, having second flame detecting means associated therewith and adapted to be responsive only to a flame at said second pilot burner,

a fuel flow conduit adapted to connect said second pilot burner to the downstream side of the main valve, said fuel flow conduit including means adapted to be controlled by said controller and by said first flame detecting means to facilitate sampling for fuel at the downstream side of the main valve only when the main valve is controlled to be closed at a time when flame is detected at said first pilot burner,

time delayed safety cutout means having an actuator and switch means to be actuated after a time period of energization of said actuator,

means to render said safety cutout means actuator inoperative when said main valve is controlled to be open,

a first relay having a winding and switch means controlled thereby, checking means to check the operation of said second flame detecting means and including said first relay winding to initially energize

said first relay winding when the main valve is initially controlled to be closed and a flame is detected at said second pilot burner as a result of residual fuel, means including said first relay switch means to maintain said first relay winding energized when a flame is thus detected,

a second relay having a winding and switch means controlled thereby, means including said second relay winding and controlled by said first relay switch means to initially energize said second relay winding upon energization of said first relay winding, means including said second relay switch means to maintain said second relay winding energized,

means including said first relay winding and controlled by said second relay switch means to energize said first relay winding when the main valve is controlled to be closed and said second relay winding is deenergized,

a timer, including switch means, adapted to time for a given time interval the burnoff of residual fuel at the downstream side of the main valve subsequent to the main valve being controlled to be closed, means including said first and second relay switch means to energize said timer upon energization of said first and second relay windings,

means including said timer switch means and said first relay switch means to render said safety cutout means actuator inoperative during said given time interval,

and means including said second flame detecting means to render said safety cutout means actuator operative when flame is detected at said second pilot burner subsequent to said given time interval.

8. Control apparatus for use with a fuel burner unit to detect a fuel leak at a given portion of the fuel burner unit, comprising:

a fuel burner unit,

controller means operably connected to said fuel burner unit,

a continuously burning pilot burner and a first flame detector responsive to flame thereat,

a second pilot burner arranged to be ignited by said continuously burning pilot burner and having a controllable fuel flow conduit adapted to be connected to a given portion of the fuel burner unit,

means controlled by said first flame detector and said controller means to sample for fuel at the given portion of the fuel burner unit when fuel is not intentionally being admitted thereto,

second flame detecting means responsive to flame at said second pilot burner,

and means controlled by said second flame detecting means having a first check mode of operation requiring the presence of flame at said second pilot burner in response to a burnoff of residual fuel at the given portion of the fuel burner unit as a result of said controller means initially interrupting operation of the fuel burner unit, and having a second leak detecting mode of operation requiring the absence of flame at said second pilot burner after the residual fuel is normally burned off.

References Cited by the Examiner

UNITED STATES PATENTS

2,532,214	11/50	Willenborg	158—123
2,585,882	2/52	Weissman et al.	158—122
2,800,176	7/57	Morrison	158—125
2,839,129	6/58	St. Clair	158—122 X
3,086,583	4/63	Reichow	158—125

FREDERICK L. MATTESON, JR., *Primary Examiner.*

MEYER PERLIN, JAMES W. WESTHAVER, *Examiners.*