

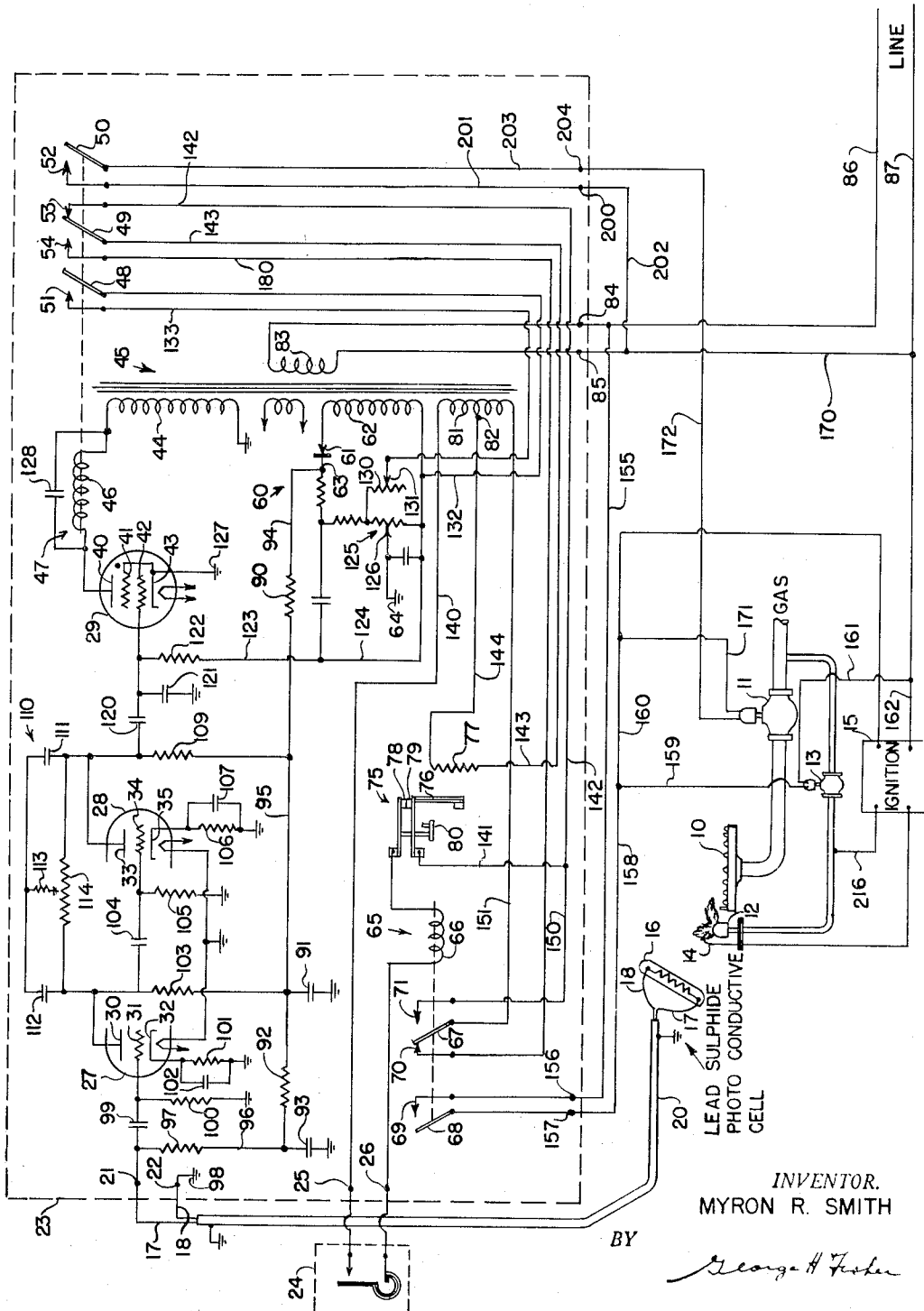
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FUEL BURNER CONTROL APPARATUS

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FUEL BURNER CONTROL APPARATUS

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6 Claims. (Cl. 250—83.3)

The present invention is concerned with an improved fuel burner control apparatus for detecting a burner flame by sensing a particular characteristic of the flame.

It is well known that a burner flame is fluctuating in character, that is, the electromagnetic wave energy emitted by the flame fluctuates in intensity and the conductivity which the flame presents to the flow of electric current fluctuates. The use of a photoelectric cell to detect this characteristic fluctuation in the intensity of wave energy emitted by a flame is shown in the Harry S. Jones patent, 2,304,641, and the use of a flame rod to sense the characteristic fluctuation in conductivity of a flame is shown in the Walter P. Wills Patent 2,352,143.

The detection of a flame by utilizing this characteristic fluctuation in wave energy radiated by the flame is a decided advantage since flame detectors utilizing this principle will not detect the radiant energy given off by the fireboxes wherein the burners are located when these fireboxes are heated to a luminous condition. This is true since the luminous character of the walls of the firebox are of a constant intensity and do not fluctuate as does the burner flame.

An additional improvement was made to this type of detector, which detected the fluctuating characteristic of the flame, when the flame detector was used with a lead sulphide photo-conductive cell. When utilizing this type of cell it was found that both oil and gas flames could be detected since the lead sulphide photo-conductive cell is sensitive to the infrared region and both the gas and oil flame emit radiations which are predominantly in the infrared region. The use of a conventional flame electrode allows the flame detector to be used only to detect a gas flame since an oil flame tends to cause the flame electrode to be covered with an excessive amount of carbon and the flame electrode is therefore unable to withstand the excessive temperatures of an oil flame. When the conventional photo-emissive cell, such as the cesium oxide silver cell, is used to detect flame it has been found that only the oil flame can be detected since this type of cell is not sensitive to the radiations from a gas flame while it is sensitive to the shorter electromagnetic waves radiated from the oil flame.

It has also been found that controls such as that shown in the above mentioned Jones and Wills patent operate more successfully if a filtering means is used to reject all control signals received from the flame sensing means which are not in the characteristic frequency range of fluctuation of the flame. It will be immediately recognized that the conductors running from the flame sensing means to the control will pick up stray signals, for example, a 60 cycle per second signal when the control is used with a 60 cycle alternating current source of power. The shielding of these conductors eliminates stray signals to a certain extent, however a filter means was used to insure that the control would be sensitive to only control signals within the characteristic frequency range indicative of flame. It has been found that this characteristic frequency of fluctuation in a flame is pre-

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dominately in the range of from 10 to 30 cycles per second

It therefore became necessary to develop a burner control apparatus which would be sensitive only to this low frequency range and yet had a simple filter means which would not burden the burner control apparatus with an excessive number of components so as to render the control apparatus acceptable in a relatively competitive market.

It is therefore an object of the present invention to provide an improved burner control apparatus having a flame sensing means to detect the fluctuating characteristic of a flame and having a simple filter network rendering the flame detector frequency selective to only the frequencies of fluctuation of the flame.

It is a further object of the present invention to provide an electronic flame detector having a photoelectric cell to detect the presence of flame and having associated therewith a filter network connected in a frequency selective degenerative feedback circuit to render the electronic flame detector sensitive to only that range of frequencies including the characteristic fluctuation in the flame to be detected.

The copending application of James W. Smith et al., Serial Number 268,182, filed January 25, 1952, shows a combustion safeguard apparatus utilizing a frequency selective amplifier in a novel adaptor unit which is used with a conventional type electronic flame detector to provide an apparatus which responds only to the flickering characteristics of the flame. This copending application also discloses a novel structure whereby a flame rod and a photocell are selectively connected to the conventional type electronic flame detector, the flame rod being directly connected and the photocell being connected through the adaptor unit.

The single figure is a circuit diagram of the improved burner control apparatus used in conjunction with a gas main burner and gas pilot burner.

The main gas burner 10 is shown with a valve 11 controlling the flow of fuel thereto. A pilot burner 12 is located in an igniting relationship to the main burner 10 and has a valve 13 controlling the flow of fuel thereto. Associated with the pilot burner 12 is an ignition electrode 14 connected to an ignition transformer 15 with the circuit for the ignition transformer 15 being completed by a connection 216 to the pilot burner 12.

A lead sulphide photoconductive cell 16 is normally positioned to view both the flame emitted from the pilot burner 12 and the flame emitted from the main burner 10. The photo-conductive cell 16 is connected by means of conductors 17 and 18, which conductors are shielded by a shield 20, to the input terminals 21 and 22 of a control apparatus shown within the broken line 23.

The burner control apparatus 23 is under the control of a condition responsive means such as a thermostat 24 which is located in the space to be heated by the main burner 10. The thermostat 24 is arranged so that on a call for heat, or a need for operation of the burner 10, a circuit is completed from terminal 25 to terminal 26 of the control apparatus 23.

The control apparatus 23 includes an input stage including a first electron discharge device 27, an intermediate stage including a second electron discharge device 28 and an output stage including a third gaseous electron discharge device 29. The discharge device 27 comprises an anode 30, a control electrode 31 and a cathode 32. The discharge device 28 comprises an anode 33, a control electrode 34 and a cathode 35. The gaseous discharge device 29, commonly known as a thyatron, includes an anode 40, a suppressor electrode 41, a control electrode 42 and a cathode 43.

The discharge device 29 has as its power source a

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secondary 44 of a transformer 45 and is arranged to energize a relay winding 46 of a relay 47. Switch blades 48, 49, and 50 of the relay 47 are biased by means not shown to the position shown in the single figure when the relay 47 is not energized. Upon energization of the relay 47 the switch blades 48 and 50 move into engagement with stationary contacts 51 and 52 respectively. The switch blade 49 on the relay 47 becoming energized disengages contact 53 and moves into engagement with contact 54.

The discharge devices 27 and 28 are energized by means of a direct current power source 60 having a selenium rectifier 61 connected to a secondary 62 of the transformer 45 to produce a direct current voltage source wherein terminal 63 is rendered positive with respect to ground terminal 64.

Connected in circuit with the before mentioned input terminals 25 and 26, which are arranged to be connected by the thermostat 24, is a relay 65 having a winding 66. Switch blades 67 and 68 of the relay 65 are biased by means not shown to assume the position shown in the single figure when the relay winding 66 is not energized. Upon the energization of the relay winding 66 the switch blade 68 moves into engagement with stationary contact 69 and the switch blade 67 moves out of engagement with a stationary contact 70 and moves into engagement with stationary contact 71.

Also in circuit with the relay winding 66 is a safety cut-out device 75. The safety cut-out device 75 comprises a bimetal actuator 76 having a bimetal heater 77 associated therewith and having normally closed contacts 78 and 79. Upon the heating of the bimetal warps to the right and allows the contact 79 to disengage from the contact 78. Upon cooling of the bimetal 76 a reset actuator 80 can be depressed to again reset the safety cut-out device and when the reset actuator 80 is released the device will again assume the position shown in the single figure.

The winding 66 of the relay 65 is connected in circuit with the safety cut-out device 75 and the bi-metal heater 77 to be energized by a secondary winding 81 of the transformer 45. A center tap 82 is provided on this secondary winding 81. A primary winding 83 for the transformer 45 is connected to terminals 84 and 85 which are adapted to be connected to power line conductors 86 and 87.

Referring particularly to the operation of the three electronic stages of the control apparatus 23, the proper signal applied to the input terminals 21 and 22 is amplified by the electronic discharge devices 27 and 28 and their associated circuits and is applied to the control electrode 42 of the thyatron 29 to cause energization of the relay 47 in the manner to be described.

As before mentioned, the lead sulphide photo-conductive cell 16 is sensitive to the infrared wave energy being radiated by the flame at the pilot burner 12 and the main burner 10. This infrared wave energy fluctuates in intensity in a characteristic frequency range of from 10 to 30 cycles per second. This causes the conductivity of the cell 16 to vary in a characteristic frequency range of from 10 to 30 cycles per second. A direct current source of voltage is supplied to the cell 16 from the direct current source of power 60 through two graded RC filters comprising a resistor 90, a capacitor 91, a resistor 92, and a capacitor 93. This energizing circuit for the photo-conductive cell 16 can be traced from the terminal 63 of the power supply 60 through conductor 94, resistor 90, conductor 95, resistor 92, conductor 96, load resistor 97, input terminal 21, conductor 17, photoconductive cell 16, conductor 18, input terminal 22, and ground connection 98 to the negative terminal of the power supply 60 at ground connection 64. A fluctuating direct current flows in this circuit when the photoconductive cell 16 is exposed to a flame and a fluctuating signal voltage is thereby developed across the load resistor 97.

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This fluctuating control signal is applied to the control electrode 31 of the discharge device 27 through a blocking capacitor 99 and a resistor 100. This first amplification or input stage is a conventional stage making use of cathode biasing obtained by cathode resistor 101 and capacitor 102. The fluctuating control signal is amplified by the electronic discharge device 27 and is developed across a plate load resistor 103 which connects the direct current source of power 60 to the anode 30.

The amplified control signal developed across the plate load resistor 103 is applied to the control electrode 34 of the discharge device 28 through the input circuit of the intermediate stage including a coupling capacitor 104 and a resistor 105. The second amplifying or intermediate stage is also a conventional stage making use of cathode biasing by means of cathode resistor 106 and capacitor 107. The control signal is again amplified by the discharge 28 and is developed across a plate load resistor 109 in its output circuit which connects the direct current source of power 60 to the anode 33.

The second amplifying stage of the control apparatus 23 as so far described would amplify all signals applied to the input terminals 21 and 22 and would cause the gaseous discharge device 29 to fire regardless of the frequency of the input signal. As before mentioned, the only signal which is indicative of the pressure of flame at the pilot burner 12 of the main burner 10 lies within the frequency range of from 10 to 30 cycles per second. It is therefore desirable to render the control apparatus 23 selective to frequencies lying only within this predetermined range. Two things to be considered while selecting the proper circuit to render this amplifier as so far described frequency selective are, first, that the amplifier must be selective to a relatively low frequency and second, that the means used to render the amplifier frequency selective must be relatively simple so as not to unduly burden the control apparatus 23 with the large number of components.

In the present invention it has been found desirable to connect a bridge T null network from the anode 33 of the discharge device 28 to the control electrode 34 of this discharge device. This bridge T null network is shown generally at 110 and has a first capacitive leg 111 connected to the anode 33 of the discharge device 28. A second capacitive leg 112 is connected through the coupling capacitor 104 to the control electrode 34 of the discharge device 28. A third resistive leg 113 is connected to ground or reference potential as the cathode 35 of the discharge device 28 is connected to the reference potential through the resistor 106. A bridging resistor 114 is provided which shunts the first and second capacitive legs 111 and 112 respectively.

In the present invention it has been found desirable to select the following values for the components of the bridge T null network.

Resistor 113.....	.2 megohm.
Resistor 114.....	10 megohms.
Capacitor 111.....	.005 microfarad.
Capacitor 112.....	.005 microfarad.

The operation of this bridge T null network can be readily understood when it is recognized that this network is connected to give degenerative feed-back from the anode 33 to the control electrode 34 of the discharge device 28. The nature of this feed-back is such that for all frequencies except that within a predetermined range, 10 to 30 cycles per second, this second amplifier stage is degenerative and the control signal for these frequencies is not developed across the plate load resistor 109 of the discharge device 28. For control signals lying within the range of from 10 to 30 cycles per second which are applied to the input terminals 21 and 22 the bridge T null network 110 is not a degenerative feedback circuit and

a signal voltage of from 10 to 30 cycles per second is developed across the plate load resistor 109.

The control signal developed across the plate load resistor 109 is applied to the control electrode 42 of the discharge device 29 through blocking capacitor 120 and capacitor 121. A biasing circuit is supplied for the discharge device 29 and can be traced from the control electrode 42 through a resistor 122, conductor 123, conductor 124, potentiometer 125, potentiometer tap 126, ground connection 64, and ground connection 127 to the cathode 43 of the discharge device 29. The nature of the voltage present across the potentiometer 125 is such that a negative bias is supplied to the discharge device 29 and the position of the tap 126 determines the sensitivity of the discharge device 29, that is, the greater the negative bias supplied to the device 29, the greater the magnitude of signal developed across the plate load resistor 109 necessary to fire the discharge device 29.

When a signal of the proper magnitude is developed across the plate load resistor 109 the gaseous discharge device 29 will fire to energize the relay 47. Since alternating current power is supplied to the anode cathode circuit of the discharge device 29, pulsating current will flow through the winding 47 and a filtering capacitor 128 is provided across the winding 46 to filter this pulsating current.

A set-back control is also provided for the discharge device 29. The function of this set-back control is to reduce the direct current bias voltage on the discharge device 29 when the relay 47 becomes energized and thereby insure that the relay 47 will be positively energized and that the associated switch contacts will be positively moved to their actuated positions. The set-back control comprises a potentiometer 130 having a movable tap 131. Assuming that relay 47 is energized, a biasing circuit for discharge device 29 can be traced from the control electrode 42 through resistor 122, conductor 123, conductor 124, conductor 132, movable switch blade 48 and contact 51 of relay 47, conductor 133, movable tap 131 of potentiometer 130, movable tap 126 of potentiometer 125, ground connection 64, and ground connection 127 to the cathode 43 of the discharge device 29. The potentiometer 130 is effectively in parallel with the potentiometer 125 and the effect of this parallel connection is to reduce the negative bias voltage applied to the control electrode 42 of the discharge device 29 thereby increasing the sensitivity of the discharge device 29 once the relay 47 has been energized.

Operation

It will first be assumed that the thermostat 24 is not calling for heat, that the valves 11 and 13 are deenergized and that the ignition transformer 15 is deenergized. Upon a subsequent call for heat by the thermostat 24, relay 65 will be energized by means of a circuit which can be traced from the upper terminal of the secondary 81 through conductor 140, terminal 25, thermostat 24, terminal 26, relay winding 66, safety cut-out contacts 78 and 79, conductor 141, conductor 142, stationary contact 53 and movable switch blade 49 of relay 47, conductor 143, safety cut-out heater 77, and conductor 144 to the tap 82 of the transformer secondary 81. It will be noted from this last traced circuit that it is necessary for the relay 47 to be deenergized so that the movable switch blade 49 will engage stationary contact 53 in order for the relay 65 to be energized. This is a component checking feature in the improved burner control apparatus and insures that upon the relay 47 being energized to falsely indicate flame it is impossible for the relay 65 to be energized and, as will be explained later, unless the relay 65 is energized the valves 11, 13 and the ignition transformer 15 cannot be energized.

Energization of the relay 65 causes the movable switch blades 67 and 68 to move to their operative position. The movement of the switch blade 67 to engage the contact 71 establishes a holding circuit for the relay 65 which is

independent of the safety cut-out heater 77. This circuit can be traced from the upper terminal of the secondary 81 through conductor 140, terminal 25, thermostat 24, terminal 26, relay winding 66, contacts 78 and 79 of the cut-out device 75, conductor 141, conductor 150, contact 71 and switch blade 67 of relay 65, and conductor 151 to the lower terminal of the secondary 81. However the heater 77 of the safety cut-out device remains energized through a circuit which can be traced from a tap 82 of the secondary 81 through conductor 144, heater 77, conductor 143, switch blade 49 and contact 53 of relay 47, conductor 142, conductor 150, stationary contact 71 and switch blade 67 of relay 65, and conductor 151 to the lower terminal of the secondary 81. In order to deenergize the heater 77 of the cut-out device 75 it is necessary for the relay 47 to be energized thereby braking the above traced circuit when a switch blade 49 disengages from the stationary contact 53.

Energization of the relay 65 also causes the movable switch blade 68 to engage the stationary contact 69. This causes the valve 13 and the ignition transformer 15 to be energized by means of wiring which is external to the control apparatus 23. The energizing circuits for the valve 13 and the ignition transformer 15 can be traced from the power line conductor 86 through conductor 155, terminal 156, stationary contact 69 and movable switch blade 68 of relay 65, terminal 157, conductor 158, conductors 159 and 160 to the valve 13 and the ignition transformer 15 respectively and conductors 161 and 162 from the valve 13 and the ignition transformer 15 respectively to the power line 87.

Gas now passes to the pilot burner 12 and is ignited by means of the ignition transformer 15 and the ignition electrode 14. The lead sulphide photoconductive cell 16 senses the fluctuations in infrared radiations emitted by the flame at the pilot burner 12 and supplies a signal in the characteristic frequency range of from 10 to 30 cycles per second to the input terminals 21 and 22 of the control device 23. In the matter above described the relay 47 of the control apparatus 23 is energized as an indication of the presence of flame at the pilot burner 12. The movable switch blades 48, 49, and 50 are therefore actuated to their energized positions.

Movable switch blade 48 engaging contact 51 completes the set-back circuit for the discharge device 29 and increases the sensitivity of the discharge device in the manner above described. The switch blade 49 disengages from the contact 53 to deenergize the heater 77 of the cut-out device 75 in the manner above described. The switch blade 49 then engages the stationary contact 54, the purpose of this arrangement is to provide a further safety feature in the improved burner control apparatus which will be described later.

Engagement of the switch blade 50 with the stationary contact 52 is effective to energize the valve 11 and thereby cause gas to flow to the main burner 10. This energizing circuit can be traced from the power line conductor 87 through conductor 170, conductor 202, terminal 200, conductor 201, contact 52 and switch blade 50 of relay 47, conductor 203, terminal 204, conductor 172, valve 11, conductor 171, conductor 160, conductor 158, terminal 157, switch blade 68 and contact 69 of relay 65, terminal 156, and conductor 155 to power line conductor 86.

A flame will now be established at the main burner 10 and heat will be supplied to the space wherein the thermostat 24 is located.

Operation on flame failure

Should the flame at the pilot burner 12 and main burner 10 now accidentally become extinguished, the photoconductive cell 16 no longer senses the characteristic fluctuations of the flame and although electrical disturbances may be picked up in the shielded conductors 17 and 18 and applied to the input terminals 21 and 22, the before mentioned bridge T null network 110 connected to be

degenerative to all frequencies other than the characteristic fluctuations of the flame will prevent these disturbances from firing the discharge device 29. A voltage is no longer developed across the plate load resistor 109 and the gaseous discharge device 29 is extinguished on the alternating current half cycle that the anode 40 is negative with respect to the cathode 43. The discharge device 29 remains in the inactive condition because of the absence of a signal voltage across resistor 109 and the relay 47 is deenergized.

The switch blade 48 disengages from the contact 51 and thereby decreases the sensitivity of the gaseous discharge device 29. The movable switch blade 49 engages the contact 53 to again energize the safety cut-out heater 77 in the manner above described. The movable switch blade 50 disengages from the contact 52 to deenergize the valve 11 and thereby turn off the flow of gas to the main burner 10. However, the energizing circuit for the valve 13 and the ignition transformer 15 is unaffected since relay 65 remains energized to retain the movable switch blade 68 engaged with the contact 69 of relay 65, which switch blade and contact control the energization of the valve 13 and ignition transformer 15.

A predetermined time after the deenergization of relay 47 the safety cut-out heater 77 heats the bimetal 76 to a point where it warps to the right and allows the contact 79 of the cut-out device to disengage from the contact 78. This deenergizes the relay 65 to cause the switch blade 68 to disengage from the contact 69 thereby deenergizing the valve 13 and the ignition transformer 15.

The opening of the cut-out device contacts 78 and 79 also deenergizes the heater 77 of the cut-out device and a predetermined time thereafter, the bimetal 76 returns to its cool condition. An operator may then actuate the reset button 80 to again reset the contacts 78 and 79 to their engaged position. The apparatus is now in a condition to make a second attempt to establish flame at the pilot burner 12 and the main burner 10 if there is still a need for such operation as evident by the thermostat 24.

Operation on false indication of flame

It will now be assumed that the thermostat 24 has been satisfied and has caused the connection from terminal 25 to terminal 26 to be broken. Relay 65 is thereby deenergized and causes the valve 11, the valve 13 and the ignition transformer 15 to be deenergized.

It will also be assumed that the relay 47 does not respond to the absence of flame at the pilot burner 12 and the main burner 10 caused by the deenergization of the valves 13 and 11 respectively. The apparatus has now returned to the position shown in the single figure with the exception that the relay 47 remains energized to falsely indicate the presence of flame. Under these conditions an energizing circuit can be traced for the heater 77 of the safety cut-out device from the tap 82 of the secondary 81 through conductor 144, heater 77, conductor 143, switch blade 49 and contact 54 of relay 47, conductor 180, contact 70 and movable switch blade 67 of relay 65, and conductor 151 to the bottom terminal of the secondary 81. After a predetermined length of time the safety cut-out device 75 will be actuated to cause disengagement of the contacts 78 and 79. The thermostat 24 can therefore no longer cause energization of the relay 65 since the energizing circuit for relay 65 is open at safety cut-out contacts 78 and 79.

So long as this faulty condition exists and relay 47 falsely indicates a presence of flame, depressing actuator 80 of the safety cut-out device 75 does not reset the contacts 78 and 79 to their engaged positions since the heater 77 will remain energized by means of the above traced circuit, which circuit will remain energized as long as relay 47 falsely indicates the presence of flame. In order to again establish flame at the main burner 10 it is necessary for the fault in the system to be corrected so that the flame relay 47 again returns to its no flame posi-

tion as shown in the single figure. The bimetal 77 then cools and cut-out device 75 is in a condition to be reset by means of reset actuator 80.

It can therefore be seen that I have shown an improved burner control apparatus capable of sensing the fluctuating characteristics of the flame and having a simple and inexpensive filter network connected to render the burner control apparatus frequency responsive to the characteristic fluctuations of the flame.

I claim as my invention:

1. A flame detector for use with a fuel burner which supports a flame fluctuating in intensity in a characteristic frequency range when fuel is supplied thereto, comprising: a photoelectric means sensitive to the presence of a flame; an amplifier having an input stage and an output stage adapted to control a burner control means; means connecting said photoelectric cell to the input stage of said amplifier; an intermediate stage within said amplifier means having an input and an output circuit with said circuits connected to a reference potential level; and a null network connected to form a feedback circuit from said input circuit to said output circuit of said intermediate stage; said network including a first resistor directly connected in an alternating current sense at one end to said input circuit and at the other end to said output circuit, two series connected capacitors connected in parallel with said first resistor, and a second resistor connected from the common connection of said capacitors to said reference potential level; said network thereby causing said intermediate stage to reject all signal voltages not within a predetermined band of frequencies substantially identical to the characteristic frequency range of the flame by producing degeneration of all signal voltages not within said predetermined band of frequencies.

2. A flame detector for detecting the characteristic fluctuations in intensity of the infrared radiations emitted by a flame and for use with a burner which supports a flame when fuel is supplied thereto, comprising: a photoconductive cell sensitive to infrared wave energy, said cell varying in conductivity in accordance with the fluctuations in the intensity of infrared radiation impinging upon said cell when said cell is exposed to a flame; a direct current source of power; a load impedance; means connecting said source of power, said load impedance and said photoconductive cell in series whereby a fluctuating signal is developed across said load impedance when said cell is exposed to a flame; amplifier means having an input stage, an intermediate stage having an input and an output circuit connected to a reference potential level, and an output stage adapted to control the energization of a burner control means; means connecting said photoconductive cell to the input stage of said amplifier means, and a null feedback network associated with said intermediate stage to thereby cause said intermediate stage to be degenerative to all signals not within the range of the characteristic fluctuations of a flame, said null network including a first resistor directly connected in an alternating current sense from the input to the output circuit of said intermediate stage, two series connected capacitors connected in parallel with said first resistor, and a second resistor connected from the common connection of said two capacitors to said reference potential level.

3. A flame detector for detecting the characteristic frequency range of fluctuation in intensity of the infrared wave energy emitted by a flame and for use with a fuel burner, comprising: a photoconductive cell sensitive to infrared wave energy, said cell varying in conductivity in accordance with the characteristic fluctuations in intensity of the infrared wave energy when said cell is exposed to a flame, a source of direct current power, a load resistor; means connecting said source of power, said load resistor and said photoconductive cell in a series circuit whereby a fluctuating signal voltage is developed

across said load resistor when said cell is exposed to a flame; amplifier means comprising an electron discharge device having an anode, cathode and control electrode; means connecting said load resistor through a coupling capacitor to said control electrode; means connecting said cathode to a reference potential; a bridge T null network associated with said electron discharge device to form a frequency selective degenerative feed-back circuit which is effective to cause said amplifier means to substantially reject all fluctuating control voltages applied to said control electrode which do not lie within the characteristic frequency range of fluctuation of a flame, a first capacitive leg of said T network connected to said control electrode through said coupling capacitor, a second capacitive leg connected directly to said anode, a third resistive leg connected to said reference potential and a bridge resistor connected directly to said anode and through said coupling capacitor to said control electrode and means connected to said anode to be energized when said fluctuating signal voltage applied to said control electrode lies within said characteristic frequency range and adapted to control burner control means.

4. A flame detector for use with a fuel burner which supports a flame emitting infrared wave energy fluctuating in intensity in a characteristic frequency range comprising, a photoelectric cell sensitive to infrared wave energy, an amplifier having an input stage, an intermediate stage and an output stage; means energized by said output stage when a control signal is applied to said output stage and adapted to control burner control means; means connecting said photoelectric cell to said input stage to thereby apply a fluctuating control signal of a characteristic frequency range to said input stage when said photoelectric cell is exposed to a flame; a direct current source of power; an electron discharge device in said intermediate stage and having a cathode, anode and control electrode; means connecting said cathode to a reference potential level; means connecting said anode through a load impedance to said direct current source of power; means connecting the connection of said load impedance and said anode to said output stage; means connecting said control electrode to said input stage through a coupling capacitor, and a bridge T null network connected to form a degenerative feedback circuit for said intermediate stage, said bridge T network having a first capacitive leg connected to said control electrode through said coupling capacitor, a second capacitive leg connected to the connection of said load impedance and said anode, a third resistive leg connected to said reference potential level and resistance means connected from the connection of said load impedance and said anode to said control electrode through said coupling capacitor, said intermediate stage thereby being degenerative to all control signals not within said characteristic frequency range to effectively prevent all such control signals from affecting said output stage.

5. A flame detector for use with a fuel burner to detect a flame at the burner by sensing a characteristic fluctuation in the flame, comprising: flame sensing means for sensing the characteristic fluctuation in a flame; an electronic amplifier having a plurality of stages; means connecting said flame sensing means to the input stage of

said amplifier to apply a control signal of said characteristic fluctuation to said amplifier when said flame sensing means is exposed to a flame; a further stage for said amplifier having an input circuit connected to a reference potential level and an output circuit including a load impedance connected to the output of said further stage and to said reference potential level, means connecting said input stage to the input circuit of said further stage through a coupling capacitor, said further stage having a bridge T null network associated therewith to form a frequency selective degenerative feedback circuit for said further stage to cause said further stage to be degenerative to all control signals not within the range of characteristic fluctuation of a flame, said bridge T network having a first capacitive leg connected through said coupling capacitor to the input circuit of said further stage, a second capacitive leg connected to the connection of said load impedance to the output of said further stage, a third resistive leg connected to said reference potential, and bridge resistive means having one end connected to the connection of said load impedance to the output of said further stage and the other end connected through said coupling capacitor to the input circuit of said further stage; and means adapted to connect the output circuit of said further stage to control burner control means, said last named means being effective only when the control signal applied to said input stage is within the range of characteristic fluctuation of a flame.

6. A flame detector for use with a fuel burner which supports a flame when fuel is supplied thereto, comprising, flame sensing means sensitive to fluctuation in the intensity of electromagnetic wave energy emitted by a flame to supply a fluctuating control signal indicative of the presence of flame, amplifier means having an input and an output and having a reference potential, bridge T filter means associated with said amplifier means to render said amplifier means frequency selective to only that range of frequencies including said fluctuation in wave energy emitted by a flame, said filter means having a first capacitive leg directly connected to the output of said amplifier means and a second capacitive leg directly connected in an alternating current sense to the input of said amplifier means, a third resistive leg connected to said reference potential, and resistor bridging said first and second legs, means connecting said photoelectric flame sensing means in controlling relation to the input to said amplifier, and means rendered operative upon a control signal within said range of frequencies being supplied to the input of said amplifier means and adapted to control burner control means.

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