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BURNER CONTROL APPARATUS

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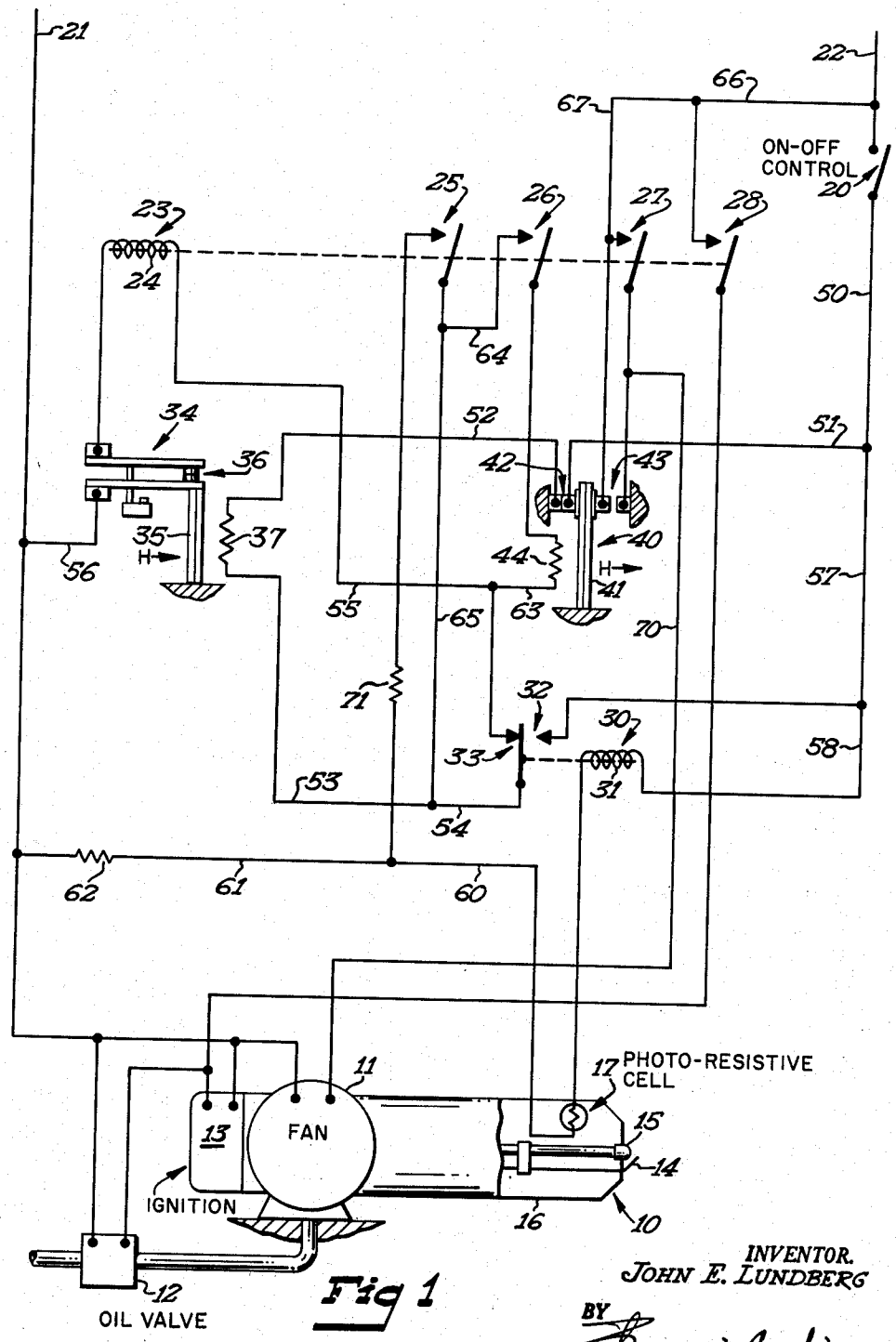



Fig 1

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# BURNER CONTROL APPARATUS

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The present invention is concerned with an improved burner control apparatus and particularly with a burner control apparatus utilizing a photoresistive cell as the flame sensing means, the photoresistive cell being connected into a unique electrical circuit providing optimum conditions of operation for the photoresistive cell.

The photoresistive cell can be characterized as an electrical impedance element which is photosensitive and which has a high dark resistance, this resistance being, for example, in the nature of 100,000 ohms. This resistance greatly decreases, for example to approximately 500 ohms, when the cell is subjected to the light from a flame. An example of such a cell is the cadmium sulfide photocell which possesses current carrying capabilities allowing direct operation of a flame relay. That is, the cadmium sulfide cell may be connected directly in circuit with the flame relay without the interposition of amplifying means.

The present invention is concerned with a burner control apparatus utilizing such a cell and further providing a unique electrical circuit such that upon initial call for operation of an associated fuel burner unit, a relatively high operating voltage is applied to the cadmium sulfide cell, for example 50 volts, such that an unsafe dark resistance, for example 10,000 or less ohms, of the cadmium sulfide cell will cause the flame relay to falsely pull in and by virtue of a component checking circuit, operation of the associated fuel burner unit is prevented.

Should the cadmium sulfide cell possess a safe dark resistance, as it normally does, a main control relay is energized and a further circuit is provided to lower the operating voltage of the cadmium sulfide cell from the higher initial voltage to a lower operating voltage, for example 30 volts. This lowering of the voltage of the cadmium sulfide cell prevents possible damage to the cell due to arcing or the like which may occur at the higher voltage due to moisture or deposits of conductive material on the cell. Furthermore, the current flowing through the cell is reduced at this lower voltage and thus the heating of the cell due to the power dissipation in the cell is reduced.

When flame is detected, the flame relay is operative to again modify the circuit which supplies voltage to the cadmium sulfide cell and as a result the operating voltage of the cadmium sulfide cell is lowered to a still lower value, for example 20 volts, during the running period of the fuel burner unit. As has been mentioned, the resistance of the cadmium sulfide cell during running of the fuel burner unit is relatively low. The lowering of the voltage during this period reduces the current which flows through the cell and likewise reduces the power dissipated in the cell to limit the temperature rise of the cell, it being remembered that the cell at this time is being subjected to radiant energy from the flame tending to heat the cell.

Thus, with the construction of my invention, the electrical conditions under which the cadmium sulfide cell operates provide the optimum in safety insofar as operation of the associated fuel burner is concerned, and at the same time provide operating conditions contributing to longer life of the cadmium sulfide cell.

The present invention will be apparent to those skilled in the art upon reference to the following specification,



claims, and drawing, of which the single figure of the present application discloses the preferred embodiment of my invention.

Referring to the single figure, reference numeral 10 designates generally a fuel burner unit in the form of a gun type oil burner having a fan 11, an oil valve 12, and an ignition transformer 13 connected to ignition electrodes 14 adjacent an oil nozzle 15. Reference numeral 16 designates the blast tube of the gun type oil burner and a photoresistive cell 17 is located within this blast tube, positioned to be subjected to the presence or absence of flame adjacent the nozzle 15.

The fuel burner unit 10 may be controlled by automatic means such as a temperature responsive thermostat. I have, for purposes of simplicity, shown an on-off control 20 as the means by which associated components may be connected to power lines 21 and 22, connected to a source of alternating voltage, not shown.

Reference numeral 23 designates a control relay having a winding 24 and switch means comprising the normally open switches 25, 26, 27 and 28.

Reference numeral 30 designates a flame relay having a winding 31 and switch means comprising a normally open switch 32 and a normally closed switch 33.

Reference numeral 34 designates safety cutout means in the form of a bimetal operated safety switch having a bimetal operator 35 associated with a normally closed switch 36 and an actuating heater 37.

Reference numeral 40 designates generally a start interlock means and a purge timing means in the form of a further bimetal operated switch having a bimetal operator 41, a normally closed switch 42, a normally open switch 43, and an actuating heater 44.

Thus far, the major components of the burner control apparatus of my invention have been briefly described. The inter-relation of these components can be understood by a consideration of the operation of the apparatus of my invention. The apparatus as disclosed in the single figure is in the standby condition wherein a flame is not present at the fuel burner unit 10, wherein the means 34 and 40 are in a cold condition, wherein the relays 23 and 30 are de-energized, and wherein the on-off control 20 is in an open condition indicative of the fact that there is no need for operation of the fuel burner unit 10.

Assume now that a need for operation of the burner unit 10 arises. This is evidenced by a closing of the on-off control 20. A circuit may now be traced from power line conductor 22 through control 20, conductors 50 and 51, start interlock switch 42, conductor 52, heater 37, conductors 53 and 54, switch 33 of flame relay 30, conductor 55, winding 24 of relay 23, switch 36, and conductor 56 to the other power line conductor 21. From this above traced circuit, it can be seen that in order for winding 24 to be energized, it is necessary that three conditions be satisfied. The first of these conditions is that the means 40 be in a cold condition wherein switch 42 is closed. The second condition is that the heater 37 have electrical continuity. The third condition is that switch 33 of the flame relay be closed.

The closing of control 20 is also effective to apply an operating voltage to photoresistive cell 17. This can be seen by tracing a circuit from conductor 22 through switch 20, conductors 50, 57 and 58, winding 31, photoresistive cell 17, conductors 60 and 61, and a first impedance in the form of a resistor 62 to power line conductor 21. As can be seen from this circuit, the voltage applied to the photoresistive cell is dependent upon the relative impedance of this cell, of windings 31, and of resistor 62. Since the impedance values of these components 17, 31 and 62 are inter-related, it suffices to say that the voltage

applied to the photoresistive cell 17 from a selected combination of specific components is such that a relatively high operating voltage results and the photoresistive cell 17, while still in its dark condition, will pass sufficient current to energize flame relay 30 in the event that the photoresistive cell has an impedance lying within a range which can be characterized as an unsafe dark resistance. Such as unsafe dark resistance indicates that the operability of the cell is questionable and that it is desirable to prevent burner operation rather than to allow the burner control apparatus to initiate burner operation. Maintenance of the apparatus is then required prior to the establishment of flame at the fuel burner unit. The operation of the fuel burner unit is prevented by virtue of energization of flame relay 30 which is effective to open the switch 33 in the above described initial energizing circuit for relay 23. By virtue of the construction of flame relay 30, which is a sensitive relay, this relay is energized prior to the energization of the main control relay 23 and thus the opening of switch 33 results before the control relay 23 has had time to move to an energized condition.

Assuming that the photoresistive cell 17 has not experienced an unsafe dark resistance, the energization of main control relay 23 is effective to close its switches 25–28. The closing of switch 26 completes a circuit which shunts the switch 33 of the flame relay. This circuit can be seen by tracing a circuit from the stationary switch member of switch 33 through conductor 63, heater 44, switch 26, and conductors 64 and 65 and 54 to the movable switch member of switch 33.

The closing of switches 27 and 28 completes energizing circuits for the fan 11 and the ignition and valve means respectively of the fuel burner unit 10. The energizing circuit for the fan 11 can be seen by tracing a circuit from power line conductor 22 through conductors 66 and 67, switch 27, conductor 70, and fan 11 to power line conductor 21. The energizing circuit for the ignition and valve can be seen by tracing a circuit from power line conductor 22 through conductor 66, switch 28 to the ignition 13 and the valve 12 and then to the power line conductor 21.

The closing of switch 25 is effective to modify the operating voltage to the photoresistive cell 17 by virtue of a further impedance in the form of a resistor 71. Resistor 62, resistor 71, and heater 37 comprise a voltage dividing impedance network across power lines 21 and 22. This can be seen by tracing a circuit from power line conductor 22 through control 20, conductors 50 and 51, start interlock switch 42, conductor 52, heater 37, conductors 53 and 65, switch 25, resistor 71, conductor 61, and resistor 62 to conductor 21. Thus, upon the closing of switch 25, the impedances represented by resistor 71 and heater 37 are connected in parallel with the series connected photoresistive cell 17 and the winding 31 of flame relay 30. As a result of this modification of the energizing circuit for photoresistive cell 17, the voltage applied to this cell is reduced to a lower voltage. The initial high voltage, above described, is applied to the photoresistive cell 17 for only a short period of time for the purpose of checking the magnitude of the dark resistance of this cell. By virtue of the above traced circuit including resistor 71 and switch 25, this lower voltage applied to the photoresistive cell 17 renders the cell operative to subsequently detect the presence of flame at the fuel burner unit 10.

A flame is normally established at the fuel burner unit 10 and this flame is sensed by the photoresistive cell, whose impedance then decreases to a relatively low value and allows enough current to flow through the cell and the winding 31 of flame relay 30 to energize this relay. Energization of this relay opens the above mentioned switch 33 and closes switch 32. The opening of switch 33 opens the starting circuit for the winding of control relay 23 and places the heater 44 in series with relay winding 23 to thus operatively energize this heater to cause heating of the bimetal 41.

The closing of switch 32 effectively shorts the heater 37 of safety cutout means 34. This can be seen by tracing a circuit from the movable switch blade of switch 32 through conductors 54 and 53 to the lower terminal of heater 37, and from the stationary switch member of switch 32 through conductors 57, 51, switch 42, and conductor 52 to the upper terminal of heater 37. Thus, by virtue of the fact that flame has now been detected at the fuel burner unit 10, the operation of safety cutout means 34 is interrupted to allow continued operation of the fuel burner unit 10. As is well known in the art, safety cutout means 34 functions upon failure to establish flame at the fuel burner unit 10 to cause bimetal 35 to warp to the right, as shown in the single figure, to thus allow switch 36 to open, placing the apparatus in the cutout or safety lockout position.

After a time period of energization of heater 44, bimetal 41 warps to the right and its switch 42 opens, thus opening the start interlock switch. Switch 43 closes, placing a circuit in parallel with switch 27 of control relay 23. As is apparent, a subsequent opening of switch 27 does not de-energize fan 11 but allows this fan to continue running for a postpurge period, this period being determined by the cooling of bimetal 41. After bimetal 41 has again assumed its cool condition, start interlock switch 42 closes and recycle may occur, should a further call for operation of the fuel burner unit 10 be evidenced by the closing of on-off control 20.

As has been mentioned, the closing of switch 32 of relay 30 is effective to short or shunt heater 37 of safety cutout means 34 to prevent opening of the switch 36. Furthermore, the shorting of this resistor alters the voltage divider network to which photoresistive cell 17 is connected to thus again lower the operating voltage of the photoresistive cell. This can be seen by tracing a circuit from power line conductor 22 through control 20, conductors 50 and 57, switch 32, conductors 54 and 65, switch 25, resistor 71, conductor 61 and resistor 62 to conductor 21. From this circuit it can be seen that heater 37 has now been eliminated from the above described voltage divider network and as a result the voltage applied to the series connected photoresistive cell 17 and winding 31 of flame relay 30 is reduced to a lower value. This reduction in the voltage at the photoresistive cell during the running period of the fuel burner unit 10 is effective to limit the temperature rise at the photoresistive cell by limiting the current flowing through the cell. This reduction in voltage, in combination with the greatly decreased resistance of the photoresistive cell 17 allows sufficient current to flow to maintain winding 31 energized and at the same time the power dissipated within the photoresistive cell 17 is lower than that achieved by a simple direct connection across a source of voltage, as found in the prior art.

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

I claim as my invention:

1. In combination,

a fuel burner unit having means adapted to provide a flame thereat,

first control means including an electrically energizable actuator and means operative when said actuator is energized to render said fuel burner unit operative,

safety cutout means having means connected in controlling relation to said first control means and having an electrically energizable actuator which is operative after a time period of operation thereof to render said first control means inoperative,

second control means including an electrically energizable actuator and normally open switch means controlled thereby,

electrically operable flame sensing means,

first circuit means, connecting said second control means actuator to a source of voltage and including

in a series circuit, a first impedance, said flame sensing means, and said second control means actuator, to thereby apply an operating voltage to said flame sensing means,

second circuit means, including said safety cutout means actuator, connected to shunt a portion of said first circuit means including said flame sensing means,

and third circuit means including the normally open switch means of said second control means connected to shunt said safety cutout means actuator to thereby render the same inoperative and to lower the magnitude of said operating voltage applied to said flame sensing means.

2. In combination,

a fuel burner unit having means adapted to provide a flame thereat,

first control means including an electrically energizable actuator and means operative when said actuator is energized to render said fuel burner operative,

safety cutout means having means connected in controlling relation to said first control means and having an electrically energizable actuator which is operative after a time period of operation thereof to render said first control means inoperative,

second control means including an electrically energizable actuator and normally open switch means controlled thereby,

flame sensing means in the form of a photosensitive cell adapted to sense the presence or absence of flame at said fuel burner unit,

first circuit means, connecting said second control means actuator to a source of voltage and including in a series circuit, a first impedance, said photoresistive cell, and said second control means actuator, to thereby apply an operating voltage to said photoresistive cell,

second circuit means, including said safety cutout means actuator, connected to shunt a portion of said first circuit means including said photoresistive cell,

and third circuit means including the normally open switch means of said second control means connected to shunt said safety cutout means actuator to thereby render the same inoperative and to lower the magnitude of said operating voltage applied to said photoresistive cell.

3. Burner control apparatus comprising;

first control means adapted when energized to control a fuel burner in a manner to provide flame thereat,

safety cutout means having an electrically energizable actuator and having further means connected in controlling relation to said first control means, said safety cutout means functioning to prevent prolonged operation of the fuel burner in the absence of flame,

a flame relay including a winding and switch means,

flame sensing means having a resistance element variable in accordance with the presence or absence of flame,

impedance means,

first circuit means including said impedance means in series with said safety cutout means actuator to operatively energize said safety cutout means actuator,

second circuit means including said flame sensing means in series with said flame relay winding connected in parallel with said safety cutout means actuator to apply an operating voltage to said flame sensing means,

and further circuit means including said flame relay switch means connected to de-energize said safety cutout means actuator and to thereby change the operating voltage of said flame sensing means upon the presence of flame being sensed.

4. Burner control apparatus for use with a fuel burner having a controller adapted to be actuated to initiate fuel burner operation to provide a flame thereat, the apparatus comprising:



a safety cutout means having a normally closed switch adapted to be connected in over-all control of the fuel burner to render the same inoperative upon opening of said switch,

a time delayed electrically energizable actuator adapted to open said switch after a time period of energization of said actuator,

a first and a second impedance,

first circuit means including in series said first and second impedances and said actuator connected to a source of voltage to operatively energize said actuator,

a photoresistive cell whose resistance decreases upon a flame being sensed at the fuel burner,

a relay having a normaly open switch and a winding,

a second circuit means including in series said photoresistive cell and said relay winding connected in parallel with that portion of the first circuit means which includes said second impedance and said actuator to thereby apply a first magnitude energizing voltage to said photoresistive cell,

and further circuit means connecting said normally open switch in parallel with said actuator to thereby render said actuator inoperative upon a flame being sensed at the fuel burner and to also reduce the magnitude of the energizing voltage for said photoresistive cell.

5. Burner control apparatus for use with a fuel burner which, when energized, is normally effective to produce a flame at the fuel burner, comprising;

a control relay having first and second normally open switches and a winding,

means adapted to energize said winding upon a need for operation of the fuel burner,

means controlled by said first control relay switch adapted to energize the fuel burner,

safety cutout means having a normally closed switch and a time delay electrically energizable actuator,

means connecting said safety cutout means switch in series with said winding,

a first and a second impedance,

a photoresistive cell having a high resistance in the absence of flame and a low resistance in the presence of flame,

a flame relay having a normally open switch and a winding,

means connecting said first impedance, said cell and said flame relay winding in a series circuit to a source of voltage to apply a first magnitude operating voltage to said cell,

means connecting said second impedance, said second control relay switch, and said actuator in series with each other and in parallel with said series connected cell and flame relay winding to apply a second lower magnitude operating voltage to said cell upon energization of said control relay winding,

and means connecting said flame relay switch in parallel with said actuator to apply a third lower magnitude operating voltage to said cell and to render said actuator inoperative upon the presence of flame being sensed by said cell.

6. Burner control apparatus for use with a fuel burner unit, comprising;

a start interlock means having a normally closed switch and an electrically energizable actuator therefor,

a control relay having first and second normally open switches and a winding,

a safety cutout means having a normally closed switch and a time delay electrically energizable actuator,

a flame relay having a normally closed switch, a normally open switch, and a winding,

circuit means including in series said safety cutout means switch, said control relay winding, said flame relay normally closed switch, said safety cutout

means actuator, and said start interlock means switch adapted to energize said control relay winding upon a need for operation of the fuel burner unit,

a circuit means including said start interlock means actuator in series with said first control relay switch connected in parallel with said flame relay normally closed switch,

a first and a second impedance,

a photoresistive cell adapted to be subjected to a flame at the fuel burner unit and having a high resistance in the absence of flame,

a circuit means connecting said first impedance, said cell, and said flame relay winding to a source of voltage,

circuit means including said second impedance in series with second control relay switch connected to the junction of said first impedance and said series connected cell and flame relay winding, and to the junction of said flame relay normally closed switch and said series connected safety cutout means actuator and start interlock means switch,

and circuit means connecting said flame relay normally open switch in parallel with said series connected safety cutout means actuator and start interlock means switch.

7. In combination;

a main burner control relay adapted to be connected to a fuel burner unit to institute operation thereof upon energization of said main burner control relay,

a flame relay having electrically energizable actuating means,

a photoconductive cell having a high dark resistance and a low light resistance and adapted to be subjected to a flame at the fuel burner unit,

circuit means connecting said actuating means of the flame relay in series with said cell,

initial energizing means connecting said series connected actuating means and cell to a relatively high magnitude voltage to thereby check the magnitude of the dark resistance of said cell,

and means connecting said flame relay in controlling relation to said main burner control relay to prevent operation of said main burner control relay upon said cell having an unsafe low magnitude dark resistance, and means connecting said series connected flame relay actuating means and said cell to a relatively low operating voltage when a safe magnitude dark resistance exists at said cell.

8. Burner control apparatus for use with a fuel burner unit comprising:

control means adapted to institute operation of the fuel burner unit,

a flame relay having electrically energizable actuating means and a normally closed switch, said switch being connected in circuit with said control means,

a photoconductive cell having a high resistance when dark and a low resistance when subjected to a flame,

means for initially providing a checking function for safe dark resistance of said cell including means connecting said flame relay actuating means and said cell in series to a source of high magnitude voltage to apply a voltage to said cell which is of a magnitude greater than the normal operating voltage thereof to thereby cause energization of said flame relay and opening of said normally closed switch to render said control means inoperative if the dark resistance of said cell is below a safe level,



and means connecting said flame relay actuating means and said cell in series to a relatively lower voltage operating circuit when the checking function reveals a safe dark resistance of said cell.

9. In a burner control apparatus of the type including a control device adapted to institute operation of a fuel burner unit, a combustion responsive photoconductive cell having a high dark resistance and a low light resistance, a flame relay having electrically energizable actuating means, said cell and said relay actuating means being directly connected in series and adapted to be normally connected to an operating voltage such that said relay is de-energized when said cell is dark and so that said relay is energized when said cell is lighted by the presence of combustion at the burner,

the improvement comprising:

means for checking the dark resistance of said cell including means operable upon initial demand for operation of said control device to connect said series connected cell and relay actuating means to a relatively higher voltage having a magnitude sufficient so that said relay is energized if the dark resistance of said cell is below a safe magnitude;

and means operable by said flame relay to render said control device inoperative if said relay is energized due to unsafe dark resistance of said cell.

10. In a burner control apparatus of the type including a control device adapted to institute operation of a fuel burner unit, a combustion responsive photoconductive cell having a high dark resistance and a low light resistance, a flame relay including electrically energizable actuating means, said cell and said relay actuating means being directly connected in series and adapted to be normally connected to an operating voltage such that said relay is de-energized when said cell is dark and so that said relay is energized when said cell is lighted by the presence of combustion at the burner,

the improvement comprising:

means for checking the dark resistance of said cell including means operable upon initial demand for operation of said control device to connect said series connected cell and relay actuating means to a relatively higher voltage having a magnitude sufficient so that said relay is energized if the dark resistance of said cell is below a safe magnitude;

means operable by said relay to render said control device ineffective to institute operation of said burner unit if said relay is energized due to unsafe dark resistance of said cell;

and means for connecting said series connected cell and relay actuating means to said normal operating voltage when said relay remains de-energized during application of said higher voltage thereto.


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