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Hron

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[54] FUEL BURNER CONTROL SYSTEM

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[51] **Int. Cl.** **F23n 5/08**
[58] **Field of Search** 431/69, 79

[56] **References Cited**

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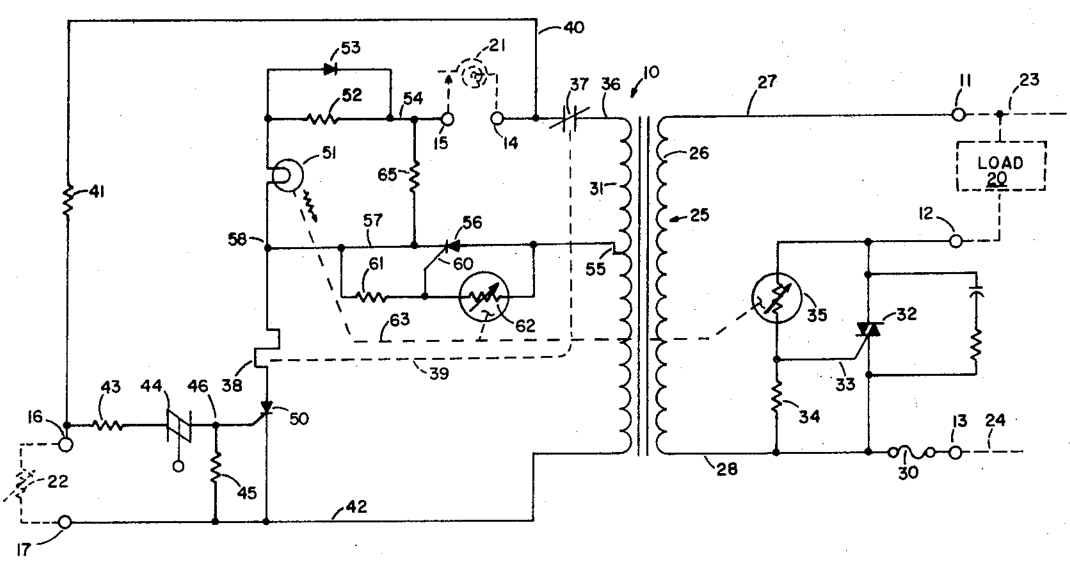
[57] **ABSTRACT**

An all solid state control system which is adapted to be connected to a fuel burner is disclosed that uses a pair of solid state switches each having a radiation responsive gating means that is responsive to a single radiation generator means. The first solid state switching means is gated "on" to energize the fuel burner or load, while the second radiation responsive gating means is gated "on" to continuously energize the radiation generator means to act as a latching mechanism to hold the system energized. The radiation generator means is initially energized through a flame responsive circuit and thermostat to initiate operation of the system.

10 Claims, 2 Drawing Figures



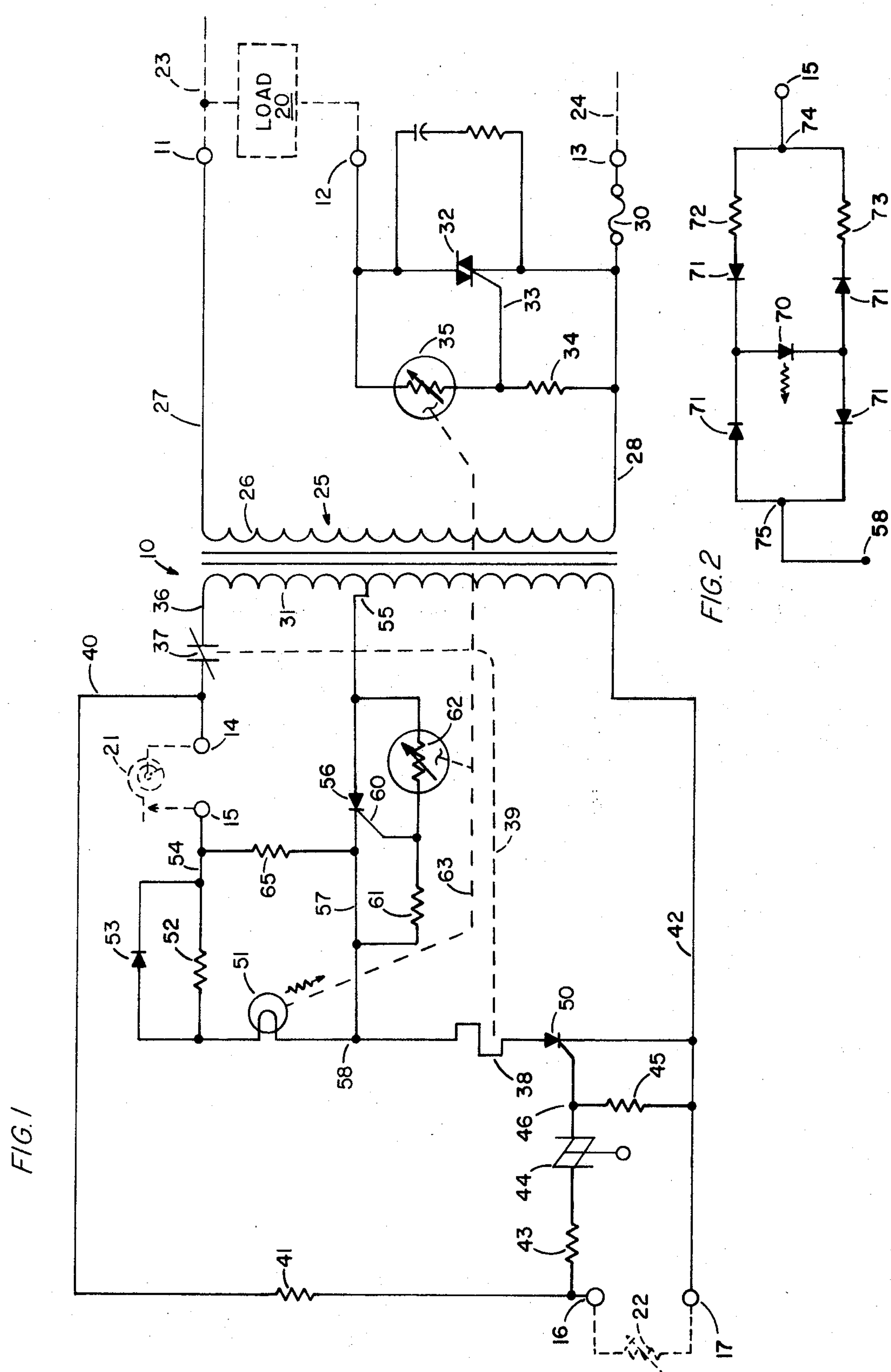


FIG. 1

FIG. 2

FUEL BURNER CONTROL SYSTEM

BACKGROUND OF THE INVENTION

Fuel burner control systems have as one of their primary considerations the safe and reliable operation of the burner. In order for this to be accomplished, the control system itself must use reliable components. An earlier system which utilizes generally solid state components is disclosed in the U.S. Pat. No. 3,416,038 to Mierendorf. This circuit utilizes a conventional relay and this relay has been found to be one source of potential trouble. An attempt to avoid this type of relay problem has been approached by substituting solid state devices for the relay as is shown in patents such as the U.S. Pat. No. 3,671,169 to Hron et al. and U.S. Pat. No. 3,672,811 to Hron. Both of these last cited circuits use solid state components and use a single photo responsive resistor for operation in response to two light sources. This type of an arrangement lends complexity to the overall system and is avoided by the simplified arrangement of the present invention.

SUMMARY OF THE INVENTION

The present invention is directed to a fuel burner control system that is adapted to be connected to a fuel burner means, a condition sensing means or thermostat, and which is capable of reliable operation through the use of solid state components. The multiple switching functions that are normally accomplished by a relay are accomplished in the present invention by the use of a radiation generator means or light that operates a pair of radiation responsive solid state switch means. This pair of switch means acts as, firstly a means of switching "on" the load or fuel burner itself, and secondly as a latching means for the device. Components or packages which include a single light source and two photo responsive cells are available, but their application to the particular type of circuit involved was not readily apparent. This circuit requires not only the latching function of the relays, but a safe means of energizing the circuit and reliably sensing the existence or absence of a flame in conjunction with other safety equipment. The present fuel burner control system is unique in its safe operation and solid state reliability.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 of the present application is a complete schematic diagram of a burner control system adapted to be connected to a load such as a fuel burner, a condition responsive means such as a thermostat, and to a flame responsive device such as a photo or flame responsive resistor, and;

FIG. 2 is a portion of the circuit showing a radiation generator means utilizing a full-wave bridge and light emitting diode.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment includes a fuel burner control system generally disclosed at **10** which is adapted to be connected by way of seven external terminals **11** to **17** to a load **20** in the form of a fuel burner, a condition responsive means **21** in the form of a thermostat, and a flame responsive resistor means **22** that normally would be a cadmium sulfide cell. The fuel burner control system **10** is also adapted to be connected by terminals **11** and **13** to a conventional source of alternating current supplied between conductors **23** and **24**.

A transformer means **25** is disclosed having a primary winding **26** that is connected by conductor **27** to terminal **11** and by conductor **28** and fuse **30** to terminal **13**. This provides the necessary energizing potential for the transformer means **25** which in turn energizes a tapped secondary winding **31**.

Included in the line or source side of the fuel burner control system **10** is gated solid state switch means **32** in the form of a triac which is connected between the terminal **12** and the conductor **28**. A gate **33** is connected through a resistor **34** to conductor **28** and the gate **33** is also connected to a radiation responsive gating means **35** in the form of a light responsive resistor or cadmium sulfide cell. The resistor **34** and the cadmium sulfide cell **35** are connected in series to form a gating circuit for the triac **32**.

The tapped secondary winding **31** has a conductor **36** which is connected through a normally closed safety switch contact **37** of a conventional design which mechanically locks in an open position once it is activated. The normally closed safety switch contact **37** is operated in response to a safety switch heater means **38** and this is indicated by the dash connection **39**. The normally closed contact **37** is connected by conductor **40** through a resistor **41** to the terminal **16** and then through the flame responsive resistor means **22** to terminal **17** where it is connected by conductor **42** back to the tapped secondary winding **31**. The circuit including the normally closed contact **37** and the flame responsive resistor means **22** forms a flame responsive circuit means that acts as a gating arrangement through a resistor **43**, a switch (such as a diac) **44**, and a resistor **45**. The junction **46** between the bidirectional switch **44** and the resistor **45** is connected to a second gated solid state switch means in the form of a silicon controlled rectifier **50**. The silicon controlled rectifier **50** is connected in series with the safety switch heater means **38** and a radiation generator means **51** which is disclosed as a simple incandescent light bulb. The light bulb **51** is connected through a paralleled resistor **52** and diode **53** to a conductor **54** that is in turn connected to the terminal **15** and through the thermostat **21** to the terminal **14**. This series circuit is adapted to be energized whenever the thermostat **21** closes, and the resistor **52** has been placed in the circuit to insure that the control will not "turn on" below a given line voltage level. Diode **53** has been placed in the circuit to adjust current values for proper latching of the silicon controlled rectifier **56**. Their presence is not essential, but are disclosed as a practical means of controlling the minimum line voltage at which the control will function.

A tap **55** of the tapped secondary winding **31** is connected through a gated solid state switch means **56** disclosed as a silicon controlled rectifier which is in turn connected by conductor **57** to a junction **58** between the incandescent light **51** and the safety switch heater means **38**. The silicon cntrolled rectifier **56** has a gate **60** that is connected through a resistor **61** to the conductor **57** and also through a radiation responsive means **62** back to the tap **55** on the tapped secondary winding **31**. The radiation responsive means **62** forms a radiation gating means for the silicon controlled rectifier **56** and again can be a cadmium sulfide cell.

The radiation generator means or incadescent light **51** emits a radiation or light indicated at **63** which falls on both of the radiation gating means or cadmium sulfide cells **35** and **62.** These three elements, that is the light **51** and the two cells **35** and **62,** are enclosed in a light tight package so only the radiation from the radiation generating means **51** falls on the two cells **35** and **62.**

To complete the hookup of the present system in a practical matter a resistor **65** is connected between the conductor **57** and the terminal **15** of the thermostat **21** to provide a current conduction path that is necessary to provide a correct current balance in the thermostat for proper cycling of the thermostat in a conventional manner. The resistor **65** has been added solely for this purpose and is not essential to the operation of the basic burner control system.

DESCRIPTION OF OPERATION OF FIG. 1

It is initially assumed that the load or fuel burner **20** is "off" but that power is supplied between conductors **23** and **24** thereby energizing the transformer means **25.** The thermostat **21** is open and the photo responsive cadmium sulfide cells **22, 35** and **62** are all relatively high in values since they are exposed to dark environments. The flame responsive resistor means **22** is in a dark environment since the fuel burner **20** is "off," and cadmium sulfide cells **35** and **62** are in a dark environment since the incandescent light **51** is "off."

Upon a call for heat, the thermostat **21** closes thereby completing a circuit through the normally closed switch **37** and the conductor **40** through the resistor **41** and the resistors **43, 45** and the bidirectional switch **44.** The application of voltage on this circuit triggers the silicon controlled rectifier **50** into conduction when conductor **40** is positive with respect to conductor **42.** The triggering of the silicon controlled rectifier **50** into conduction allows current to flow through the thermostat **21,** the resistor **52,** the incandescent light **51,** and the safety switch heater means **38.** This current flow performs two functions. The first is to energize the incandescent light **51** and secondly provides an energizing voltage to check the continuity of and start the operation of the heating of the safety switch heater means **38.** On the reverse half cycle nothing happens since the silicon controlled rectifier can only conduct in one direction. After a short number of half cycles, the current flow through the incandescent light **51** is sufficient to supply radiation to the cadmium sulfide cells **35** and **62** lowering their resistances and thereby gating "on" the triac **32** and the silicon controlled rectifier **56.**

As soon as the triac **32** begins to conduct due to the lowering of the resistance of the cadmium sulfide cell **35,** current flows on both half cycles through the load or oil burner **20.** The oil burner **20** starts the conventional flow of fuel and ignition process, and the ignition of the fuel must occur within a preset time or the heating of the safety switch heater means **38** will cause the switch **37** to open and lock out requiring manual reset in a conventional manner.

If it is assumed that flame is generated in the fuel burner **20,** this flame will cause the radiation to fall on the cadmium sulfide or flame responsive resistor means **22** thereby lowering its resistance substantially. This effectively shorts out the gate of the silicon controlled rectifier **50** and it ceases to conduct. The energy from the incandescent light **51** has during this period of time been falling on the cadmium sulfide cell **62** causing it to gate the silicon controlled rectifier **56** into conduction on half cycles thereby reinforcing the current flow through the incandescent light **51** in the reverse direction from that which triggered the system into initial operation. The diode **53** has been provided to allow for a substantial current flow each time the proper half cycle is applied so that the silicon controlled rectifier **56** conducts. The light falling on the dacmium sulfide cell **62** from the source **51** keeps the silicon controlled rectifier **56** in conduction which in turn keeps the light energized. This, in effect, acts as a locking or holding contact of a relay and since the cadmium sulfide cells **35** and **62** have a substantially long memory of the light, that is the resistance of these cells remains relatively low for a period of time after the light has been removed, the system does not de-energize on the half cycles of a reverse polarity to the silicon controlled rectifier **56.**

With the arrangement disclosed the system remains in operation as long as the thermostat **21** allows current to flow through the light **51** to keep the cell **62** in a low resistance value. tHe shorting out of the gate circuit of the silicon controlled rectifier **50** by the lowering of the resistance of the flame responsive resistor means **22** de-energizes the safety switch heater means **38.** With the arrangement thus disclosed, a substantially all solid state burner control system has been disclosed and provides a distinct advantage over a conventional electromagnetic relay which has contacts which wear and erode during operation thus limiting the life of the conventional relay operated system.

The incandescent light **51** can be replaced by solid state components as is disclosed in FIG. **2.** In FIG. **2** a light emitting diode **70** is disclosed in a full-wave bridge arrangement made up of diodes **71.** In series with the legs of the bridge are a pair of resistors **72** and **73.** The resistors **72** and **73** have been picked to provide proper current flows through the light emitting diode for controlling the minimum operating voltage level and latching on the two half cycles of the current applied. The resistors **72** and **73** have a common junction **74** which is connected as at terminal **15** of FIG. **1.** The diodes at the opposite end of the bridge have a junction **75** that is connected at junction **58.** The bridge configuration including the light emitting diode **70** can be substituted for the incandescent light **51** and the resistor **52** along with its parallel diode **53.**

The operation of this system including the light emitting diode **70** is identical to that of the system as described in FIG. **1.** The current flow between the terminal **15** and the junction **58** is through the light emitting diode **70** which in turn provides the illumination or radiation for the cadmium sulfide cells **35** and **62.** With the light emitting diode, it is possible to provide an all solid state configuration. The selection of an incandescent light **51** versus the light emitting diode **70** is a matter of economics and convenience, and these two arrangements are completely interchangeable in the presently disclosed fuel burner control system.

The present invention provides for a solid state burner control system having the unique properties of eliminating all mechanical components except the normally closed safety switch contact **37,** which for safety reasons must be a mechanical switch that is capable of being locked in an open position so that the device requires manual reset to bring to the attention of service personnel the fact that some malfunction may have ocqurred in the system. The present invention advances the burner control art by providing more reliable and long lived device and the scope of the present invention is limited solely by the appended claims.

The embodiments of the invention in which an exclusive property or right is claimed are defined as follows:

1. A fuel burner control system including: transformer means having a primary winding and a secondary winding with said primary winding adapted to be connected to a source of voltage; gated solid state switch means including radiation responsive gating means for control of said switch means with said switch means adapted to connect a fuel burner to said source; flame responsive circuit means having normally closed safety switch contact means and second gated solid state switch means; said second gated solid state switch means adapted to be connected to flame responsive resistor means; said second gated solid state switch means, safety switch operator means, and radiation generator means forming a series circuit which is adapted to be connected to said secondary winding through said normally closed safety switch contact means by condition responsive means; and third gated solid state switch means including second radiation responsive gating means for control of said third solid state switch means connecting said secondary winding to a junction between said operator means and said radiation generator means; both said radiation gating means being responsive to only the radiation from said radiation generator means.

2. A fuel burner control system as described in claim 1 wherein said first solid state switch means is a triac, said second and third solid state switch means are silicon controlled rectifiers, and said secondary winding has a tap for connection to said third solid state switch means.

3. A fuel burner control system as described in claim 2 wherein both of said radiation responsive gating means are light responsive resistors.

4. A fuel burner control system as described in claim 3 wherein said radiation generator means is an incandescent light.

5. A fuel burner control system as described in claim 4 wherein said series circuit includes a parallel combination of a diode and a resistor to allow said incandescent light to be energized by voltage from said secondary winding on each half cycle of said source by conduction of both of said silicon controlled rectifiers.

6. A fuel burner control system as described in claim 5 wherein a thermostat heater resistor is placed in parallel circuit with said parallel combination of said diode and resistor, and said incandescent light to provide for an adequate current flow in said condition responsive means when said condition responsive means is activated to energize said incandescent light through said last named silicon controlled rectifier.

7. A fuel burner control system as described in claim 6 wherein said safety switch operator means is a resistor, and said operator means is operatively energized during the absence of a flame in said burner to open said normally closed safety switch contact means to deenergize and mechanically lock out said flame responsive circuit means and said incandescent light after a pre-selected time to be determined by the heating of said heater means.

8. A fuel burner control system as described in claim 7 wherein said light responsive resistors are both cadmium sulfide cells having relatively long memories of the light incident thereon.

9. A fuel burner control system as described in claim 1 wherein said radiation generator means incudes light emitting diode means.

10. A fuel burner control system as described in claim 1 wherein said radiation generator means includes a full-wave rectifier bridge and a light emitting diode.

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