TRANSISTOR FLAME DETECTOR

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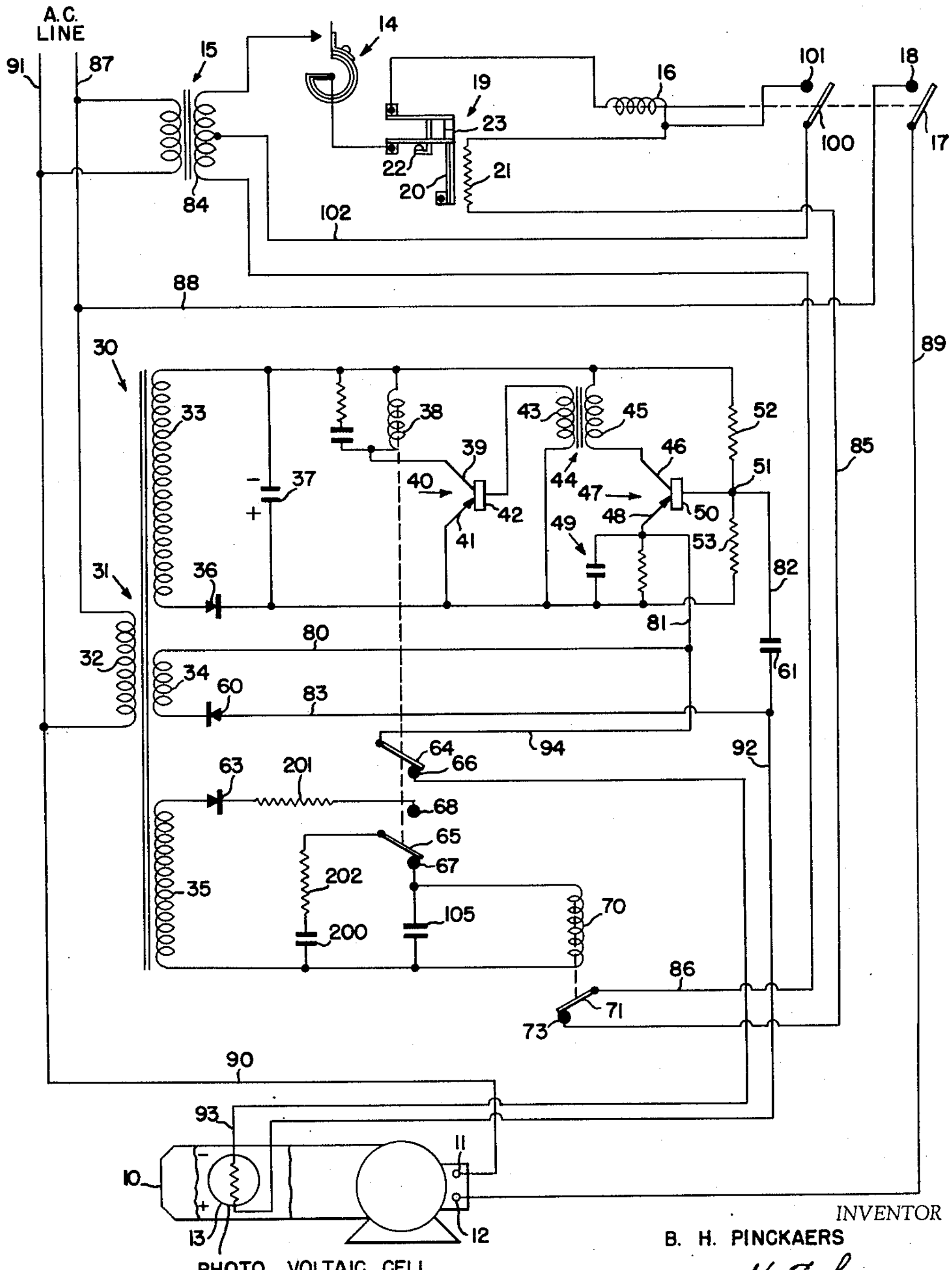

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TRANSISTOR FLAME DETECTOR

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The present invention is concerned with an improved flame detector and in particular with an improved flame detector utilizing transistors.

It is an object of the present invention to provide a transistor flame detector wherein the emitter to base current is controlled by flame sensing means and caused to continuously pulsate when flame is present.

It is a further object of the present invention to provide a transistor type flame detector having a constant flame checking circuit to insure continued proper operation of the flame detector.

These and other objects of the present invention will become apparent to those skilled in the art upon reference to the following specification, claims, and drawing, of which

The single figure is a schematic showing of the improved transistor flame detector.

Referring to the single figure, the numeral **10** designates a gun-type oil burner having power input terminals **11** and **12**. Energization of terminals **11** and **12** energizes the motor within the gun-type burner **10** and energizes an ignition means to ignite the oil flowing from the gun-type burner. Also located at burner **10** is a photoelectric flame sensing means **13**. This may take one of many forms. However, for purposes of explanation photocell **13** has been shown as a photovoltaic cell, that is, a photocell which generates a voltage when the cell views a flame.

Operation of burner **10** is controlled by a thermostat **14** which supplies power from a transformer **15** to a main control relay **16**. Control relay **16** controls movable switch blades **17** and **100** and is arranged when energized to cause switch blades **17** and **100** to engage stationary contacts **18** and **101** respectively.

Also included in circuit with relay **16** is a safety cutout device **19** having a bimetal element **20**, an actuating heater **21**, a manual reset button **22**, and a normally closed switch **23**. Safety cutout device **19** is effective upon a predetermined time period of energization of heater **21** to cause bimetal element **20** to warp to the right to allow switch **23** to open. Upon cooling of bimetal **20** the manual reset actuator **22** can be depressed to reset switch **23** to the position shown.

The transistor flame detector is designated generally by the reference numeral **30**. Power is applied to flame detector **30** by means of a transformer **31** having a primary **32**, and secondaries **33**, **34**, and **35**. Secondary **33** in combination with a rectifier **36** and a capacitor **37** form a direct current source of power, capacitor **37** being charged to the polarity shown. A relay **38**, which may be called a cycling relay, is connected with one terminal to the negative terminal of the direct current source of power and the other terminal to a collector electrode **39** of a transistor **40**. The transistor **40** has an emitter electrode **41** connected to the positive terminal of the direct current source of power and has a base electrode **42** connected to the positive terminal of the direct current source of power through the secondary **43** of a transformer **44**. The primary **45** of transformer **44** has one terminal thereof connected to the negative terminal of the direct current source of power and has the other terminal connected to a collector electrode **46** of a transistor **47**. The emitter electrode of transistor **47** is connected through a parallel resistor capacitor combination **49** to the positive terminal of the direct current source of power. The base electrode **50** of transistor **47** is connected to a tap **51** on a voltage dividing network consisting of resistors **52** and **53**, which resistors are connected in series across the direct current source of power.

Relay **38** is shown in the deenergized position; in this position movable switch blade **64** engages stationary contact **66** while movable switch blade **65** engages stationary contact **67**. Energization of relay **38** causes movable switch blade **64** to disengage contact **66** and causes movable switch blade **65** to engage a stationary contact **68**.

Secondary **34** in combination with a rectifier **60** is connected in a half-wave rectifying circuit. Secondary **34** is effective through rectifier **60** to charge a capacitor **61**, as will be later described.

Secondary **35** in combination with a rectifier **63** is also connected to form a half-wave rectifier. Connected in circuit with secondary **35** and rectifier **63** is a flame relay **70**.

A flame relay **70** includes movable switch blade **71** and stationary contact **73**. Relay **70** is shown in the deenergized position in which movable switch blade **71** engages stationary contact **73**.

Operation of the system of the single figure will now be described. The apparatus is shown in the standby condition, that is, in the condition wherein operation of the burner **10** is not required. In this condition main control relay **16** is deenergized, cycling relay **38** is deenergized, and flame relay **70** is deenergized. Capacitor **37** is charged to the polarity indicated, and capacitor **61** is charged.

The charging circuit for capacitor **37** is apparent. The charging circuit for capacitor **61** can be traced from the upper terminal secondary **34** through conductor **80**, conductor **81**, emitter electrode **48** and base electrode **50** of transistor **47**, junction **51**, conductor **82**, capacitor **61**, conductor **83**, and rectifier **60** to the lower terminal of secondary **34**. It can be seen that this current flows for a very short time period necessary to fully charge capacitor **61**. After capacitor **61** has been fully charged the emitter to base current of transistor **47** is reduced substantially to zero and therefore the emitter to collector current of transistor **47** is of a steady value.

Primary **45** of transformer **44** is connected so that the emitter to collector current of transistor **47** passes through the primary thereof and therefore, a signal is induced in the secondary **43** only when a pulsating or changing current flows through primary **45**. At this time, there is no pulsating or changing current flowing through primary **45** and therefore the base electrode **42** of transistor **40** is, in a voltage sense, connected directly to the emitter electrode **41**. Therefore, no emitter to collector current flows in transistor **40** or in cycling relay **38**.

If it is now assumed that thermostat **14** indicates that there is a need for operation of the burner **10**, the relay **16** is energized through a circuit which can be traced from the upper terminal of secondary **84** through thermostat **14**, switch **23** of safety cutout device **19**, relay **16**, actuating heater **21** of safety cutout device **19**, conductor **85**, stationary contact **73** and movable switch blade **71** of flame relay **70**, and conductor **86** to the lower terminal of secondary **84**. Energization of relay **16** causes movable switch blade **17** to engage stationary contact **18**. This completes an energizing circuit for the burner **10** which can be traced from a power line conductor **87** through conductor 88, stationary contact 18 and movable switch blade 17 of relay 16, conductor 89, terminals 12 and 11 of burner 10, and conductor 90 to a second power line conductor 91.

Energization of relay 16 also causes switch blade 100 to engage contact 101. This completes a holding circuit for relay 16 which can be traced from the upper terminals of secondary 84 through thermostat 14, safety cutout device 19, relay 16, contact 101 and switch blade 100, a conductor 102 to the tap of secondary 84. Actuating heater 21 of safety cutout device is maintained energized through a circuit which can be traced from the tap of secondary 84 through conductor 102, switch blade 100 and contact 101 of relay 16, heater 21, conductor 85, contact 73 and switch blade 71 of relay 70, and conductor 86 to the lower terminal of secondary 84.

The flame is normally now established at burner 10 and is detected by the flame sensing photocell 13. As above described, photocell 13 is of the type which generates a D. C. voltage upon the photocell being subjected to flame. This voltage is of the polarity shown and causes a discharge circuit for capacitor 61 to be instituted, which circuit can be traced from capacitor 61 through a conductor 92, photocell 13, conductor 93, stationary contact 66 and movable switch blade 64 of cycling relay 38, conductor 94, conductor 81, parallel resistor capacitor combination 49, resistor 53, and conductor 82 to the positive terminal of capacitor 61. This circuit tends to discharge capacitor 61 on the alternate half-cycle of secondary 34 in which a charging current can not flow to capacitor 61 due to the polarity of the connection of rectifier 60. However, with capacitor 61 now substantially discharged a charging current will flow through rectifier 60 on the next half-cycle of secondary 34 and therefore an emitter to base current will flow through transistor 47. This pulsating current will continue to flow in the emitter to base circuit of transistor 47 so long as flame is detected at photocell 13.

A pulsating current now also flows in the emitter to collector circuit of transistor 47, which circuit includes primary 45 of secondary 44. This induces a signal in the secondary 43 of transformer 44 and causes an emitter to base current to flow in transistor 40. Therefore, an emitter to collector current also flows in transistor 40, this current flowing through cycling relay 38 to energize this relay. Energization of relay 38 causes switch blade 64 to disengage stationary contact 66. This breaks the discharge circuit for capacitor 61 and thereby simulates a condition of no flame at the burner 10.

Energization of cycling relay 38 also causes movable switch blade 65 to engage stationary contact 68. This establishes a charging circuit for a capacitor 200 which can be traced from the upper terminal of secondary 35 through rectifier 63, resistor 201, stationary contact 68 and movable switch blade 65 of relay 38, resistor 202, and capacitor 200 to the lower terminal of secondary 35.

As was pointed out above, energization of the cycling relay 38 simulates the condition of no flame at the burner 10 since the discharge circuit for capacitor 61 is open circuited. This causes capacitor 61 to remain charged after it is initially recharged. After capacitor 61 is recharged a pulsating current no longer flows in the emitter to collector circuit of transistor 47. Therefore, a signal is no longer applied between emitter 41 and base electrode 42 of transistor 40, thereby causing cycling relay 38 to be deenergized.

Deenergization of cycling relay 38 again causes moving of switch blade 64 to engage stationary contact 66 and once again establish a discharge circuit for capacitor 61, provided that photocell 13 is still detecting the presence of flame at the burner unit 10.

Deenergization of cycling relay 38 also causes the movable switch blade to engage stationary contact 67 of relay 38. A discharge circuit is now established for capacitor 200 and this capacitor is discharged into a circuit including relay 70 connected in parallel with a capacitor 105. This energizes the flame relay 70 and causes movable switch blade 71 to disengage stationary contact 73, it being remembered that movable switch blade 71 is in the energizing circuit including actuator 21 of safety cutout device 19. Therefore, the energization of flame relay 70 at this time discontinues the energization of the actuator 21 of safety cutout device 19.

It will be noted, that so long as flame is sensed at the burner 10 the capacitor 61 will be discharged and recharged through the emitter to base circuit of transistor 47. This causes cycling relay 38 to be energized and energization of cycling relay 38 opens the discharging circuit for capacitor 61 so that a pulsating current no longer flows from the emitter to base of transistor 47. This results in the deenergization of relay 38 to once again establish the discharge circuit for capacitor 61 which in the manner above described, again causes cycling relay 38 to be energized. Therefore, it can be seen that cycling relay 38 has continuing recurring cycles of energization and deenergization so long as the flame is continuously detected at burner 10.

Energization and deenergization of cycling relay 38 causes capacitor 200 to be charged in the energized position of relay 38 and causes the charged capacitor 200 to be discharged into capacitor 105 in the deenergized position of relay 38. Since relay 70 is connected in parallel with capacitor 105, relay 70 is maintained continuously energized so long as relay 38 continues in recurring cycles of alternate energization and deenergization to cause alternate charging of capacitor 200 and then discharging of capacitor 200 into capacitor 105.

This is the running condition of the control apparatus and in this condition main relay 16 is energized, actuating heater 21 of safety cutout device 19 is deenergized, burner 10 is energized, flame relay 70 is energized, and cycling relay 38 is cycling between the energized and the deenergized position.

If it is assumed that the flame at burner 10 is extinguished or that photocell 13 fails so that capacitor 61 is not discharged, it can then be seen that the emitter to base current of transistor 47 no longer flows and relay 38 remains in the deenergized position which causes flame relay 70 to be deenergized and again establish an energizing circuit for heater 21 of safety cutout device 19. After a predetermined time period of energization of heater 21 the normally closed switch 23 of safety cutout device 19 will be open to deenergize main relay 16 and cause the deenergization of burner unit 10.

Likewise, if a fault occurs in the flame detector such that cycling relay 38 is maintained continuously in the energized or deenergized position, the flame relay 70 will again be deenergized to actuate safety cutout device 19 since in order for flame relay 70 to be maintained energized it is necessary for the relay 38 to cycle alternately between the energized and deenergized position.

It can therefore be seen that a transistor flame detector has been provided wherein a component checking circuit assures that no failure of the electrical components of the flame detector will cause continued energization of the flame relay 70.

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

I claim as my invention:

1. A flame detector comprising: a transistor having a collector, a base, and an emitter, switching means having a first position indicative of the presence of flame and a second position indicative of the absence of flame, means including circuit means connected to said switching means and said collector and responsive only to pulsating current flow to energize said switching means, a capacitor, a source of direct current voltage, circuit means connecting said capacitor and source of power in circuit

with said base and emitter to cause a charging current to flow to charge said capacitor for a short time period until said capacitor is in a charged condition after which time no current normally flows, flame sensitive means arranged to be positioned to be subjected to a flame to be detected, and circuit means including said flame sensitive means for tending to discharge said capacitor upon said flame sensitive means being subjected to a flame to thereby cause a continuously recurring charging current to flow to recharge said capacitor.

2. A flame detector comprising: a semiconductor device having a collector, an emitter and a base element, with the emitter to collector current flow being an amplified current indicative of the emitter to base element current flow; means responsive to changing current flow therethrough to produce a signal voltage, means connecting said last named means to said collector so that said emitter to collector current flows therethrough, switching means having an energized and a deenergized condition and having an actuator, means connecting said actuator to said means responsive to changing current flow to energize said actuator upon the presence of said signal voltage; capacitive means, a pulsating unidirectional source of voltage, means connecting said source of voltage and said capacitive means to said base element and said emitter to cause a unidirectional current to flow from said emitter to said base element until said capacitor is charged, flame sensing means, a discharge circuit for said capacitor controlled by said flame sensing means to discharge said capacitor upon said flame sensing means being subjected to a flame, to thereby cause recurring pulses of unidirectional current to flow from said emitter to said base to continually recharge said capacitor, means controlled by said switching means to open circuit said discharge circuit when said switching means is deenergized, electrically energizable means having a first condition indicative of flame and a second condition indicative of no flame, and circuit means controlled by said switching means connected to said electrically energizable means to continuously energize said electrically energizable means only upon intermittent energization of the actuator of said switching means.

3. A flame detector comprising: a transistor having a base, a collector, and an emitter; a capacitor, a pulsating unidirectional source of voltage, means connecting said capacitor and said source of voltage to said base and emitter to cause a capacitor charging current to flow, a transformer having a primary and a secondary, means connecting said primary in circuit with said emitter and collector, an electrically energizable actuator, means connecting said actuator to said secondary to energize said actuator upon a changing current flowing through said primary, flame sensing means arranged to be positioned to be subjected to a flame, circuit means controlled by said flame sensing means to discharge said capacitor upon said flame sensing means being subjected to a flame, means controlled by said actuator to open circuit said last named circuit means upon said actuator being energized to thereby cause intermittent energization of said actuator so long as said flame sensing means is subjected to a flame, a second source of direct current voltage, a second capacitor, means controlled by said actuator when deenergized connecting said second capacitor to said second source of direct current voltage to charge said second capacitor, a flame relay having a winding, and means controlled by said actuator when energized connecting said second capacitor to said relay winding to discharge said second capacitor through said winding, continued energization of said relay winding being dependent upon continued intermittent energization of said actuator.

4. In combination: semiconductor means having a collector electrode, a base electrode, and an emitter electrode; alternating current responsive means connected to said collector electrode, a capacitor, a direct current source of power, means connecting said capacitor and direct current source of power in a series circuit to said base and emitter electrodes to cause a pulsating capacitor charging current to flow through said series circuit until said capacitor is charged, and control means including circuit means to discharge said capacitor.

5. In combination: a transistor having collector, emitter, and base electrodes, with the current flow from said emitter electrode to said collector electrode being an amplified current indicative of the current flow from said emitter electrode to said base electrode, pulsating current responsive means, means connecting said current responsive means to said collector electrode so that the current from said emitter electrode to said collector electrode flows therethrough, a capacitor, a pulsating direct current source of power; circuit means connecting said capacitor, said direct courrent source of power, said base electrode, and said emitter electrode in a series circuit so that a charging current for said capacitor flows from said emitter electrode to said base electrode for a short time duration necessary to charge said capacitor; and control means including circuit means connected to discharge said capacitor so that a pulsating charging current continuously flows in said series circuit to thereby control said current responsive means.

6. In combination: a transistor having a collector, an emitter, and a base electrode; a capacitor, a rectifier, an alternating current source of voltage, circuit means connecting said capacitor, said rectifier, and said source of voltage in a series circuit to said emitter and base electrode so that current flows in said circuit means for a short time period to charge said capacitor, alternating current responsive means including an electrically energizable actuator and switching means controlled thereby, means connecting said alternating current responsive means to said collector, control means including a circuit controlled by said switching means for discharging said capacitor, and means controlled by said switching means and responsive to intermittent energization thereof.

7. In combination: a semiconductor device having a base member, a collective member, and an emitter member, pulsating current responsive means having an input and including an electrically energizable actuator and switching means controlled thereby, said actuator being energized when pulsating current is applied to said input, means connecting said input to said collector member to apply the emitter to collector current to said input, electrical means capable of receiving and storing an electrical current, unidirectional current conducting means, a source of alternating current voltage, means connecting said electrical means, said unidirectional current conducting means, and said source of voltage to said emitter and base member so that a charging current flows to charge said electrical means, means including said switching means when said actuator is deenergized arranged to discharge said electrical means, and means controlled by said switching means and responsive to continued intermittent operation of said switching means.

8. In combination: a transistor having a base, a collector and an emitter; a capacitor, a source of pulsating direct current voltage, circuit means connecting said capacitor and said source of voltage to said base and emitter to cause a charging current to flow from said emitter to said base until said capacitor is fully charged; a transformer having a primary and a secondary, means connecting said primary in circuit with said collector and emitter, switching means having an electrically energizable actuator, means connecting said actuator in energizable relation to said secondary; circuit means including said switching means for discharging said capacitor, said circuit means being open circuited upon said switching means actuator being energized to thereby cause a recurring charging current to flow from said emitter to said base and to cause intermittent energization of said actuator; a second source of direct current voltage, a second capacitor, circuit means completed by said switch-

ing means when said actuator is energized to charge said second capacitor, an electrically energizable control device having an actuator, and circuit means completed by said switching means when said actuator is deenergized to discharge said second capacitor through the actuator of said control device and thereby energize said control device, the continued energization of said control device being dependent upon continued intermittent energization of said switching means actuator.

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