Sept. 20, 1966 R. W. BROWN 3,273,626

BURNER CONTROL SYSTEM

Filed Feb. 19, 1965 4 Sheets-Sheet 1

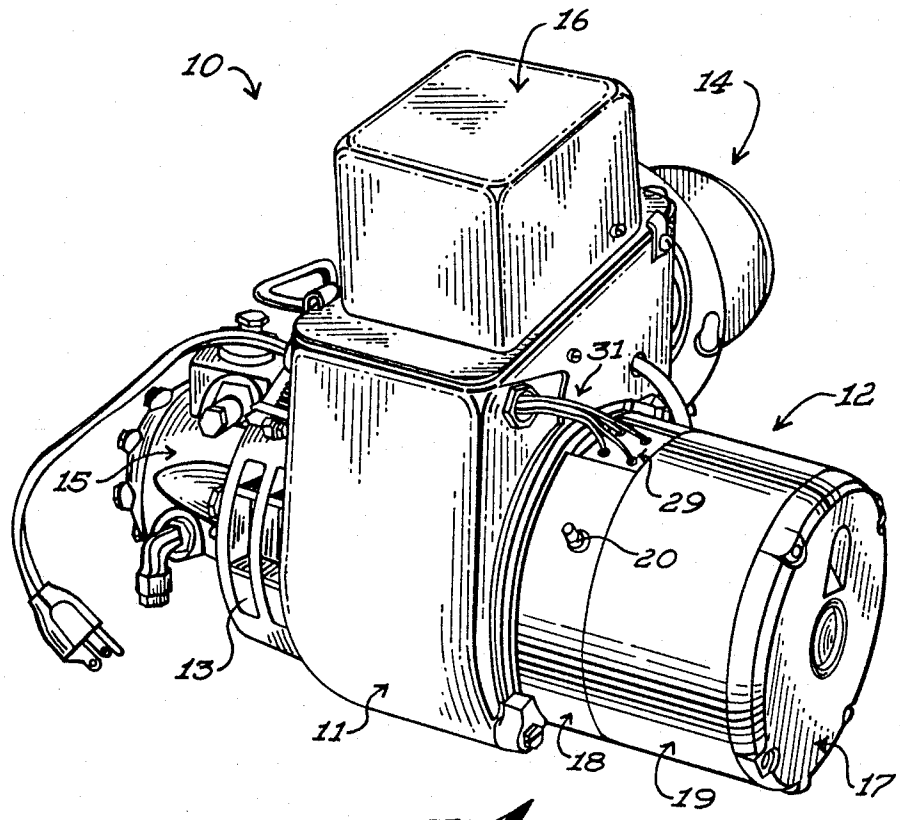



FIG. 1

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BURNER CONTROL SYSTEM

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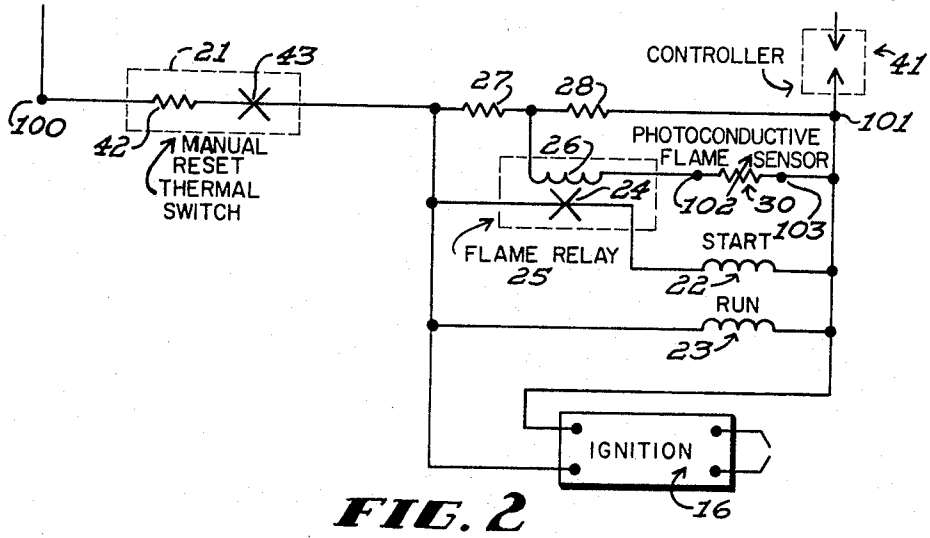



FIG. 2

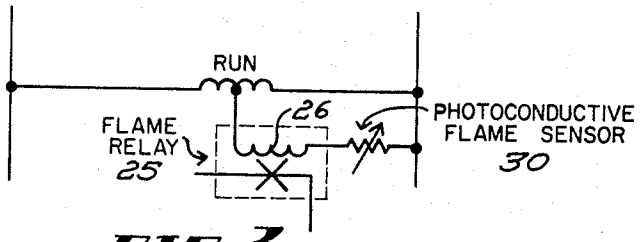



FIG. 3

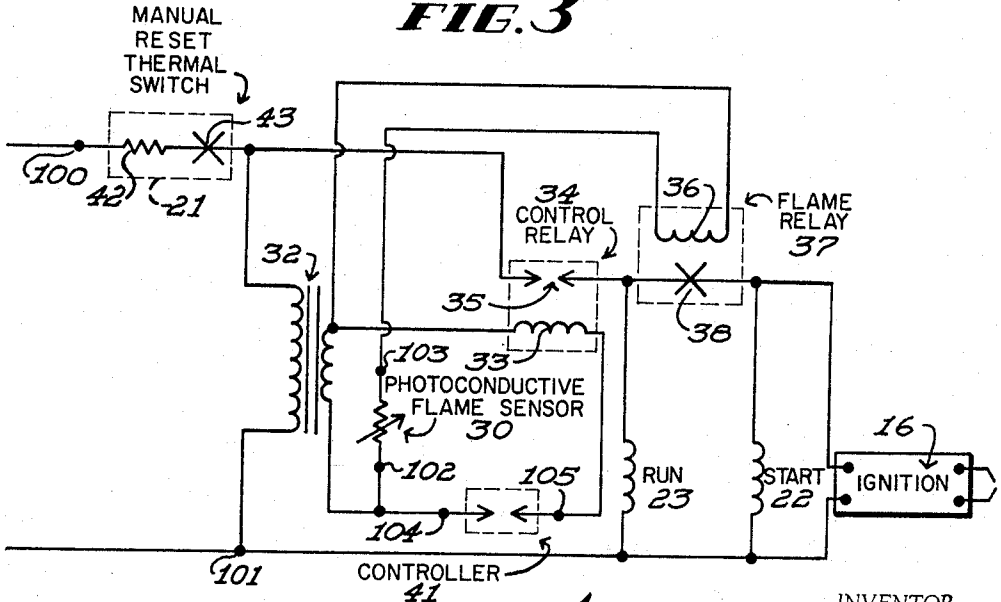



FIG. 4

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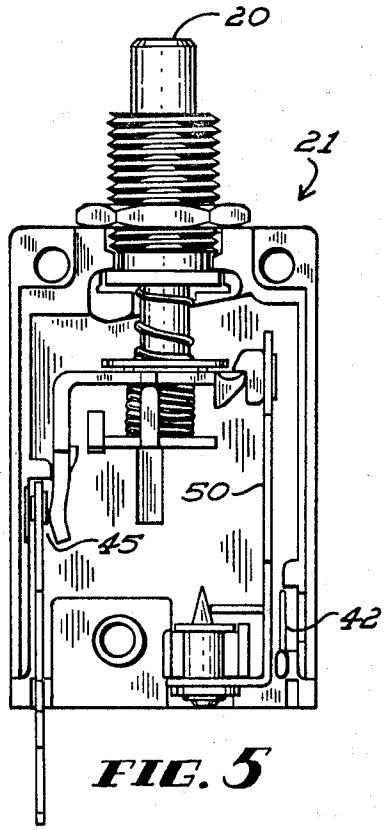



FIG. 5

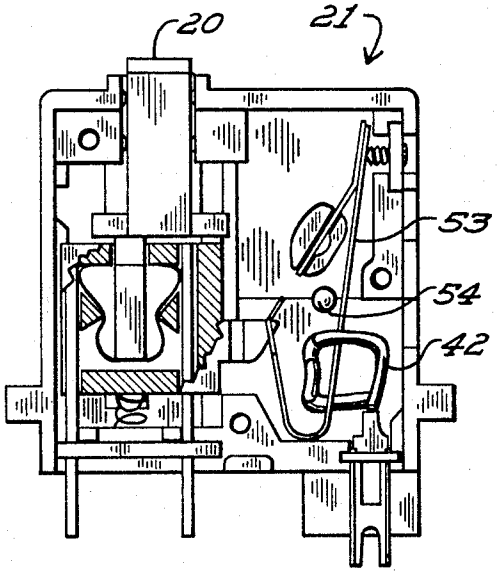



FIG. 6

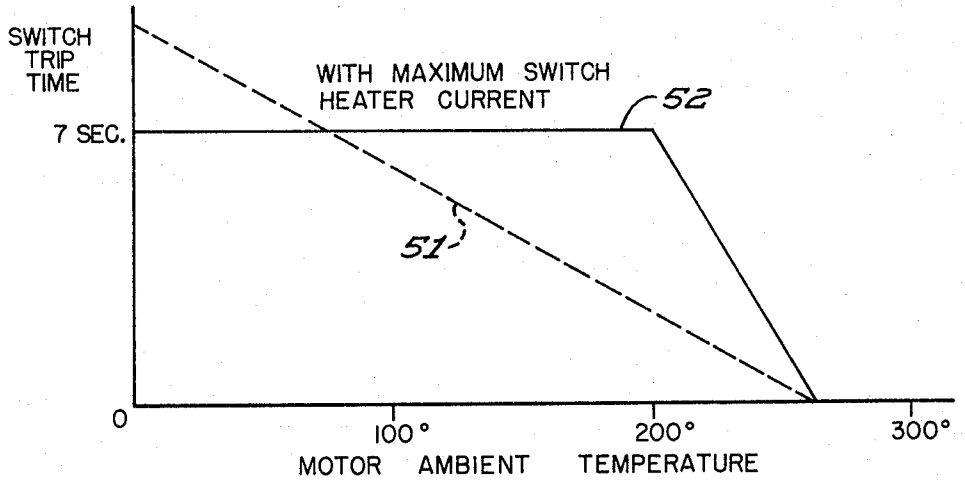



FIG. 7

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BURNER CONTROL SYSTEM

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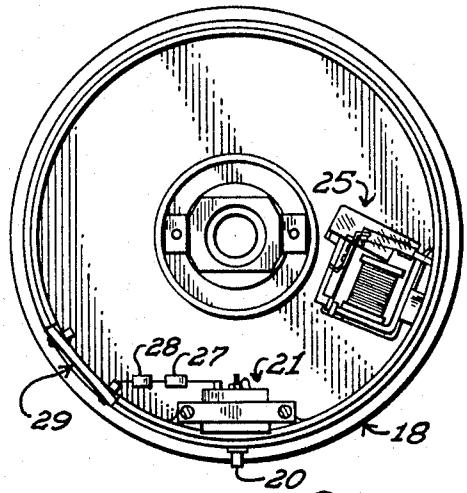



FIG. 8

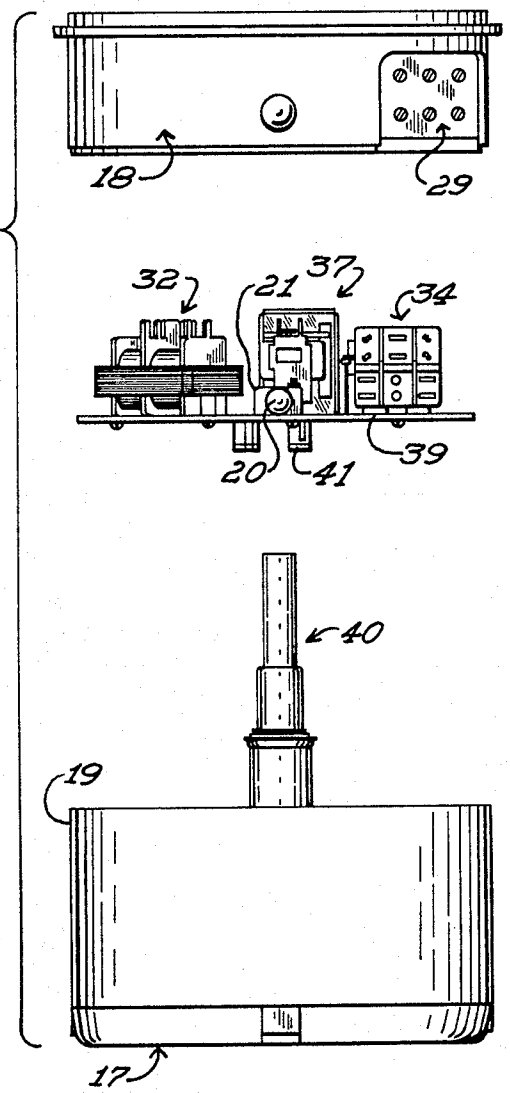



FIG. 9

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United States Patent Office 3,273,626 Patented Sept. 20, 1966



3,273,626

# BURNER CONTROL SYSTEM

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Filed Feb. 19, 1965, Ser. No. 433,851
13 Claims. (Cl. 158—28)

My invention is concerned with an improved burner control system and particularly with a burner control system wherein a minimum number of components are structurally and electrically arranged and mounted in a single unitary housing to provide a less expensive, a compact and a reliable burner control system.

My invention relates particularly to the fuel burner unit known generally in the trade as a gun-type oil burner. Such an oil burner normally includes a single phase induction motor which has an air fan and an oil pump connected to be driven by the rotor of the motor.

As is characteristic of the prior art, energization of the motor is achieved by a thermostat which is connected to a control apparatus known as an oil burner primary control. A call for operation of the oil burner is evidenced by the closing of the thermostat switch. The oil burner primary control is then effective to energize the start winding and the run winding of the motor. As the motor is brought up to speed, a centrifugal switch (or other means sensitive to the speed of the motor) is effective to disconnect the start winding of the motor and to maintain the motor running by energization of only the run winding. An oil burner pump is driven by the motor and supplies pressurized fuel to a nozzle where the fuel is aspirated to produce a combustible mixture of fuel and air, this mixture being ignited by spark ignition electrodes which are connected to a high voltage transformer. Combustion air is supplied to the environment of the combustible mixture by means of the air fan which is also driven by the motor.

Oil burner primary controls of the prior art function to sense the proper establishment of flame at the environment of the combustible mixture and to control the state of energization of a time delayed safety switch, for example a safety switch having a normally closed switch controlled by a movable bimetal member and an associated heater. As is conventional, a predetermined time period of energization of the heater causes the normally closed switch to open. This switch is connected in overall control of the burner and deenergizes the burner when the switch opens. The switch is physically latched in the open position and manual reset is required, calling attention to the fact that a malfunction has occurred. In order to give consistent timings, independent of ambient temperature, the safety switch is especially constructed to be insensitive to changes in the ambient temperature of the air surrounding the bimetal.

In order to protect the motor from damage, due to overheating, the motor is provided with a thermal cutout switch which is responsive to both the ambient temperature of the motor and to motor current, to open a switch in series with the start and run windings of the motor in the event that abnormally high motor temperature or motor current occurs. When this switch opens, the thermostat loses control and is unable to start the motor even though a need for operation is indicated by the thermostat.

My invention relates to a novel manner of accomplishing the above described function of the prior art by means of a new burner control system.

Specifically, I have originated a burner control system in which the oil burner primary control and the oil burner motor are uniquely mounted and positioned within a



single housing, to produce a compact and a less expensive structure. Furthermore, by virtue of this construction I am able to eliminate certain parts, and to consolidate the function of certain parts into other parts, to make possible a reduction in size and reduction in cost.

More specifically, I utilize an electric-type flame detector in the form of a cadmium sulfide photocell to directly energize a flame relay. A normally-closed switch of the flame relay is connected in series with the start winding of the motor. By virtue of this construction, I am able to eliminate the centrifugal switch of the induction motor and, by virtue of the fast acting effect of this electric flame detector in detecting the establishment of flame, I am able to use a standard motor, it being unnecessary to resort to a motor having a heavy-duty start winding.

I incorporate the function of the safety switch of the oil burner primary control and the function of the motor thermal cutout switch into a single switch which is sensitive to the magnitude of the motor current and to the magnitude of the motor ambient temperature. Since the electric flame detector of my invention is effective to open the motor start winding upon the establishment of flame, I use the motor current magnitude as an indication of the presence or absence of flame. Thus, the safety switch of my invention is operatively de-energized when the start winding of the motor is open. Furthermore, by virtue of the physical location of my safety switch within the housing of the motor, this safety switch is responsive to the ambient temperature of the motor and serves to protect the motor and to prevent a start or a run of the motor when an abnormally high ambient motor temperature exists. In order to accomplish this result, the safety switch of my invention is especially constructed to be sensitive to ambient temperature, it being recognized that the oil burner primary control safety switches of the prior art are purposely constructed to be insensitive to ambient temperature.

By virtue of the fact that I utilize a fast-acting electric flame detector, I am able to sense the presence or absence of flame in a fraction of a second and, therefore, in the event of an accidental extinguishment of flame, my device provides an immediate recycle of the fuel burner in an attempt to re-establish flame.

My invention will be apparent to those skilled in the art upon reference to the following specification, claims and drawings, of which:

FIGURE 1 is a showing of a gun type oil burner embodying the unitary motor and burner primary control of my invention,

FIGURE 2 is a schematic diagram showing a line voltage primary control,

FIGURE 3 is a modification of the schematic diagram of FIGURE 2,

FIGURE 4 is the schematic diagram of a low voltage primary control,

FIGURES 5 and 6 are showings of two different thermal cutout switches, the switch of FIGURE 5 being uncompensated for ambient temperature and the switch of FIGURE 6 being compensated for ambient temperature within a given temperature range,

FIGURE 7 is a graphical representation of the operation of the switches of FIGURES 5 and 6,

FIGURE 8 is a showing of the mounting of the components of the line voltage primary control within the motor housing, and

FIGURE 9 is a showing of the mounting of the components of the low voltage primary control within the motor housing.

Referring to FIGURE 1, reference numeral **10** designates generally a gun type oil burner. Within the housing **11** is disposed an air fan or blower which is connected

to the rotor of a motor contained generally within the housing **12**. The blower functions to draw combustion air through louvers **13**, supplying this combustion air to an oil burner nozzle **14**. Reference numerals **15** and **16** designate an oil pump, also connected to the rotor of the motor, and an ignition transformer which, when energized, supplies spark ignition to electrodes located in the vicinity of the oil burner nozzle **14**. Referring specifically to motor housing **12**, this motor housing includes a pair of end bells **17** and **18** which close the respective ends of the motor. The central part of the motor includes a housing **19** containing the stator windings of the motor.

Motor **12** is a motor having a starting requirement calling for the energization of both a run actuator and a start actuator, with the start actuator being subsequently de-energized as the motor is brought up to speed. For example, a split phase motor includes a rotor, a stator, and a centrifugal switch. The stator carries a continuously energized run winding and a start winding which is energized only until the motor is brought up to speed. A capacitor start motor is also of this type, wherein a capacitor is connected in series with the starting winding and a centrifugal switch disconnects the capacitor and start winding upon the motor being brought up to speed. The term "motor" within the terms of my invention is intended to be this general type motor wherein the starting condition of the motor, with both actuators energized, results in a high starting current, and wherein the run condition of the motor, with only the run actuator energized, provides an appreciably reduced running current.

An essential feature of my invention is the integrated construction of the motor and a burner primary control into a single housing, utilizing components which are structurally and electrically integrated in the manner taught herein.

Referring to FIGURES 8 and 9, I disclose the structural motor elements **17**, **18** and **19** as related to the line voltage and low voltage burner primary control elements which are disclosed in FIGURES 2 and 4 respectively while in each case I have disclosed the components of the burner primary control as being mounted in the end bell **18**, it is within the teachings of my invention to mount these elements within the end bell **17**, to facilitate removal of this end bell for replacement or repair of the burner primary control without the necessity of removing the main portion of the motor housing **12**.

In either the line voltage or low voltage burner primary control, I provide a thermal cutout switch having a reset actuator **20**, FIGURES 1, 8 and 9. In the schematic diagrams of FIGURES 2 and 4 I identify this thermal switch by reference numeral **21**, and this switch structure is identified generally in FIGURES 8 and 9 by a like reference numeral. The thermal switches disclosed in the various figures are of the manual reset type, that is these switches are actuated to an open position and mechanically locked and must be manually reset, as by depressing reset button **20**, to reset the switch to a closed position.

Referring to FIGURE 2, the start winding **22** and the run winding **23** of the motor are contained with the portion **19** of the motor housing, the start winding being connected in series with a normally closed switch **24** of a flame relay **25** having a winding **26**. In FIGURE 8 this flame relay is identified generally by the reference numeral **25**. Also contained within the end bell **18** are voltage dividing resistors **27** and **28**. These resistors are connected to a terminal of a terminal board **29** held in the periphery of the end bell **18** and to thermal switch **21**. These resistors form a voltage divider for winding **26** of the flame relay. Energization of winding **26** is achieved by a photoconductive flame sensor **30**. This flame sensor is located in the vicinity of the oil burner nozzle **14** of FIGURE 1 and the flame sensor is electrically interconnected to the structure within the end bell **18** by means of electrical conductors **31** of FIGURE 1.

Photoconductive flame sensor **30** may be of the cadmium sulfide type having a high dark resistance and low light resistance, as when exposed to the flame at the oil burner nozzle. This low resistance is effective to operatively energize the winding of flame relay **25**, causing switch **24** to open.

In FIGURE 3 I show a tapped motor run winding which provides the voltage divider action necessary to energize the winding **26** of flame relay **25**.

In FIGURE 4 I disclose a low voltage burner primary control having a step down transformer **32** whose secondary winding is connected to the winding **33** of a control relay **34** having a normally open switch **35**. Also connected to the secondary winding of this transformer is the winding **36** of a flame relay **37** having a normally closed switch **38**. The structural elements **32**, **34** and **37** are identified by like reference numerals in FIGURE 9. The elements **31**, **32**, **34** and **37** of FIGURE 9 are mounted on a mounting board or chassis member **39**, having a central opening to receive the shaft **40** of the motor rotor, and having terminals **41** adapted to be connected to the terminal board **29** located in the periphery of the end bell **18**. For purposes of simplicity I have not shown the electrical conductors in either FIGURE 8 or 9.

Referring again to FIGURE 4, the motor run winding **23** and the motor start winding **22** are connected to be energized through the normally open switch **35** of control relay **34**.

In the disclosure of FIGURE 2, I connect the ignition transformer in parallel with motor run winding **23** to provide intermittent ignition. In the disclosure of FIGURE 4 I connect the ignition transformer in parallel with the motor start winding, these parallel connected elements being connected in series with the normally closed switch **38** of flame relay **37** to thus provide interrupted ignition. It is within the teachings of my invention to connect the ignition transformer in series with either the run or start winding rather than in parallel.

In both FIGURES 2 and 3 a controller **41** is identified and is intended to be located externally of the gun type oil burner. For example, controller **41** may be a room thermostat located in the area to be heated by operation of the oil burner. The thermal cutout switches identified by means of reference numerals **21** of FIGURES 2 and 4 include actuator heaters **42** which are effective to open the normally closed switch **43** upon a time period of operative energization of heater **42**. The thermal cutout switches **21** are constructed and arranged to be sensitive to an abnormally high motor ambient temperature to cause switch **43** to open, to thus protect the motor. Additionally, the thermal switches are constructed and arranged to be sensitive to the magnitude of electrical current drawn by joint energization of the motor start winding and the motor run winding to open switch **43** after a predetermined time period of joint energization of these windings. Switch **43** will not open however upon continuous energization of only the motor run winding.

In FIGURE 5 I disclose a switch which is sensitive to motor ambient temperature over a complete range of motor temperatures. In this switch a bimetal actuator **50** has associated therewith the heater **42** to control switch **43**. The operation of this switch is plotted in the graph of FIGURE 7 by means of the broken line identified by reference numeral **51**. This graph plots the switch trip time versus motor ambient temperature with maximum heater current, that is with both the motor run winding and the motor start winding energized. From this graph it can be seen that the trip time of switch **43** will decrease until at a temperature of 250° the switch opens due to only ambient temperature.

The solid line **52** discloses the operating characteristics of the switch of FIGURE 6. This switch includes a

generally U-shaped bimetal member **53** which operates to compensate this switch for changes in ambient temperature until the ambient temperature reaches the range of 200°. At this point the bimetal engages a fixed stop **54** to inactivate the compensating portion of the bimetal. Thereafter, the characteristics of operatioin of the switch are altered such that the switch also trips to an open position upon the motor ambient temperature reaching the range of 250°. In the case of this switch, the trip time remains constant until stop **54** is engaged by bimetal **53**.

Referring now to the operation of my invention, with particular reference to FIGURE 2, the need for operation of the gun type oil burner is indicated by the closing of switch **41**. With the motor thermal switch in a closed position (the normal position), voltage dividing resistors **27** and **28** are connected across the source of power through the heater **42** and switch **43** of thermal switch **21**. If the resistance value of the photoconductive flame sensor **30** is at the normal high value, flame relay **25** is de-energized and switch **24** is closed. The motor start winding, the motor run winding, and the ignition transformer are then energized.

As the motor is brought up to speed, combustion air and oil are supplied to the vicinity of the nozzle **14** to produce a combustible mixture. This mixture is ignited by the spark ignition means, and flame sensor **30** senses the presence of flame to energize winding **25**, causing switch **24** to open. Opening of switch **24** de-energizes the motor start winding. Thereafter the motor continues to run with only the run winding energized and the magnitude of current flowing through heater **42** of the thermal switch is insufficient to cause this switch to trip to an open position.

In the above description the assumption has been made that flame sensor **30** has a high resistance value in the absence of flame. If it is assumed that this element has become defective, or is shorted as by soot or the like, then the initial closing of the switch of controller **41** is effective to energize flame relay **25** and an attempt is made to start motor **12** with only the run winding energized. The motor will not start in this condition and a locked rotor current flows through the thermal switch heater to cause the switch **43** to open after a given time period.

If a flame failure is experienced, flame relay **25** is de-energized to close switch **24**, re-energizing the motor start winding. This has no effect on the running characteristics of the motor but does appreciably increase the current through the heater of the thermal switch. The thermal switch will then trip to a lockout condition in a given period of time.

In FIGURE 3 I disclose a modification wherein energizing voltage for the winding of flame relay **25** is obtained from a tapped motor run winding rather than from the voltage divider network **27–28** as shown in FIGURE 2.

In FIGURE 4 flame relay **37** is a low voltage relay and the controller **41**, also a low voltage device, is effective to control the energization of a control relay **34** whose switch **35** energizes the windings of the motor and the ignition transformer. Here again, the normally closed switch **38** of flame relay **37** is connected in series with the motor start winding such that improper operation of the flame relay, as by falsely detecting flame during a standby period, is effective to prevent energization of the motor producing a locked rotor current to trip thermal switch **31**. In the structure of FIGURE 4 I have disclosed an arrangement whereby the switch **38** of flame relay **37** is also effective to de-energize the ignition means upon the detection of flame.

As seen in FIGURES 1, 8 and 9, a portion of the motor housing holds a terminal strip or card **29**. This card carries terminals adapted to be connected to power lines and the like. In FIGURES 2 and 4 reference numerals **100** and **101** identify terminals adapted to be connected to the power lines. Reference numerals **102** and **103** identify terminals adapted to be connected to the flame sensor, and numerals **104** and **105** of FIGURE 4 identify terminals adapted to be connected to the controller.

From the above description it can be seen that I have provided an improved burner control system wherein the burner motor and the burner control are integrated to provide an integrated and unitary device. Modifications of my invention will be apparent to those skilled in the art and it is intended that the scope of my invention be limited solely by the scope of the appended claims.

I claim as my invention:

**1.** In an oil burner system in which an oil pump is rotated by the rotor of an electric motor having a run actuator to provide running torque and a start actuator to aid the run actuator in providing a high starting torque which is necessary to institute rotation of the rotor;

a time delayed temperature responsive switch mounted to be responsive to the ambient temperature of the motor, and having a single electrically energizable actuator electrically connected in circuit with the run and start actuator to be responsive to the electrical current drawn by the motor,

and a fast-acting electric flame detector including a flame relay having a normally closed no-flame switch connected in series with only the start actuator to de-energize the start actuator upon detection of flame, to provide oil burner safety cutout action by operation of the temperature responsive switch in respone to the electrical current drawn by the motor in the event of failure to sense the establishment of flame, to prevent start of the motor and subsequently to provide oil burner safety cutout action in response to the locked rotor current of the motor in the event of the false sensing of flame during a standby period, and to provide motor protection in the event of an abnormally high motor ambient temperature.

**2.** An integrated oil burner primary control apparatus and oil burner motor, the motor having a rotor, a run winding, and a start winding;

a housing for said motor to contain and support the rotor and the run and start windings,

a flame relay mounted within said housing and having a winding and a normally closed switch,

a manual reset thermal switch mounted within said housing and having a movable ambient temperature sensitive element, an electric heater associated in heating relation with said temperature sensitive element, and a normally closed switch controlled by said temperature sensitive element,

and electrical circuit means connecting the heater and the normally closed switch of said thermal switch in series with both the motor start and the motor run winding, and connecting the normally closed switch of said flame relay in series with only the motor start winding.

**3.** In a gun type oil burner having a motor with a start winding and a run winding, and having an oil pump and a combustion air fan to be driven by the motor to supply oil and air to an area adapted to support combustion, the improvement comprising;

a housing for the motor to hold the motor rotor and the run and start windings in cooperating relation,

a normally closed, manual reset, current sensitive and ambient temperature sensitive cutout switch means mounted within said housing and electrically connected in series with the run and start windings to be tripped to an open condition by virtue of prolonged operation of the motor with both windings energized or by virtue of an abnormally high motor ambient temperature,

and normally closed flame relay switch means mounted

within said housing and electrically connected in series with only the start winding.

4. In a fuel burner system having an electric motor with a housing, a rotor, a start winding, and a run winding, the electric motor being adapted to be energized upon a call for heat and when so energized to then supply fuel to a fire box, the improvement comprising;

a photocell adapted to be positioned to view the fire box,

a flame relay having a winding connected in circuit with said photocell to be energized upon the presence of fire in the fire box, said relay having a normally closed switch connected in series with the start winding of the motor, the switch functioning to prevent a start of the motor in the event of an unsafe failure of said photocell and also functioning to maintain a high motor current until fire is detected,

normally closed, manual reset, safety cutout switch means mounted within the motor housing, having a temperature sensitive element which is sensitive to ambient temperature, and having a single current sensitive heater which is sensitive to motor current, to trip said cutout switch means to an open condition upon an abnormally high motor temperature or upon a prolonged period of energization of both the motor start and run windings,

and circuit means connecting said safety cutout switch means in overall control of the fuel burner system to prevent operation of the same upon opening of said cutout switch means.

5. Burner apparatus comprising;

a motor adapted for use with a gun type oil burner and having a housing, a start winding, and a run winding,

a flame relay mounted within said housing having a winding and a normally closed switch,

circuit means connecting the switch of said flame relay in series with said start winding,

and thermally responsive manual reset safety switch means mounted within said housing and having a normally closed switch, said switch means being constructed and arranged to be responsive to motor ambient temperature and to time integrate the concurrent energization of said start and run windings to open said switch upon an abnormally high ambient temperature or upon a given time period of concurrent energization of said start and run windings.

6. A burner control system comprising;

a burner motor having a housing containing a rotor, a start winding and a run winding,

a flame relay mounted within said housing, having a winding and a normally closed switch connected in series with the start winding,

a photocell connected to the winding of said flame relay and adapted to view a fire in the firebox and to energize said winding upon the presence of fire,

and manual reset thermal cutout means mounted within said housing, having heater means connected in series with both said start and said run winding, and having a movable temperature responsive means responsive to ambient temperature and to energization of said heater means for controlling a manually closed switch which is connected in series with both said start and said run windings.

7. A burner control system as defined in claim 6 wherein said run winding is provided with a tap and the winding of said flame relay is connected through said photocell to the tap and an end terminal of said run winding.

8. A burner control system as defined in claim 6 wherein fuel ignition means is electrically connected in circuit with said start winding.

9. A burner control system as defined in claim 6 wherein fuel ignition means is electrically connected in circuit with said run winding.



10. In combination;

a motor having a rotor, a start winding, and a run winding mounted within a unitary housing,

means including a flame relay mounted within said housing, terminals on said housing adapted to be connected to a flame sensitive photocell, circuit means connecting the winding of said flame relay to said terminals, and circuit means controlled by said flame relay effective to open circuit said start winding upon sensing of flame,

and a manual reset thermal cutout switch mounted within said housing and including ambient temperature compensated bimetal means, a heater connected in series with both said start and run windings, a normally closed switch controlled by said bimetal means and connected in series with both said start and run windings, and including means effective to modify the response of said bimetal means to ambient temperature to render the same uncompensated to ambient temperature at a temperature which is related to a maximum safe motor temperature.

11. An integrated electrical motor and burner control apparatus for use in a fuel burner installation, comprising:

a housing containing a rotor, a start winding, and a run winding of the motor,

a mounting plate mounted at one end of said housing,

a flame relay mounted on said plate and having a winding and a normally closed switch,

manual reset thermal cutout means mounted on said plate and constructed and arranged to be sensitive to ambient temperature, having a heater element adapted to be connected in an electrical circuit to render said cutout switch sensitive to the current flowing in the circuit, and having a normally closed switch adapted to open upon a high ambient temperature or a prolonged period of high current flow,

a pair of electrical power input terminals mounted on said housing,

a pair of photocell terminals mounted on said housing,

electrical circuit means connecting the winding of said flame relay in series with said photocell terminals to said power input terminals,

electrical circuit means connecting said start winding in series with the switch of said flame relay to said run winding,

and electrical circuit means connecting said run winding in series with the heater and switch of said cutout means to said power input terminals.

12. An integrated electrical motor and burner control apparatus for use in a fuel burner installation, comprising:

a housing containing the rotor, start winding, and run winding of the motor,

mounting means within said housing,

a step-down transformer mounted on said mounting means and having a high voltage primary winding and a low voltage secondary winding,

a flame relay mounted on said mounting means and having a winding and a normally closed switch,

manual reset thermal cutout means mounted on said mounting means and having a normally closed switch, temperature sensitive means controlling said switch, and a heater associated with said temperature sensitive means, said cutout means being constructed and arranged to be sensitive to ambient temperature and to the time integral of the current flowing through said heater,

a control relay mounted on said mounting means and having a winding and a normally open switch,

photocell terminals, controller terminals and power input terminals mounted on said housing,

and electrical circuit means connecting the winding of said flame relay in series with said photocell terminals to said secondary winding, connecting the

winding of said control relay in series with said controller terminals to said secondary winding, connecting said primary winding in series with the heater and switch of said cutout means to said power input terminals, connecting said run winding in series with the switch of said control relay to said primary winding, and connecting said start winding in series with the switch of said flame relay to said run winding.

13. Apparatus as claimed in claim 12 including ignition terminals connected to said start winding and adapted to be connected to burner ignition means.




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JAMES W. WESTHAVER, *Primary Examiner.*