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BURNER CONTROL SYSTEM

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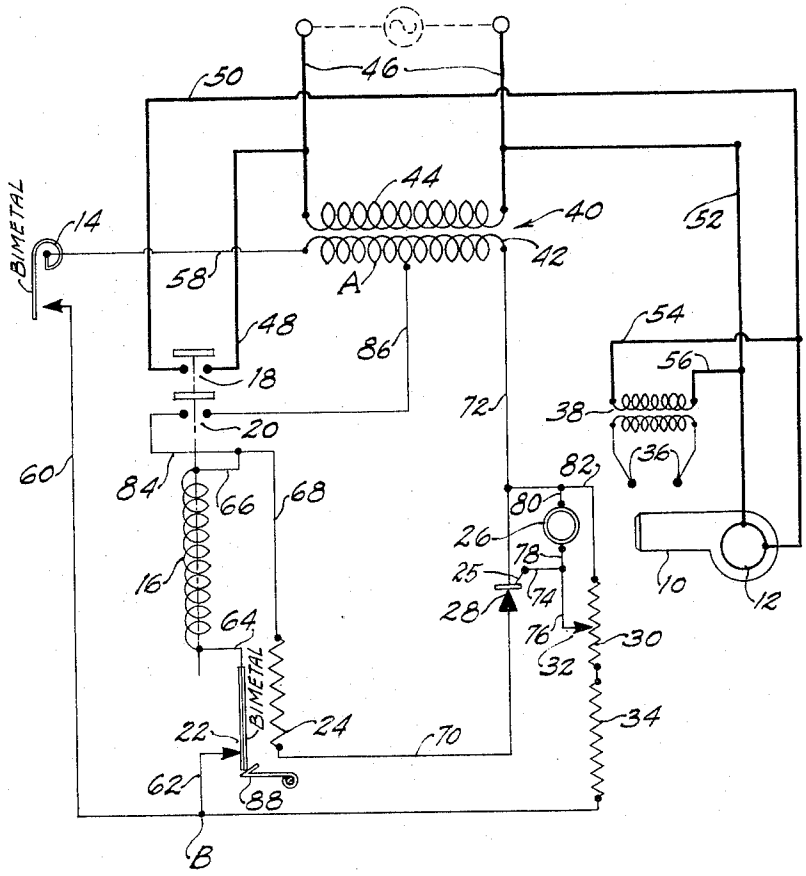

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BURNER CONTROL SYSTEM

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This invention relates to automatic control systems for fluid fuel burners which includes safety means operative to permit the supply of fuel to the burner when there is combustion flame and to cut off such supply in event combustion flame is not established or having been established is extinguished, and which safety means includes a photoconductive device and a solid state switching device.

The primary object of the invention is to provide a generally new and improved safety control system for fluid fuel burners incorporating instantly responsive, combustion flame detecting means and solid state switching means in a novel arrangement which provides a particularly simple, economical, and reliable construction.

Further objects and advantages will appear from the following description when read in connection with the accompanying drawing.

The single figure of the drawing is a diagrammatic illustration of a control system for a conventional, pressure-type oil burner.

Referring to the drawing, the primary elements of the system include an oil burner **10** having a driving motor **12**, a space thermostat **14**, a motor relay having a winding **16** with two sets of normally open contacts **18** and **20**, a normally closed thermal time switch **22** (safety switch) including an electrical resistance heater **24**, a light sensitive element **26**, a silicon-controlled rectifier **28** (SCR) having a control electrode **25** and a control network comprising the light sensitive cell **26**, a control resistor **30** with sliding contact **32**, and a fixed major voltage dropping resistor **34**, a spark igniter comprising electrodes **36** and a step-up transformer **38**, a voltage step-down, power supply transformer **40** having a primary winding **44** and a secondary winding **42**, and a pair of power supply leads **46** for connection to a suitable source of A.C. power.

The oil burner **10** includes the usual blower and fuel pump which, when driven by motor **12**, supply atomized oil and combustion air to the burner nozzle where it is ignited by arcing across spark electrodes **36**. The motor **12** and igniter transformer **38** are connected in parallel across the power supply leads **46** and through normally open motor relay contacts **18**, when closed, by leads **48**, **50**, **52**, **54**, and **56**. The motor **12** and igniter **38** are therefore energized simultaneously when relay contacts **18** are closed.

The motor relay winding **16** is connected across the entire secondary winding **42** through a circuit which may be traced from the left side of secondary **42** as follows: a lead **58**, thermostat **14**, a lead **60**, a lead **62**, safety switch **22**, a lead **64**, relay winding **16**, a lead **66**, a lead **68**, safety switch resistance heater **24**, a lead **70**, SCR **28**, and a lead **72** to the right side of transformer secondary **42**.

The light sensitive element **26** is of the semiconductor type having an extremely high electrical resistance in the absence of light and becoming considerably less resistive when impinged by the light of burner flame. The positioning of light sensitive element **26** so as to be responsive to burner flame and yet be shielded from ambient light is preferably that shown and described in United States Letters Patent, No. 3,079,982, issued March 15, 1963, to Bernardus J. Staring.

The resistors **30** and **34** are series connected across the SCR **28**, and the SCR control electrode **25** is connected

to the left side of transformer secondary winding **42** through a lead **74**, a lead **76**, and slider contact **32**, a portion of the control resistor **30**, the major voltage dropping resistor **34**, a lead **60**, thermostat **14**, and a lead **58**. The light sensitive cell **26** and a portion of control resistor **30** are connected in parallel between the SCR control electrode **25** and the cathode side of the SCR by the lead **74** and by lead **76** and slider **32** and by leads **78**, **80**, and **82**. The resistance between the SCR control electrode **25** and the left side of transformer secondary **42** due to resistor **34** and a portion of resistor **30** is such that sufficient or just slightly more than sufficient voltage is applied to the SCR control electrode during the conductive half cycle of the SCR and upon closure of thermostat **14** to effect conduction of the SCR under conditions of no flame at the burner **10** when the resistance of light sensitive element **26** is very high. Upon the appearance of combustion flame at burner **10**, the resistance of element **26** decreases and the voltage drop thereacross which then occurs is such that the voltage applied to the SCR control electrode falls below that which will effect conduction of the SCR.

The motor relay winding **16** is also connected across a lefthand portion A of the transformer secondary winding **42** by a circuit branch extending from a point B at the junction of leads **60–62** and comprising the lead **62**, the safety switch **22**, lead **64**, motor relay winding **16**, lead **66**, a lead **84**, relay contacts **20**, and a lead **86** connected to the transformer secondary winding **42** at an intermediate point therealong.

The motor relay winding **16** and secondary winding **42** are so constructed, and the connection of lead **86** with winding **42** is so positioned therealong, that the half wave energization of relay winding **16** as effected by its connection across the entire secondary winding **42** through SCR **28** is sufficient to effect the closing of relay contacts **18** and **20**, while, on the other hand, the full wave, A.C. energization of winding **16** as effected by its connection across the portion A of transformer secondary **42** is insufficient to cause the operation of the relay from open to closed contact position, but is sufficient to hold the relay in closed contact position once it is in closed contact position.

Operation

Under normal operating conditions, the closure of thermostat **14** upon call for burner operation effects half-wave energization of relay winding **16** through safety switch **22**, safety switch heater **24**, and SCR **28** across the entire secondary winding **42** to cause the closing of contacts **18** and **20**. The resistance of light sensitive element **26** under these conditions of no flame is very high, and a firing signal is therefore applied to SCR **28** each conducing half cycle. The closing of relay contacts **18** completes the circuit across power supply leads **46** thereby energizing burner motor **12** and igniter **38**, whereupon fuel and air are supplied to the burner and ignited. The closing of relay contacts **20** completes the circuit branch connecting the relay winding **16** through the safety switch **22** (but not through the safety switch heater **24**) across the lefthand portion A of transformer secondary winding **42**.

When combustion flame appears at the burner **10**, conduction of the SCR **28** is cut off and the relay contacts **18** and **20** remain closed due to the described branch circuit connecting relay winding **16** across portion A of the secondary winding **42**. As stated hereinbefore, the power supplied to relay winding **16** by portion A of secondary winding **42**, while sufficient to hold relay contacts **18–20** closed once they have been closed, is insufficient to effect the closing of these contacts. When conduction through SCR **28** is cut off due to the appearance of burner flame, the safety switch heater **24** is de-energized and the burner

will continue to operate under normal conditions until thermostat **14** opens.

If upon closure of thermostat **14** and energization of burner motor **12** ignition of the combustible mixture fails to occur within a predetermined time, or having been ignited is extinguished for any reason and fails to re-ignite in a predetermined time, the safety switch heater **24** will warp the bimetal contact blade of the safety switch **22** and effect opening of the safety switch contacts, thereby breaking both the circuit connecting relay winding **16** across the entire secondary winding **42** and the branch circuit connecting it across the portion A of secondary winding **42**. Under these conditions operation of the burner and igniter are cut off, as well as energization of the safety switch heater **24** and conduction through SCR **28**. A spring latching device **88** is provided which is operative to retain safety switch **22** in an open position when it is warped open so that manual resetting of the safety switch is required to re-start the system.

If the SCR **28** malfunctions in a manner so as to conduct when it should not, or if the light sensitive element **26** fails to respond to burner flame and cut off conduction of SCR **28**, the safety switch will open, the safety switch heater **24** being in series with the SCR **28**. If SCR **28** malfunctions in a manner so as to fail to conduct when it should, or if light sensitive element **26** malfunctions or is inadvertently exposed to ambient light so as to prevent the application of a signal voltage to the SCR gate, the system will fail safely inasmuch as, under these conditions, relay winding **16** will not be energized sufficiently to close contacts **18–20**.

In event of a power supply failure during operation of the burner, the relay winding **16** will be required to be energized through the safety switch heater **24** upon recurrence of the power supply, in order to again close contacts **18–20**, so that continued operation of the burner motor is always contingent upon successful ignition within the predetermined trial period.

The purpose of the slider contact **32** on control resistor **30** is to permit optimum calibration of the SCR gate network for light conditions of the particular installation and to compensate for variations in the resistivity of light sensitive element **26**. Moving the slider contact **32** toward the anode side of the SCR, or left side of secondary winding **42**, increases the signal voltage on the SCR gate while moving it toward the cathode side of the SCR, or right side of secondary winding **42**, decreases the signal voltage when the resistance of light sensitive element **26** is constant.

It is to be understood that the power supply voltage step-down transformer **40** may be dispensed with if a lower voltage than the available power supply is not required or desired. In such an arrangement the leads **58** and **72** are connected to the respectively adjacent leads **46**, and the branch circuit lead **86** is connected to the righthand lead **46** through a suitable impedance.

The foregoing description is intended to be illustrative and not limiting, the scope of the invention being set forth in the appended claim.

We claim:

In a burner control system, a burner, an A.C. power source, a power source transformer having a secondary winding, a normally open relay operative when closed to cause fuel to be supplied to said burner and to cause the operation of ignition means to ignite it, a relay winding, a circuit connecting said relay winding across said secondary winding which when completed effects sufficient half wave energization of said relay to close it, said circuit including in series relationship and in the order recited a space thermostat, a normally closed safety switch, said relay winding, a resistance heater which when energized for a predetermined short time effects opening of said safety switch, and a silicon-controlled rectifier having a control electrode, a flame responsive control network for said rectifier including a light sensitive element and a control resistor connected in parallel between said control electrode and the cathode side of said rectifier, and a voltage dropping resistor connected between said control electrode and the anode side of said rectifier at a point in said circuit between said safety switch and said thermostat, said light sensitive element being responsive to burner flame and having considerably higher electrical resistance in the absence of flame than when flame exists, the electrical resistance values of said resistors and of said light sensitive element in the absence of flame being such as to effect conduction of said rectifier, and the decrease in resistance of said light sensitive element in response to burner flame being such as to reduce the signal applied to said control electrode below that required to effect conduction, and a branch circuit completed upon closure of said relay connecting said space thermostat, said safety switch and said relay winding across such portion of said transformer secondary winding as will effect sufficient full wave energization thereof to hold said relay closed, but insufficient to effect its closing.

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