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BURNER CONTROL CIRCUIT PROTECTION SYSTEM

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An object of my invention is to provide a protection system of simple, and inexpensive construction for burner control circuits. A further object is to provide in connection with a burner control circuit, a protection system which gives low voltage protection, a single relay or the like being operable to cut in at as low as 80% of the full line voltage, and to cut out at a point not lower than approximately 65% of the full line voltage, whereas in the usual systems in which relays are used for burner control circuits, the relay, when properly designed to give sufficient motion for operation of the contacts, cuts out at about 35% of the full line voltage. This is particularly important because at about 60% of the full line voltage, the burner functions improperly, its efficiency is low, the air velocity and oil pressure being decreased, and the opening of the solenoid or pressure regulating valve which usually controls the oil supply is restricted. Also low voltage in the ignition transformer occurs which causes entire loss of, or at least irregular, spark. This results in the burner "popping" and sometimes in an explosion. The problem is particularly present in small localities where current consumption varies greatly, and in most all localities where sleet gathers on the transmission wires and causes a temporary drop in voltage, which may last for sometimes an hour or more. It is, therefore, obvious that cut out of the relay at or above 65% of the full line voltage is desirable.

One object of my invention is to provide a relay which can be cut in at one voltage and thereafter maintained in the cut-in position by a reduced voltage, so that it is then easier to drop out upon subsequent line voltage drop, and the dropping out of the relay will occur before an excessive drop in the full line voltage occurs whereas if the initial current supply (instead of a reduced current supply due to such reduced voltage) were maintained for keeping the relay energized, the line voltage at which the relay drops out would be excessively low.

A further object is to provide a system which is especially adapted for use in connection with an anticipating type of room thermostat, so that the current flowing through the heater of the thermostat is substantially proportional to the line voltage regardless of whether a safety switch heater used in connection with the system is either in the circuit, or out of the circuit.

With these and other objects in view my invention consists in the construction, arrangement and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawing, in which:

The figure is an electrical diagrammatical view of the system. I use the reference character M to indicate a motor or the like of a fuel burner. The burner itself is indicated generally at B. A transformer T is provided having a primary coil 10 and a secondary coil 12, provided with a tap 14 intermediate its ends. A room thermostat RT is provided, and this thermostat is illustrated as having an anticipating heater indicated at H. The purpose of the heater H is to slightly raise the temperature of the atmosphere surrounding the temperature responsive element of the room thermostat so that its high-temperature response will be to an ambient temperature relatively close to its low temperature response. This type of thermostat and its operation are fully disclosed in the Shafer Patent Number 1,563,496, of May 4, 1926. A relay coil R is included in the system and so is a combustion switch CS.

For controlling the main circuit, a safety switch SS is provided, which is normally closed. It is adapted to be opened by energization of a safety switch heater SSH for a predetermined length of time, as will hereinafter be described.

The room thermostat RT is provided with contacts 16. The relay R includes an armature 18 attracted by the coil of the relay when it is energized, and operable to close holding contacts 20 and motor control contacts 22. The combustion switch CS may include a leaf spring 24, with the end of which a notched disk 26 coacts in the manner set forth in the Williams Patent, Number 1,827,703, dated October 13, 1931.

Briefly, a bimetal coil 28 has one end anchored to a stationary bearing 30, and its other end anchored to the end of a rod 32 on which the disk 26 is mounted. The bimetal coil 28 extends into the stave of a furnace heated by the burner B, and is thus responsive to combustion. Upon combustion occurring, the coil 28 unwinds for opening the contacts 34 of the combustion switch.

The safety switch is normally closed by an arm 36 held in the position shown on the drawing by a bimetal latch 38. As the temperature of the safety switch heater rises, due to energization thereof, the bimetal latch 38 warps upwardly and finally after a predetermined period of time permits a spring 40 to move the arm 36 and separate the contacts of the safety switch SS.
Practical operation

When the room thermostat RT calls for heat, a circuit is established through the following elements on the drawing: a, H, RT, 16, b, R, c, d, SSH, e, 34, 24 and f. The current for this circuit is supplied by the entire secondary coil 12. Assuming the secondary voltage to be 25, then there are 25 volts available for causing cut-in of the heater contacts. The parts can be so designed that the relay can cut in at 80% of this value, so that the relay is thus operable at anywhere above 80% of the full line voltage supplied to the primary coil 10.

As soon as the holding contacts 20 are closed by energization of the relay, two circuits are established. The first, or relay holding circuit, includes the following elements: a, H, RT, 16, b, R, c, g, 20, h and 14. Thus the upper portion of the secondary coil 12 is then the only source for holding the relay closed. This current, obviously, is weaker than the initial current from the entire secondary coil 12, and consequently the gaps in the relay contacts can be quite wide and yet the relay will cut out upon only a substantially small drop in the normal line voltage.

The second circuit is established by closing of the holding contacts 20 through the following elements: 14, h, 20, g, d, SSH, e, 34, 24 and f. The lower portion of the secondary coil 12 is therefore the source of current for the safety switch heater with the elements g, 20, h and 14 of the relay holding circuit constituting a common return.

If combustion does not occur within the time for which the safety switch is set, the contacts 34 will remain closed and the safety switch will trip out, thus necessitating remedying the trouble and resetting the safety switch, or a recycling operation after a purging period if the system is designed for such.

If combustion does occur, the contacts 34 will be separated as soon as heat in the stack is sufficient to rotate the disk 28 counter-clockwise. Thereupon only the relay holding circuit will remain established, the safety heater circuit being broken.

With my circuit I provide a current load for the anticipating heater H of the room thermostat which is substantially always in proportion to the line voltage. As soon as the initial circuit is established, the contacts 20 close, so that the holding circuit for the relay is then effective through the heater. Thereafter, while the safety switch heater is in the circuit of the lower portion of the transformer secondary, a certain value of current in proportion to the line voltage will flow through the heater H, whereas when the heater SSH is cut out of this circuit, the current flow through the circuit for the heater H will remain substantially unchanged. To insure this, the secondary of the transformer must deliver substantially constant voltage. Therefore it is essential that the impedance of the transformer be negligible in comparison with the load impedance i.e. SSH, R and H. The impedance of SSH is considerably less than the sum of the impedances of R plus H. There is a very slight difference due to the current flowing through the safety switch heater circuit, and consequently the strength of the relay holding circuit including the heater H is increased but slightly by this difference. According to measurements I have taken, this difference is so very slight that the heater H will produce substantially the same temperature rise in a given period, whether the combustion switch contacts 34 are closed or open.

In other types of circuits, it has been impossible to obtain such a desirable result.

It is thus obvious that with a single relay and a transformer having an intermediate tap, it is possible to utilize a stronger current for initially closing the relay than is necessary for maintaining it closed, and by using a lower voltage for maintaining it closed, the relay will drop out at a higher line voltage. At the same time the circuit provides current supply for the heater H which is always substantially proportional to the line voltage, and also for the heater SSH, thus insuring proper operation within proper limits of these two heaters when they are energized.

It will be seen that my system can be used in a number of ways. Although I have shown one form in which it may be constructed, considerable change can be made in the details of construction without departing from the real spirit and purpose of my invention and it is my intention to cover by my claims, any modified forms of structure or use of mechanical equivalents, which may be reasonably included within their scope.

I claim as my invention:

1. In a protection system for burners, a transformer, a room thermostat, a relay operable upon energization to cause operation of the burner, a circuit including the secondary of said transformer and said relay and controlled by said room thermostat, said room thermostat establishing said circuit upon closure of the room thermostat, and means thereafter operable to maintain said relay energized from a portion only of said secondary.

2. In a protection system for burners, a transformer, a room thermostat, a relay operable upon energization to cause operation of the burner, a circuit including the secondary of said transformer and said relay and controlled by said room thermostat, said room thermostat establishing said circuit upon closure of the room thermostat, and means thereafter operable to maintain said relay energized from a portion only of said secondary, and a combustion switch in circuit with the remaining portion of said secondary and normally closed but opened upon the presence of combustion.

3. In a protection system for burners, a transformer, a room thermostat, a relay operable upon energization to cause operation of the burner, a circuit including the secondary of said transformer and said relay and controlled by said room thermostat, said room thermostat establishing said circuit upon closure of the room thermostat, and means thereafter operable to maintain said relay energized from a portion only of said secondary, and a combustion switch in circuit with the remaining portion of said secondary and normally closed but opened upon the presence of combustion.

4. In a protection system for burners, a transformer, an initial room thermostat circuit, including a room thermostat, means operable upon energization by the secondary of said transformer to initiate operation of the burner, a safety switch heater circuit with contacts, said combustion switch contacts being closed in the absence and open in the presence of combustion, a safety switch normally closed but opened by said safety switch heater upon energization thereof for a pre-determined period of time, a second circuit energized by a portion only
of said secondary of said transformer and including said room thermostat and said means, holding contacts for establishing said second circuit and for maintaining it when said combustion switch contacts are separated, said holding contacts being closed by energization of said means and a third circuit energized by the remaining portion of said secondary and including said holding contacts, said safety switch heater and said combustion switch contacts, said second and third circuits being established and said initial room thermostat circuit being altered as to current supplied thereto by closure of said holding contacts, said combustion switch contacts upon opening due to combustion establishment discontinuing said third circuit and upon subsequent closure due to combustion failure reestablishing said third circuit to thereby energize said safety switch heater to cause it to open said safety switch.

5. In a protection system for burners, a transformer, an initial room thermostat circuit including a room thermostat, means operable upon energization by the secondary of said transformer to initiate operation of the burner and combustion switch contacts, said combustion switch contacts being closed in the absence and open in the presence of combustion, a second circuit energized by a portion only of said secondary of said transformer and including said room thermostat and said means, holding contacts for establishing said second circuit and for maintaining it when said combustion switch contacts are separated, said holding contacts being closed by energization of said means and a third circuit energized by the remaining portion of said secondary and including said holding contacts and said combustion switch contacts, said second and third circuits being established and said initial room thermostat circuit being altered as to the current supplied thereto by closure of said holding contacts.

6. In a protection system for burners, a transformer having an intermediate tap for furnishing two sources of current supply, an initial room thermostat circuit connected across said transformer and including a room thermostat, means operable upon energization by closure of the room thermostat to initiate operation of the burner, a safety switch heater and combustion switch contacts in said initial room thermostat circuit, said combustion switch contacts being closed in the absence and open in the presence of combustion, a safety switch normally closed but opened by said safety switch heater upon predetermined energization thereof, holding contacts closed by energization of said means and connected with said initial room thermostat circuit for dividing it so that upon closure of the holding contacts a second circuit is established through said room thermostat and said means, and a third circuit is established through said safety switch heater and said combustion switch contacts, said second and third circuits being thereby established and said initial room thermostat circuit being altered as to current supplied thereto, said combustion switch contacts upon opening discontinuing said third circuit and upon subsequent closing due to combustion failure reestablishing the third circuit whereby to energize said safety switch heater to cause it to open said safety switch.

7. In a protection system for burners, a transformer having an intermediate tap for furnishing two sources of current supply, an initial room thermostat circuit connected across said transformer and including a room thermostat, means operable upon energization by closure of the room thermostat to initiate operation of the burner, a safety switch heater and combustion switch contacts in said initial room thermostat circuit, said combustion switch contacts being closed in the absence and open in the presence of combustion, a safety switch normally closed but opened by said safety switch heater upon predetermined energization thereof, holding contacts closed by energization of said means and connected with said initial room thermostat circuit for dividing it so that upon closure of the holding contacts a second circuit is established through said room thermostat and said means, and a third circuit is established through said safety switch heater and said combustion switch contacts, said second and third circuits being thereby established and said initial room thermostat circuit being altered as to current supplied thereto, said combustion switch contacts upon opening discontinuing said third circuit.

8. A burner control system comprising a burner, an operating circuit therefor including a burner switch, a source of current for said circuit, a transformer connected with said source and having a tapped secondary, a room thermostat and magnetic relay serially connected initially with the end terminals of the secondary, said relay constructed to close said burner switch when energized in response to closure of the room thermostat switch, and means operated by said relay upon energization thereof to connect a terminal of the relay with the tap of said secondary to thereby reduce the operating current of said relay and enable the same to open upon a predetermined minimum fall of line voltage.

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