Aug. 23, 1955 J. W. SMITH 2,715,939

RELAY CONTROL APPARATUS FOR BURNERS AND THE LIKE

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FIG. 1

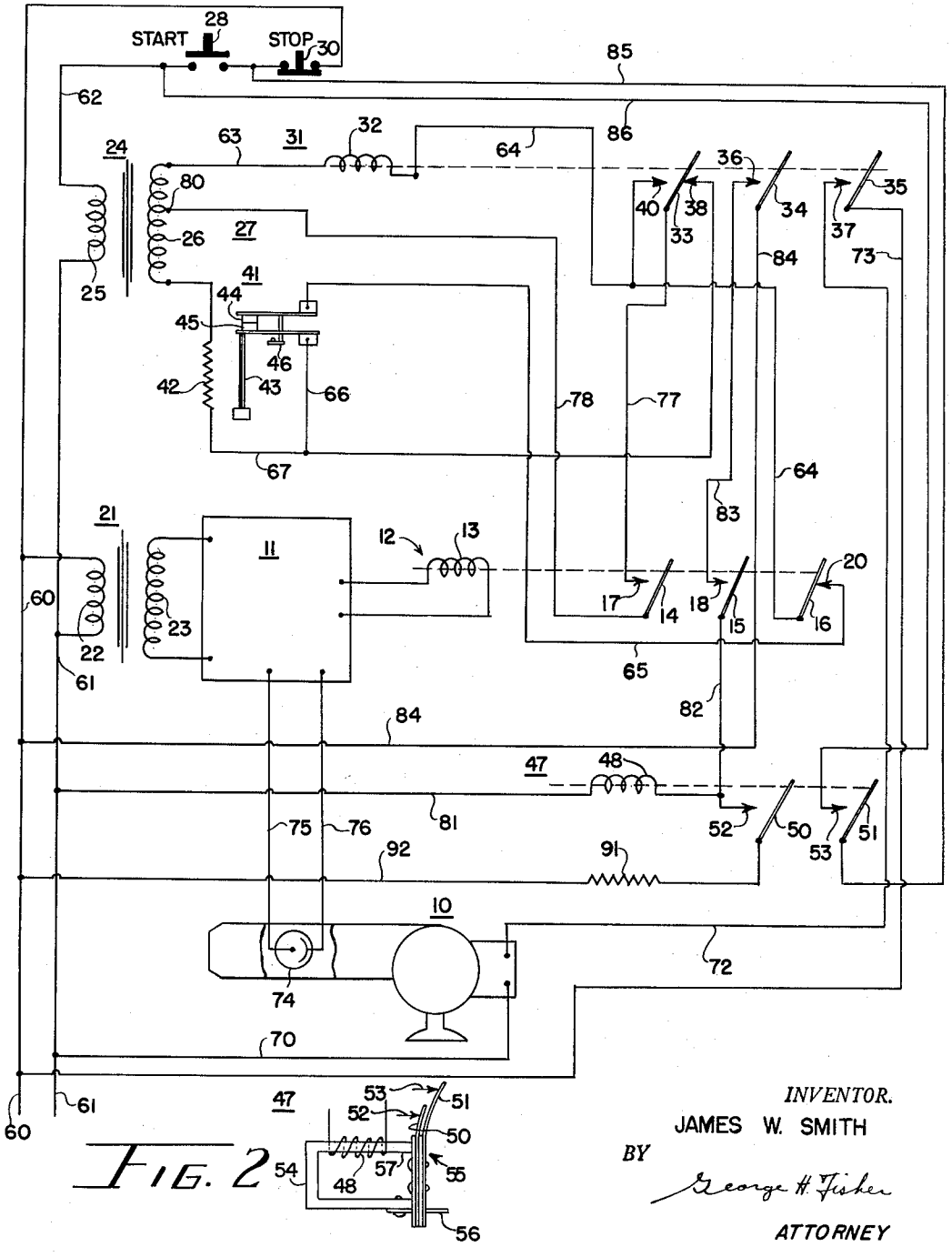


FIG. 2

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RELAY CONTROL APPARATUS FOR BURNERS AND THE LIKE

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12 Claims. (Cl. 158—28)

The present invention is concerned with the elimination of the sticking of relay armatures as caused by residual magnetism and in particular the elimination of sticking relay armatures in oil bruner control circuits.

Various means have been devised in the prior art to eliminate sticking of the relay armature to the core of a relay due to residual magnetism which exists in the core after the energizing circuit for the relay winding is opened. One of these prior art anti-stick means used in connection with an alternating current relay, is that of permanently connecting the relay coil in series with a current limiting resistor and a source of power. The energization furnished to the coil through this circuit is not of sufficient magnitude to pick up the armature or to hold it in once it is picked up. As is well known, if the core of the relay tends to remain magnetized to a degree which will hold the armature in after the coil has been deenergized by the opening of a relay energizing circuit, the reduced energization which the coil receives from the above mentioned series circuit tends to reduce this residual magnetism to a level which will allow the relay armature to drop out.

However, it has been found that permanently connecting a resistor across the relay coil can lead to a dangerous condition. The resistor connected in this manner, of necessity dissipates heat and there is a marked tendency for the resistance of this resistor to lower in value until a point is reached where the above mentioned series circuit furnishes sufficient power to the relay coil to cause the armature to be picked up or held in.

It is accordingly an object of this invention to provide a means of connecting an impedance in series with the actuating coil of a relay and the energizing power line to be effective for only a period of time after an energizing circuit for the coil has been broken and the relay armature has started to drop out.

It is a further object of this invention to provide a burner control apparatus having a relay with an anti-stick means comprising a current limiting resistor connected in a reduced energization circuit for the relay and effective for a period of time whose length is determined by the interval between when the energizing circuit for the relay is broken and the relay armature has started to drop out.

Other objects and advantages will become apparent from the following description in connection with the drawings in which:

Figure 1 is a schematic view of the improved control apparatus as applied to an oil burner control, and

Figure 2 is a schematic view of the relay showing the manner in which relay contact press back may be obtained.

With reference to Figure 1, a control apparatus is shown to control the operation of an oil burner 10 having associated ignition means, not shown, which is adapted to be energized when the oil burner 10 is energized. The control apparatus includes a flame detector 11 which is of the type shown in the Richard S. Feigal Patent

2,556,961. The flame detector 11 is adapted to control a relay 12 having an actuating winding 13 and switch blades 14, 15, and 16. The switch blades 14 and 15 are biased, by means not shown, to be normally out of engagement with stationary contacts 17 and 18, and adapted to move into engagement with these contacts upon energization of the actuating winding 13. The switch blade 16 is normally biased by a means not shown to engage a contact 20 which connection is broken when the actuating winding 13 is energized. The switch blades 14 and 16 are overlapping, that is the switch blade 14 engages the stationary contact 17 before the switch blade 16 breaks its connection to the stationary contact 20. A transformer 21 having a primary 22 and a secondary 23 is connected to furnish electrical power to the flame detector 11.

A transformer 24, having a primary 25 and a secondary 26, is connected to furnish electrical power to a control network 27. An energizing circuit for the primary 25 includes a starting actuator 28 and a stop actuator 30. The control circuit 27 includes a relay 31 having an actuating winding 32 and switch blades 33, 34, and 35. The switch blades 34 and 35 are normally biased, by means not shown, to be out of engagement with stationary contacts 36 and 37 respectively and to move into engagement with these contacts upon energization of the actuating winding 32. The switch blade 33 is biased, by means not shown, to normally engage a stationary contact 38 and upon energization of the actuating winding 32 to break the connection to the stationary contact 38 and engage a stationary contact 40. A safety switch means 41 is provided, having a heater 42, a bimetal element 43, contacts 44 and 45, and a reset actuator 46.

A relay 47 having an actuating winding 48 and switch blades 50 and 51, is provided to be effective to shunt the starting actuator 28 upon a flame being established at the burner 10. The switch blades 50 and 51 are normally biased, by means not shown, to be out of engagement with stationary contacts 52 and 53 respectively and to move into engagement with these contacts upon energization of the actuating winding 48.

Referring to Figure 2, the above mentioned relay 47 is shown schematically. A core member 54 is arranged to be energized by the magnetic flux generated by the actuating widing 48 and an armature 55 carrying the switch blades 50 and 51 is mounted on a hinge means 56 and is attracted to the core 54 to abut against an upper leg 57 of the core when the relay 47 is energized, as it is shown in Figure 2. Normally, the armature 55 pivoted on a hinge 56 does not abut against the upper leg 57 of the core 54, and the switch blades 50 and 51 do not engage the contacts 52 and 53 respectively. Upon the actuating winding 48 being energized, the armature 55 is attracted to the core 54, however, before the armature 55 abuts against the leg 57 the switch blades 50 and 51 engage the stationary contacts 52 and 53. The armature 55 then continues its movement toward the leg 57 until the armature 55 abuts against the leg 57. This movement of the armature 55 from the time that the switch blades engaged the stationary contacts until the armature abuts against the core leg 57 is known as the press back of the relay. The press back is effective to cause a wiping action between the switch blades and the stationary contacts to insure good electrical contact and the spring tension of the switch blades 50 and 51 is effective to load the relay 47, since the tension of these switch blades applies a force to the armature 55 which tends to make the armature assume a position away from the leg 57.

Operation of Figure 1

The control apparatus as shown in Figure 1 is shown in its stand-by position with the starting circuit open.

As a safety feature, the flame detector 11 remains energized at all times since the primary 22 of the transformer 21 is permanently connected across a pair of alternating current power supply lines 60 and 61. Therefore the flame detector 11 is always in a condition to detect flame. If it is now desired to produce a flame at the burner 10 it is necessary to depress the starting actuator 28 and an energizing circuit is thereby completed for the primary 25 of the transformer 28. This energizing circuit can be traced from the right hand supply line 61 through the primary 25, a conductor 62, the starting actuator 28, and the stop actuator 30 to the left hand supply line 60. Energization of the primary 25 of the transformer 24 causes the relay 31 to be energized by a circuit which may be traced from the upper terminal of the secondary 26 through a conductor 63, relay actuating winding 32, conductor 64, the switch blade 16 and the stationary contact 20 of the relay 12, conductor 65, the contacts 44 and 45 of the safety switch 41, conductor 66, conductor 67, and the heater 42 of the safety switch 41 to the lower terminal of the secondary 26. Energization of the relay 31 is effective to energize the burner 10 by means of a circuit which can be traced from the right hand supply line 61 through conductor 70, burner 10, conductor 72, stationary contact 37 and switch blade 35 of relay 31, and conductor 73 to the left hand supply line 60. Energization of this last traced circuit is effective to cause oil to be admitted to a combustion chamber, not shown, in which the burner 10 is located and is also effective to energize the before mentioned ignition means associated with the burner 10. Energization of the relay 31 is also effective to cause the switch blade 33 to disengage the stationary contact 38 and to engage the stationary contact 40, and effective to cause the switch blade 34 to engage the stationary contact 36.

A flame is now normally established at the burner 10 and will be sensed by a photoelectric device 74 connected by means of the conductors 75 and 76 to the flame detector 11, and this will cause the relay 12 to be energized.

Energization of the relay 12 causes the overlapping switch blades 14 and 16 to engage the stationary contact 17 and disengage the stationary contact 20 respectively and as before mentioned, the switch blade 14 engages the stationary contact 17 before the switch blade 16 disengages the stationary contact 20. The switch blade 16 and stationary contact 20 are in the initial energizing circuit of the relay 31 however, before this circuit is broken, the switch blade 14 and stationary contact 17 are effective to complete a holding circuit for the relay 31. This holding circuit can be traced from the upper terminal of the secondary 26 through conductor 63, relay actuating winding 32, conductor 64, stationary contact 40 and switch blade 33 of relay 31, conductor 77, stationary contact 17 and switch blade 14 of relay 12, and conductor 78 to a tap 80 of the secondary 26.

The switch blade 15 moves into engagement with the stationary contact 18 when the relay 12 is energized and a circuit is now completed to energize the relay 47. This energizing circuit can be traced from the right hand supply line 61 through conductor 81, relay actuating winding 48, conductor 82, switch blade 15 and stationary contact 18 of the relay 12, condctor 83, stationary contact 36 and switch blade 34 of the relay 31, and conductor 84 to the left hand supply line 60. Energization of the relay 47 causes the switch blade 51 to move into engagement with the stationary contact 53. This completes a circuit which shunts the starting actuator 28, which circuit can be traced from the right hand side of the starting actuator 28 through a conductor 85, switch blade 51 and stationary contact 53 of the relay 47, and conductor 86 to the left hand side of the starting actuator 28.

The control apparatus is now in its operating condition and the starting actuator 28 can now be released. If it is desired to discontinue operation of the burner 10 it is necessary to depress the stop actuator 30 which is effective to deenergize the primary 25 of the transformer 24 and thereby cause deenergization of the relay 31. The relay 31 is effective to deenergize relay 47 and the burner 10; the burner flame is thereby extinguished. When the burner flame is no longer present, the photoelectric device 74 and flame detector 11 are effective to cause the relay 12 to be deenergized.

As previously described, in order to make it possible to release the starting actuator 28 and still have a flame present at the burner 10 it was necessary for the relay 47 to be energized and the energizing circuit for this relay 47 included contacts of the flame detection relay 12 and the control relay 31. Therefore, the control apparatus assures that the flame detector 11 and the control circuit 27 are both operating properly before the starting actuator 28 is shunted by the above traced circuit.

If a flame is not initially established the flame detector 11 will not energize the relay 12 and the initial energizing circuit for the relay 31, which includes the heater 42 of the safety switch 41, remains energized. After a predetermined length of time the bimetal element 43 warps to the left and the contact 45 breaks its connection to the contact 44, to thereby break the initial energizing circuit of the relay 31. After a short time delay during which the bimetal 43 cools it is possible to depress the reset actuator 46 to again close the contacts 44 and 45 and then if the starting actuator 28 is depressed the apparatus will recycle in an attempt to again establish flame at the burner 10.

If there is a flame failure after normal operation has been established, the flame detector 11 deenergizes the relay 12 and the energized circuit for the relay 47 is broken by the switch blade 15 thereby causing the shunting circuit for the starting actuator 28 to be broken. The energizing circuit for the primary 25 of the transformer 24 is thereby broken to cause the relay 31 to be deenergized and the burner 10 to be deenergized. It is then necessary to again depress the starting actuator 28 to establish a flame at the burner 10.

Another fault which may occur is that the flame detector 11 does not deenergize the relay 12 when the stop actuator 30 is depressed and the burner 10 is deenergized. However, in this case the initial energizing circuit for the relay 31 cannot be established since the switch blade 16 does not engage the stationary contact 20, which engagement is necessary to complete the initial energizing circuit of the relay 31.

It has been found that there is a pronounced tendency for alternating current relays to stick after the energizing circuit for the relay has been broken. That is, there is a tendency for residual magnetism in the core member of the relay to retain the armature in its attracted position thereby causing the armature to remain in its operative position even though the energizing circuit of the relay is broken. In connection with the relay 47, I have shown a new and novel method of overcoming this fault.

Referring to Figure 1, and more particularly to the relay 47, energization of the actuating winding 48 as before described causes the switch blade 50 to engage the stationary contact 52. A circuit is now completed which can be traced from the right hand supply line 61 through conductor 81, relay actuating winding 48, stationary contact 52 and switch blade 50 of relay 47, anti-stick resistor 91, and conductor 92 to the left hand supply line 60. This last named circuit is an anti-stick circuit which is effective to prevent the residual magnetism of the relay 47 from holding the switch blades 50 and 51 in their operative position when the energizing circuit for the relay 47 is broken.

Assume that the energizing circuit for the relay 47 is completed and that the switch blades 50 and 51 are in engagement with the stationary contacts 52 and 53 respec-

tively. It can be seen that there is no current flow through the anti-stick resistor 91 since this resistor is shunted by a portion of the energizing circuit for the relay 47. This shunting circuit can be traced from the left hand power supply line 60 through conductor 84, switch blade 34 and stationary contact 36 of the relay 31, conductor 83, stationary contact 18 and switch blade 15 of the relay 12, conductor 82, stationary contact 52 and switch blade 50 of the relay 47 to the right hand side of the anti-stick resistor 91. It can therefore be seen that during normal operation of the burner 10 it is not necessary for the antistick resistor 91 to dissipate any heat whatsoever and therefore there is no tendency for the resistance of this resistor to change value during prolonged periods of operation.

Assume now that the stop actuator 30 has been depressed and that the relay 31 has been deenergized. The energizing circuit for the relay 47 is therefore broken when the switch blade 34 disengages the stationary contact 36 of the relay 31. The above mentioned shunting circuit for the anti-stick resistor 91 is thereby broken and a reduced energization circuit for the relay actuating winding 48 is established through the switch blade 50 and stationary contact 52 of the relay 47 and through the anti-stick resistor 91. Referring now to Figure 2, assume that the residual magnetism of the core member 54 is sufficient to cause the relay armature 55 to remain in its operative position after the energizing circuit for the relay 47 has been broken as before described. In a manner well known in the art the reduced alternating current energization furnished to the actuating winding 48 by the anti-stick circuit which includes the anti-stick resistor 91 is effective to counteract this residual magnetism and cause the armature 55 to move from its operative position to its inoperative position. This anti-stick circuit is then broken as the switch blade 50 disengages the contact 52 as the armature 55 moves from its operative to its inoperative position. A relay 47 having pressback has been shown, and for this type of relay the above mentioned reduced energization circuit is not broken until an air gap is introduced between the core leg 57 and the armature 55. While it is desirable to employ pressback in a relay, it is not necessary for the application of the invention.

It can therefore be seen that in my burner control apparatus I have provided a new and novel means of safely connecting an anti-stick resistor in a reduced energization circuit for a relay for only that short period of time necessary to insure that the relay will not stick in its operative position after the energizing circuit for the relay has been broken.

While I have shown my invention as particularly adapted to the oil burner control apparatus it will be recognized by those skilled in the art that my invention may be readily applied to a great variety of relay circuits. Having thus described the invention, I claim:

1. Control apparatus comprising, an alternating current source of power; a relay having an armature and an actuating means, said relay adapted to move said armature from an inoperative to an operative position when a first level of power is applied to said actuating means and to maintain said armature at the operative position only so long as the level of power is maintained above a second level; control circuit means adapted to connect said actuating means to said source of power to apply said first level of power to said actuating means, said control circuit means remaining completed as long as relay operation in said operative position is desired; switch means controlled by said armature to be closed when said armature is in the operative position; impedance means; and further circuit means completed by said switch means connecting said source of power, said impedance means and said actuating means in a series circuit to apply said second level of energization to said actuating means, said impedance means being shorted by said control circuit means so long as said control circuit means is completed.

2. Control apparatus comprising, an alternating current source of electrical power, an electromagnetic actuator, switch means controlled by said actuator to be closed and maintained closed only when said actuator is subjected to continuous electrical current flow greater than a first value and to be opened when the current flow reduces to a value less than a second value, control means adapted in circuit closing condition to connect said actuator to said source to subject said actuator to a current flow greater than said first value, current limiting means, and circuit means closed by said switch means connecting said current limiting means and said actuator to said source to subject said actuator to a current flow less than said second value upon opening of said control means.

3. Control apparatus comprising, a relay having an actuating winding, an alternating current source of power, control circuit means adapted when closed to connect said relay winding to said source of power to operatively energize said winding such that said relay is actuated from its inoperative to its operative position, said relay being of the type normally requiring continuous operative energization of said relay winding to maintain said relay in its operative position, a resistor, and circuit means completed by closing of switch means controlled by said relay connecting said resistor and said relay winding in a series circuit with said source of power, the resistance value of said resistor being of sufficiently high magnitude to prevent operative energization of said winding through said series circuit, said series circuit being effective to prevent sticking of said relay in its operative position after said control circuit means opens.

4. Control apparatus comprising, an alternating current source of power, a relay having an operative and an inoperative condition, said relay being of the type which when operatively energized moves from said inoperative to said operative condition and normally remains in said operative condition only so long as said relay is continuously operatively energized, first relay switch means adapted to be closed when said relay is in the operative condition, second switch means, a control circuit connecting said relay to said source of power to operatively energize said relay, said control circuit, adapted to be completed by said second switch means thereby causing said relay to assume its operative condition for as long a period as said control circuit is completed, impedance means, and means including said first switch means connecting said source of power, said relay and said impedance means in a series circuit as soon as said first switch means is closed, said series circuit being ineffective to operatively energize said relay and effective upon opening of said control circuit to connect said relay in a reduced energization circuit to prevent sticking of said relay in said operative condition due to residual magnetism.

5. Control apparatus comprising, an alternating current source of power; a relay having an armature and relay actuating means, said armature having an operative and an inoperative position, said armature being adapted to move to the operative position upon operative energization of said actuating means and to normally remain at said operative position only so long as said actuating means is continuously operatively energized; switch means controlled by said armature and adapted to be closed when said armature moves from the inoperative to the operative position; control switch means, control circuit means adapted to be completed by said control switch means to connect said relay actuating means in operative energizing relation to said source of power, impedance means, and further circuit means adapted to connect said relay actuating means, said impedance means and said source in a series circuit, the impedance value of said impedance means being of sufficiently high magnitude to prevent operative energization of said relay actuating means through said further circuit means, said further

circuit means being completed by closure of said switch means and being effective upon opening of said control switch means to immediately supply reduced energization to said actuating means to prevent abnormal operation of said relay caused by residual magnetism maintaining said armature in the operative position once said control switch means is opened.

6. Burner control apparatus for use with a fuel burner comprising, an alternating current source of power, a first relay, first switch means controlled by said first relay and adapted to energize the burner, a starting switch, first circuit means adapted to be completed by closing said starting switch to connect said first relay to said source of power; a flame detector for detecting a flame at the burner, second switch means controlled by said flame detector; a second relay, said second relay having an inoperative and an operative position and movable to said operative position upon energization of said second relay above a first level of energization, said second relay normally remaining in said operative position only so long as said relay is continuously energized above a second level of energization lower than said first level, circuit means adapted to be completed by said second switch means connecting said second relay to said source of power to supply at least said first level of energization to said second relay, third switch means controlled by said second relay and including a plurality of switch contacts, holding circuit means including a first of said plurality of switch contacts maintaining said first relay energized by said source of power independent of said starting switch, impedance means, and second circuit means completed by a second of said plurality of switch contacts of said third switch means to connect said second relay, said impedance means and said source of power in a series circuit, the impedance value of said impedance means being of sufficiently high value to render said series circuit effective upon opening of said second switch means to cause energization of said second relay below said second level to thereby prevent sticking of said second relay due to residual magnetism.

7. Control apparatus comprising, a relay of the type which normally requires continuous energization above a first level in order for said relay to be maintained actuated from a first to a second condition, an alternating current source of power, control means, a control circuit adapted to be completed by said control means to connect said relay to said source of power to energize said relay above said first level to thereby cause said relay to assume said second condition, impedance means, switch means closed by said relay in said second condition, and further circuit means completed upon closure of said switch means to connect said relay, said impedance means and said source of power in a series circuit, the impedance value of said impedance means being sufficiently high to render said further circuit means effective upon opening of said control circuit to connect said relay to said source of power in a reduced energization circuit to energize said relay below said first level to thereby prevent sticking of said relay in said second condition due to residual magnetism.

8. Control apparatus comprising, a relay having actuating means, an alternating current source of power, control means having a circuit opening and a circuit closing condition, a control circuit adapted to be completed by said control means in said circuit closing condition to connect said actuating means to said source of power to continuously operatively energize said relay so long as said control means is in said circuit closing condition, switch means controlled by said relay, a resistor, and further circuit means completed by said switch means as said relay is operatively energized connecting said actuating means, said resistor and said source of power in a series circuit, the resistance value of said resistor being sufficiently high to prevent operative energization of said relay through said further circuit means, said resistor being short circuited by said control circuit until said control circuit is opened and thereafter being effective in said series circuit to supply reduced energization to said relay to operatively deenergize said relay and to prevent sticking of said relay due to residual magnetism.

9. Control apparatus comprising, an alternating current source of power; a relay having a core member and an armature, an actuating winding for said relay, said actuating winding when operatively energized from said source of power causing said armature to move from an inoperative position away from said core member to an operative position in close proximity to said core member, said armature normally remaining in said operative position only so long as said actuating winding is continuously operatively energized from said source of power; control means having a circuit closing and circuit opening condition and adapted in said circuit closing condition to connect said actuating winding to said source of power to operatively energize said actuating winding; switch means controlled by said armature and adapted to close after said armature leaves the inoperative position and before said armature arrives at the operative position; impedance means, and circuit means completed by closure of said switch means to connect said impedance means, said actuating means and said source of power in a series circuit, the impedance value of said impedance means being of sufficiently high magnitude to prevent operative energization of said actuating winding through said circuit means, said impedance means being shorted by said control means in circuit closing condition and effective in said series circuit to supply reduced energization to said actuating winding upon said control means opening to thereby prevent sticking of said armature due to residual magnetism.

10. Control apparatus comprising, an alternating current source of power, an electromagnetic actuator having an operative and an inoperative position, switch means controlled by said actuator, control means adapted to continuously connect said actuator to said source of power to operatively energize said actuator so long as operation of said actuator in said operative position is desired, impedance means, and further circuit means connected in shunt to said control means and closed by said switch means when said actuator is in said operative position, said further circuit means connecting said impedance means in series with said actuator and connecting said series connected impedance means and actuator directly to said source of power, the impedance value of said impedance means being sufficiently high to prevent operative energization of said actuator through said further circuit means while allowing reduced energization of said acutator to overcome the effect of residual magnetism.

11. Burner control apparatus for use with a fuel burner, comprising, a momentariiy closed starting switch, an alternating current source of electrical power, control means including said starting switch adapted to connect said source of power in energizing relation to the burner, flame detecting means to detect the presence of flame at the burner, first switch means controlled by said flame detecting means, a relay of the type requiring continuous operative energization to maintain said relay in an operative condition, first circuit means adapted to be completed by said first switch means to connect said source of power in operative energizing relation to said relay, second switch means including a plurality of contact pairs controlled by said relay, holding circuit means including a first of said contact pairs adapted to shunt the starting switch and maintain the burner energized, impedance means, and second circuit means completed by a second of said contact pairs of said second switch means connecting said relay, said impedance means and said source of power in circuit, the magnitude of said imped-

ance means being sufficiently high to prevent operative energization of said relay through said second circuit means, said impedance means being shorted by said first switch means when said first circuit means is completed and said impedance means being effective upon said first circuit means opening to supply reduced energization to prevent sticking of said relay.

12. Control apparatus comprising, a source of alternating current power, a relay having an operative and an inoperative position, switch means controlled by said relay to be closed when said relay is in its operative position; control switch means adapted when in a first condition to continuously connect said relay to said source of power to operatively energize said relay and thereby cause said relay to assume its operative position so long as said control switch means remains in said first condition; impedance means; further circuit means completed by said switch means connecting said relay, said impedance means and said source of power in a series circuit whenever said relay is in its operative position,

the impedance value of said impedance means being of such a high magnitude to prevent operative energization of said relay through said further circuit means, and means including said control switch means adapted to shunt said impedance means when said control switch means is in said first condition.

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