Oct. 11, 1955 C. J. BISHOFBERGER 2,720,255

SAFETY BURNER CONTROL APPARATUS

Filed Jan. 9, 1953

FIG. 1

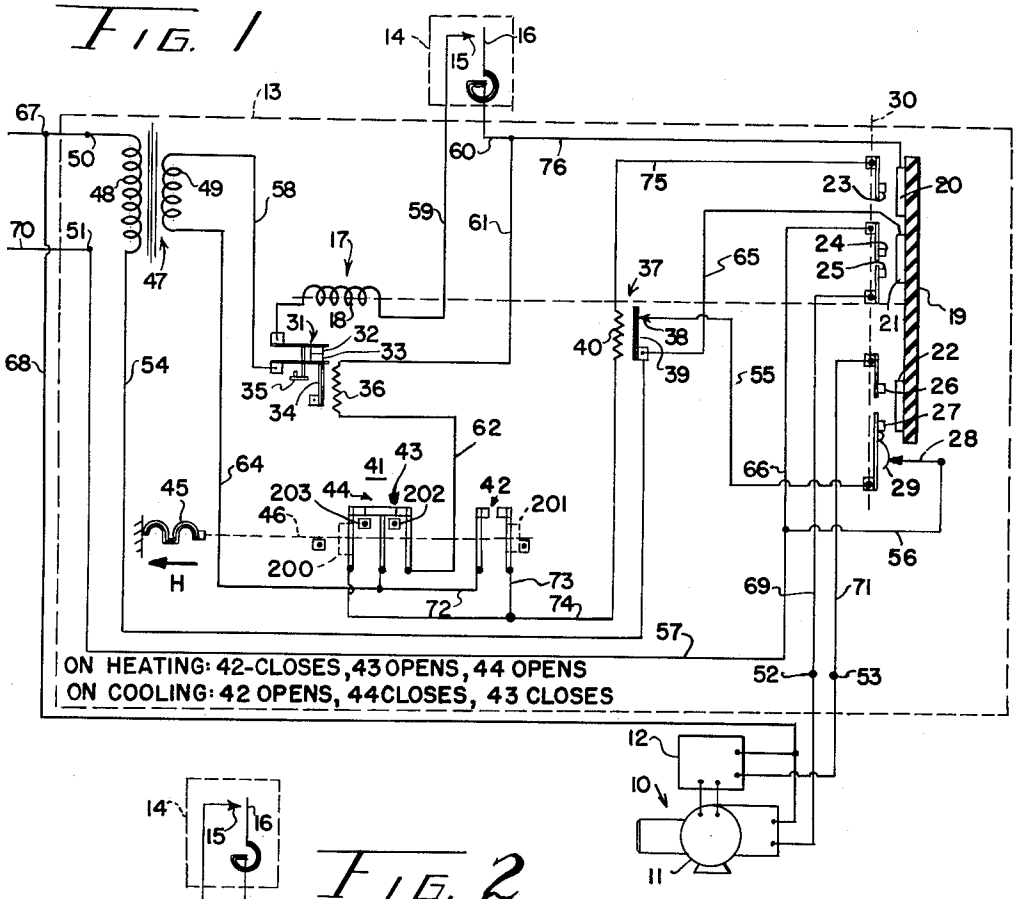
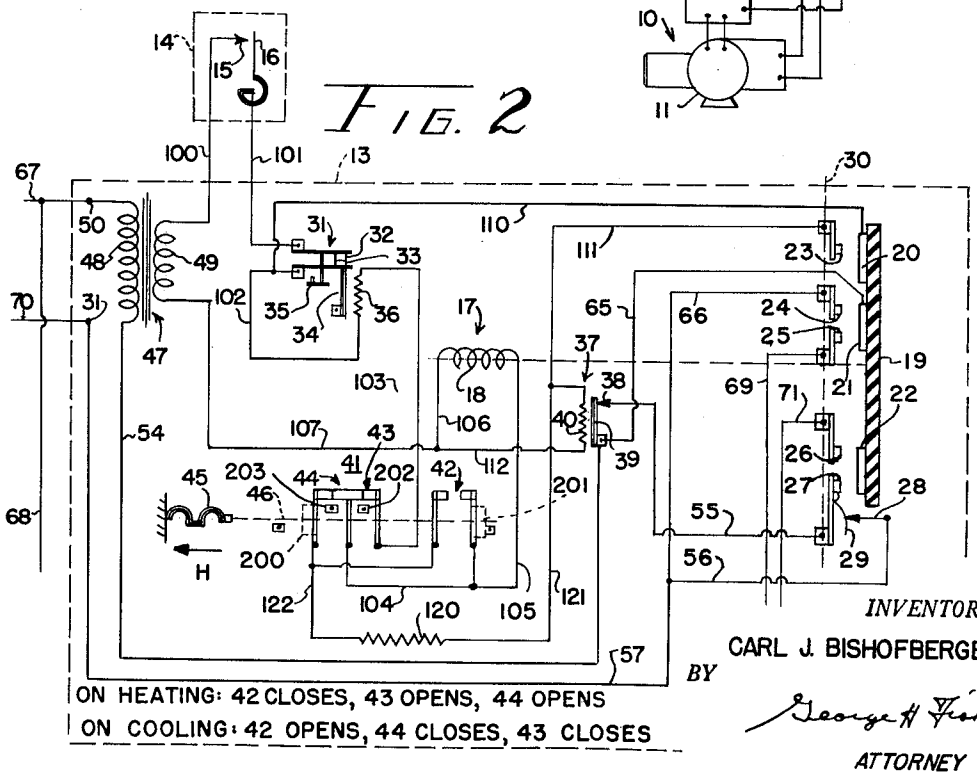


FIG. 2



INVENTOR.
CARL J. BISHOFBERGER
BY
George H. Fisher
ATTORNEY

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SAFETY BURNER CONTROL APPARATUS

Carl J. Bishofberger, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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7 Claims. (Cl. 158—28)

This invention relates to a burner control apparatus making use of a burner control relay, a safety cutout device, and a combustion responsive means, the control apparatus providing an initial energizing circuit and a non-pickup holding circuit for the relay, with the non-pickup holding circuit being controlled both by the combustion responsive means and by in contacts of the relay.

Specifically, this invention is an improvement over the burner control apparatus disclosed in the co-pending application of Carl D. Ward, Serial No. 280,103, filed April 2, 1952.

The burner control apparatus disclosed in the above mentioned co-pending application incorporates a burner control relay in a circuit including a safety cutout device, an ignition timer, and flame responsive means, with the above mentioned components connected to provide an initial energizing circuit and a holding circuit for the relay, these circuits being controlled only by the flame responsive means. In this control apparatus the momentary opening and re-closing of the room thermostat during a particular time in the operating cycle of this control deenergizes the burner, however, the relay remains partially energized through the non-pickup holding circuit which includes the actuator for the ignition timer.

It has been found that in this condition of operation, while the burner control apparatus operates in a safe manner, there is a tendency for the relay to buzz or chatter due to the energization through the non-pickup holding circuit. This noise tends to travel up the heating ducts of the furnace and creates an unpleasant sensation in the area being heated. Also, the actuator of the ignition timer is not completely deenergized and, when a bi-metal type timer is used, the recycling of the control is with a shortened ignition period.

It is therefore an object of the present invention to provide an improved burner control apparatus having ignition timing means wherein immediate recycling of the burner will not result in a shortened ignition period.

It is a further object of the present invention to provide an improved burner control apparatus having a relay with an initial energizing circuit including a safety switch actuator and having a non-pickup holding circuit including current limiting impedance means, with the non-pickup holding circuit being completed by in contacts of the relay and with flame responsive means arranged to provide for recycle on flame failure.

It is a further object of the invention to provide an improved burner control apparatus having a burner control relay with an initial energizing circuit including closed cold contacts of a flame responsive means and a safety cut-out means, and having a non pick-up holding circuit including a closed cold switch and closed hot switch of the flame responsive means, ignition timing means, and in contacts of the relay, the closed hot and closed cold switches being arranged to give recycle upon flame failure and the in contacts of the relay preventing partial energization of the ignition timer or relay during recycle.

It is a further object of the present invention to provide an improved burner control apparatus having burner control means, safety cutout means, ignition timing means, and flame responsive means with the above named means connected to allow recycle on flame failure, to prevent even limited energization of the ignition timing means or burner control means during recycle, and to provide an interlock between the energizing circuit for the apparatus and the ignition timing means.

These and other objects will readily become apparent as the following specification is read in the light of the accompanying drawing in which

Figure 1 is a showing of the improved burner control apparatus, and

Figure 2 is a showing of a modification of the improved burner control apparatus.

Referring specifically to Figure 1, a fuel burner unit **10** is shown having a fuel burner **11** and an ignition means **12**. The burner unit **10** is controlled by the improved burner control apparatus shown within broken lines **13**, and the apparatus **13** is under the control of the thermostat shown within broken lines **14**, which thermostat, upon the need for operation of the burner unit **10**, closes contacts **15** and **16**.

Referring specifically to the improved burner control apparatus **13**, a burner control relay **17** is provided having a relay winding or actuator **18** and an armature **19**. The armature **19** of relay **17** is shown in its inoperative or deenergized position and is provided with bridging bars **20**, **21**, and **22**. Upon energization of relay winding **18**, the armature moves bridging bar **20** into engagement with in contact **23**, bridging bar **21** into engagement with the in contacts **24** and **25**, and bridging bar **22** into engagement with in contacts **26** and **27**. A switch which is closed when relay **17** is deenergized is provided for the relay **17** and includes stationary contact **28** and contact blade **29** connected to and movable with the in contact **27**. Upon energization of the relay winding **18**, armature **19** moves bridging bars **20**, **21**, and **22** into engagement with the in contacts and due to the press back of the relay the in contacts **23** through **27** are moved to the left to broken line position **30**. The movement of the in contacts to this broken line position **30** moves the contact blade **29** to the left and causes the contact blade **29** to disengage the stationary out contact **28**.

Also included within the burner control apparatus **13** is a safety cutout device **31** having normally closed contacts **32** and **33**, a bi-metal member **34**, a reset ac-actuator **35**, and an electrically energizable actuating heater **36**. Upon a predetermined time period of energization of the heater **36**, the bi-metal **34** warps to the right out from under the normally closed contacts **32** and **33** to allow the contacts to disengage. Upon subsequent cooling of the bi-metal member **34**, the reset actuator **35** can be depressed to reset the contacts **32** and **33** to their normal position as shown in Figure 1.

A timer **37** is provided having a closed cold switch including contact **38**, a bi-metal member **39**, and an electrically energizable actuating heater **40**. After a predetermined time period of energization of heater **40** above a given minimum energization level, the bi-metal element **39** warps to the left to disengage the contact **38**. Upon the bi-metal element **39** cooling, the element **39** again engages contact **38** as shown in Figure 1.

A combustion responsive means **41** is shown having a closed hot switch **42**, a first closed cold switch **43**, and a second closed cold switch **44**. A bimetal actuator is shown at **45** and is normally located to be responsive to the presence or absence of combustion at the burner unit **10**. The bimetal actuator **45** is effective upon heating to move to the left as shown by the arrow in Figure 1. Movement of bimetal actuator **45** is transmitted by

means of a rod, shown by dotted line 46, and by members 200 and 201 to the switches 42, 43 and 44.

The members 200 and 201 are mounted in slip friction engagement with the rod, shown by dotted line 46, and moved with the rod until sufficient force is applied to stop such movement, at which time the members 200 and 201 will remain stationary and slide upon the rod.

The blades upon which the switches 43 and 44 are mounted are biased so that as member 200 moves to the left the switches 43 and 44 also move to the left until stops 202 and 203 are engaged to cause switches 43 and 44 respectively to open. The blade upon which right-hand member of switch 42 is mounted is biased to the right to engage member 201.

The combustion responsive means 41 is shown in the cold position in Figure 1, that is, with no flame present at the burner unit 10. Upon combustion being established at the burner unit 10, the bimetal actuator 45 begins to move to the left. This movement causes members 200 and 201 to also move to the left. When member 201 has moved a predetermined distance, closed hot switch 42 closes. Subsequently, when member 200 has moved a predetermined distance, the right-hand member of closed cold switch 43 engages stop 202 to stop this member. Further movement of member 200 causes closed cold switch 43 to open.

Again after a short time of movement, stop 203 engages the common member of closed cold switches 43 and 44 and further movement of member 200 to the left causes closed cold switch 44 to open.

When combustion ceases at the burner unit 10, the bimetal actuator 45 cools and moves to the right to the position shown in Figure 1. First initial movement to the right causes member 201 to also move to the right and open thereby closed hot switch 42. Further movement to the right causes member 200 to close closed cold switch 44. Still further movement to the right causes closed cold switch 43 to be closed.

A transformer 47 having a primary 48 and a secondary 49 is shown associated within the burner control apparatus 13 to supply power to circuits which include the burner control relay 17, the timer 37, the safety cutout device 31, and the closed hot and closed cold switches of the combustion responsive means 41. A plurality of terminals are also associated with the burner control apparatus 13. The terminals 50 and 51 are the power input terminals to the burner control apparatus 13 and are adapted to be connected to a source of electrical power, which power is supplied to the burner unit 10 under the control of the burner control apparatus 13 and the thermostat 14. The terminals 52 and 53 are adapted to be connected to the fuel burner 11 and ignition means 12 respectively to supply power to the burner unit under the control of the burner control apparatus 13.

In Figure 1 the apparatus is shown in its stand-by condition. That is, the timer 37 has its closed cold switch in closed position, the safety cutout device 31 has its contacts 32 and 33 in engaging position, the relay 17 is in its deenergized position, and the combustion responsive means 41 is in a condition indicating the absence of combustion at the burner unit 10.

Assuming that power is applied to the power input terminals 50 and 51, an initial energizing circuit can be traced for the primary 48 of the transformer 47 from the power input terminal 50 though the primary 48, conductor 54, bi-metal element 39 and closed contact 38 of timer 37, conductor 55, contact blade 29 and stationary out contact 28 of relay 17, conductor 56, and conductor 57 to the power input terminal 51. From this last traced circuit it can be seen that in the stand-by condition in order for power to be applied to the primary 48 it is necessary first for the timer 37 to be in its cold position, and second for the relay armature 19 to be in its deenergized position such that contact blade 29 engages out contact 28.

Assume now that there is a need for operation of the burner unit 10 which the thermostat 14 senses by closing contacts 15 and 16. An initial energizing circuit can now be traced for the relay 17 from the upper terminal of the secondary 49 through conductor 58, contacts 33 and 32 of safety cutout device 31, relay winding 18, conductor 59, contacts 15 and 16 of thermostat 14, conductor 60, conductor 61, actuator 36 of the safety cutout device 31, conductor 62, first closed cold switch 43 of combustion responsive means 41, and conductor 64 to the lower terminal of secondary 49.

At this time, the actuator 36 of the safety cutout device 31 is operatively energized, that is, if the combustion responsive means 41 does not operate to indicate the establishment of combustion at the burner unit 10, the safety cutout device 31 will be actuated to the position where the contacts 32 and 33 are disengaged.

Energization of relay 17 causes the relay armature 19 to move bridging bars 20, 21, and 22 into engagement with the in contacts 23 through 27. Consider at this time the instant the bridging bars 20, 21 and 22 have just engaged the in contacts 23 through 27 of the relay 17. The initial energizing circuit for the primary 48, above traced, is still completed through contact blade 29 and out contact 28, however, a holding circuit is now also established for the primary 48. This holding circuit can be traced from the power input terminal 50 through primary 48, conductor 54, conductor 65, bridging bar 21 and in contact 24 of relay 17, conductor 66, and conductor 57 to power input terminal 51. The relay armature 19 completes its movement to take up the press back of the relay and moves the in contacts 23 through 27 to the left to the position shown by the broken line 30 and therefore it causes contact blade 29 to disengage out contact 28 of the relay 17. This breaks the initial energizing circuit for the primary 48 for the transformer 47, however, the above traced holding circuit is effective to supply power to the primary 48 so long as the relay 17 remains in its energized position.

The movement of the relay armature 19 to its energized position causes power to be supplied to the burner unit 10 through terminals 52 and 53. The energizing circuit for the burner motor 11 can be traced from power line 67 through conductor 68, burner motor 11, terminal 52, conductor 69, in contact 25 bridging bar 21 and in contact 24 of relay 17, conductor 66, conductor 57, and input terminal 51 to power line conductor 70. The energizing circuit for the ignition means 12 can be traced from the power line conductor 67 through conductor 68, ignition means 12, terminal 53, conductor 71, in contact 26 bridging bar 22 and contact 27 of relay 17, conductor 55, contact 38 and bi-metal element 39 of timer 37, conductor 65, bridging bar 21 and in contact 24 of relay 17, conductor 66, conductor 57, and terminal 51 to power line conductor 70.

It will be noted that a circuit, placing actuator 40 in parallel with actuator 36, can be traced from the upper terminal of secondary 49 through conductor 58, contacts 33 and 32 of safety cutout device 31, relay 17, conductor 59, contacts 15 and 16 of thermostat 14, conductor 60, conductor 76, bridging bar 20 and in contact 23 of relay 17, conductor 75, actuator 40 of timer 37, conductor 74, second closed cold switch 44 of combustion responsive means 41, and conductor 64 to the lower terminal of secondary 49. It would appear that the actuator 40 is now operatively energized. However, the relative impedance of actuator 40 and actuator 36 is such that so long as the first closed cold switch 43 remains closed the actuator 40 is effectively shorted through actuator 36. By way of illustration, it has been found desirable to select the following impedance values for the actuators 36 and 40:

	Ohms
Actuator 36	12.6
Actuator 40	28.2

The burner control apparatus **13** is now in its starting phase wherein the burner motor **11** is energized, the ignition means **12** is energized, the timer **37** is operatively deenergized, and the safety cutout device **31** is energized.

Assume now that a flame is established at the burner unit **10**, the bi-metal actuator **45** of the combustion responsive means **41** will respond to the presence of combustion at the burner unit **10** and will actuate its associated closed hot and closed cold switches in the sequence above described. The bi-metal actuator **45** will first cause the closed hot switch **42** to close. The closing of the closed hot switch **42** has no effect at this time since closed hot switch **42** is in parallel with closed cold switch **44**, which switch is already closed.

A short time after the closing of closed hot switch **42**, the closed cold switch **43** opens. This has the effect of deenergizing the actuator **36** of the cutout device **31**, and at the same time removes the relatively low impedance shunt from the actuator **40** of the timer **37**. The actuator **40** is now operatively energized and begins to heat the bi-metal element **39**. In this condition the relay **17** is maintained energized through the closed hot switch **42** of the combustion responsive means **41**, the actuator **40** of the timer **37**, contact **23** and bridging bar **20** of relay **17**, and thermostat **14**. A short time after the opening of closed cold switch **43**, the closed cold switch **44** opens. The function of the closed cold switch **44** is to provide recycle and will be more completely explained later.

After a predetermined time period of energization of the actuator **40** of timer **37**, the contact **38** disengages bi-metal element **39**. This breaks the above traced initial energizing circuit for the primary **48** of transformer **47**, however it will be remembered that a holding energization circuit for the primary **48** has been established upon relay **17** being energized. The opening of the closed cold switch of the timer **37** also breaks the above traced energizing circuit for the ignition means **12** to thereby turn off the ignition at the burner unit **10**.

The burner control apparatus **13** is now in its runing phase with the burner motor **11** energized, the ignition means **12** deenergized, the actuator **36** to safety cutout device **31** deenergized, the bi-metal actuator **45** of the combustion responsive means **41** responding to the presence of combustion at the burner unit **10**, and the actuator **40** of the timer **37** operatively energized to maintain the timer contact **38** disengaged from bi-metal **39**.

Assume now that the thermostat **14** has been satisfied by a sufficient period of operation of burner unit **10** and has accordingly opened the contacts **15** and **16**. The energizing circuit for relay **17** is therefore broken and the relay armature **19** returns to its inoperative position such as is shown in Figure 1. This immediately deenergizes the burner unit **10** and also breaks the holding circuit for the primary **48** of transformer **47**. As shown in Figure 1, the deenergization of relay **17** causes contact blade **29** to engage out contact **28** of relay **17**.

If as soon as relay **17** is deenergized there is a second call for heat, the relay **17** cannot again be energized since the primary **48** of transformer **47** is deenergized due to contact **38** disengaging bi-metal **39** of timer **37**. After a short period of cooling, bi-metal **39** again engages contact **38**. This energizes transformer **47**. However, during the time required for the bi-metal member **39** to cool, the bi-metal actuator **45** of the combustion responsive means **41** has been cooling and first actuates the closed hot switch **42** to open position. At this time the closed cold switches **43** and **44** and the closed hot switch **42** are all open.

A short time after the opening of closed hot switch **42**, closed cold switch **44** closes. At this time the above traced non pick-up holding circuit is still open at switch blade **23** and bridging bar **20** of relay **17** and therefore relay **17** cannot be energized. If it were not for the non-pickup holding circuit being open at this time, limited energization of the relay **17** and actuator **40** of timer **37** would occur. This, as above mentioned, would cause an objectionable buzz or chatter of relay **17** and would also tend to shorten the ignition period. A short time after closing of closed cold switch **44**, the closed cold switch **43** closes. It has been found that the combustion responsive means **41** at this point in the operation of the apparatus **13** tends to produce an intermittent condition of engaging and disengaging of closed cold switch **43** for a short period of time. It will be remembered that the initial energizing circuit for the relay **17** includes the closed cold switch **43** and if it were not for the closed cold switch **44** which is closed at this point, it would be possible for the relay armature **19** to move between its operative and inoperative position a number of times before the combustion responsive means **41** positively closes closed cold switch **43**.

To explain more fully the utility of providing the closed cold switch **44**, consider that the closed cold switch **43** has been closed for a very short period of time and then opened due to the inherent characteristics of bi-metal actuator **45** of the combustion responsive means **41**. The initial closing of closed cold switch **43** completes the initial energizing circuit for relay **17** and the relay armature **19** moves to its operative position. The closed cold switch **43** now opens, however the relay is maintained energized through the non-pickup holding circuit, above traced, which includes in series with the relay winding **18**, the closed cold switch **44**, the actuator **40** of timer **37**, and in contact **23** and bridging bar **20** of relay **17**. It is immediately recognized that with relay **17** energized the burner unit **10** is energized and bi-metal actuator **45** is again subjected to the heat of combustion. In this case the closed cold switch **43**, which has been momentarily closed as pointed out above, may not re-close but bi-metal actuator **45** will be effective to close closed hot switch **42** and then open closed cold switch **44**.

However, if combustion is not again established at the burner unit **10**, the closed cold switch **43** will again close and be positively closed by bi-metal actuator **45** of combustion responsive means **41** to complete the initial energizing circuit for the relay winding **18** which includes the actuator **36** of safety cutout device **31**. Burner unit **10** then remains energized until the normally closed contacts **32** and **33** of the safety cutout device **31** are opened in response to a predetermined time period of energization of the actuator **36**. The opening of the contacts **32** and **33** deenergizes the relay **17**, thereby deenergizing the burner unit **10**. The actuator **36** of a safety cutout device **31** is now deenergized and the bi-metal member **34** subsequently cools. The depressing of the actuator **35** now resets the contacts **32** and **33** to their engaging position and if there is still a call for heat by thermostat **14** the burner control apparatus **13** begins its cycle to attempt to establish combustion at the burner unit **10**.

Species of Figure 2

Referring now specifically to Figure 2, a modification of the apparatus of Figure 1 is shown with the common elements between the two figures retaining the same reference numerals. In Figure 2 the burner unit **10** has been omitted, however, the conductors **68**, **69**, and **71** connect to the burner unit **10** in the manner shown in Figure 1.

The apparatus of Figure 2 is shown in the stand-by condition, the initial energizing circuit and holding circuit for the primary **48** of transformer **47** being identical to that of Figure 1.

Assume now that there is a call for heat by the thermostat **14**. An energizing circuit can be traced for relay **17** from the upper terminal of the secondary **49** through the conductor **100**, contacts **15** and **16** of thermostat **14**, conductor **101**, normally closed contacts **32** and **33** of safety

cutout device 31, conductor 102, actuator 36 of safety cutout device 31, conductor 103, closed cold switch 43 of combustion responsive means 41, conductor 104, conductor 105, winding 18 of relay 17, conductor 106, and conductor 107 to the lower terminal of secondary 49. Upon energization of relay 17, armature 19 moves to the energized position and in the manner above described, the holding circuit of primary 48 is established and the initial energizing circuit for the primary is broken. Also, in the manner above described, the fuel burner 11 and ignition means 12 are energized.

Upon the armature 19 moving to the energized position, the bridging bar 20 engages in contact 23 of relay 17. The engagement of 20 and 23 completes two circuits. The first of these circuits includes the actuator 40 of the timer 37 and can be traced from the upper terminal of secondary 49 through conductor 100, contacts 15 and 16 of thermostat 14, conductor 101, contacts 32 and 33 of safety cutout device 31, conductor 110, bridging bar 20 and in contact 23 of relay 17, conductor 111, actuator 40 of timer 37, conductor 112 and conductor 107 to the lower terminal secondary 49. It can be seen that the actuator 40 of the timer 37 is now operatively energized and the ignition timing period has begun. A predetermined time hereafter the contact 38 will disengage the bi-metal member 39.

The second circuit completed by engagement of bridging bar 20 within contact 23 is a circuit which includes the blocking resistor 120 and the closed cold switch 44 of combustion responsive means 41 connected in parallel with the actuator 36 of safety cutout device 31. This shunt circuit can be seen by tracing the circuit from the lower terminal of actuator 36 through a conductor 102, conductor 110, bridging bar 20 and in contact 23 of relay 17, conductor 111, conductor 121, blocking resistor 120, conductor 122, closed cold switch 44, closed cold switch 43, and conductor 103 to the upper terminal of actuator 36 of safety cutout device 31. At this time the shunt circuit including blocking resistor 120 has very litle effect due to the relative impedances of blocking resistor 120 and actuator 36. By way of illustration, it has been found desirable to select the following impedance values for the actuator 36 and the blocking resistor 120:

	Ohms
Blocking resistor 120	50.0
Actuator 36	12.6

From the above values, it can be seen that the above traced shunt circuit has a high enough impedance so that the current flow through the actuator 36 remains substantially unchanged as the armature 19 of the relay 17 moves to the energized position.

Assume that combustion is now established at the burner unit 10. The bi-metal actuator 45 of the combustion responsive means 41 will sense this combustion and actuate the closed hot and closed cold switches in the manner above described. The closed hot switch 42 is the first switch to be actuated by the combustion responsive means 41 and will be closed a short time period after the establishment of combustion at the burner unit 10. The closing of the closed hot switch 42 has no effect at this time since it is connected in parallel with the already closed cold switch 44. A short time thereafter the closed cold switch 43 opens. This has two effects. First the actuator 36 of safety cutout device 31 is deenergized, and secondly a non-pickup holding circuit is established for the relay 17. This non-pickup holding circuit can be traced from the upper terminal of the secondary 49 through the conductor 100, contacts 15 and 16 of thermostat 14, conductor 101, contacts 32 and 33 of safety cutout device 31, conductor 110, bridging bar 20 and in contact 23 of relay 17, conductor 111, conductor 121, blocking resistor 120, conductor 122, closed cold switch 44 in parallel with closed hot switch 42 to conductor 105, relay winding 18, conductor 106, and conductor 107 to the lower terminal of secondary 49. Here again it can be seen that this non-pickup holding circuit is completed only when relay 17 is energized.

A short time thereafter the ignition timer 37 is actuated due to energization of the actuator 40 and causes contact 38 to disengage bimetal 39 to deenergize the ignition means 12 in the manner above described.

The burner control apparatus 13 is now in the running condition with the burner motor 11 energized, the ignition means 12 deenergized, the actuator 40 of timer 37 energized, the actuator 36 of safety cutout device 31 deenergized, and the relay 17 energized through the non-pickup holding circuit. A short time thereafter the closed cold switch 44 opens, however, the opening of this switch at this time has no effect upon the circuit to relay 17 which remains completed through closed hot switch 42.

Upon satisfaction of the thermostat 14 the contacts 15 and 16 of the thermostat 14 open. This breaks the energizing circuit for the relay 17 and the armature 19 moves to the deenergized position to deenergize the burner 10 and to also deenergize the actuator 40 of the timer 37.

Assume now that there is an immediate call for recycle as evidenced by the contacts 15 and 16 of thermostat 14 again closing. At this time a closing of the thermostat contacts has no effect since the primary 48 of the transformer 47 is deenergized due to the contact 38 being disengaged from bi-metal member 39 of timer 37.

A short time thereafter contact 38 engages bi-metal member 39 and the primary 48 of transformer 47 is energized. During the time required for the bi-metal member 39 to cool, the bi-metal actuator 45 of the combustion responsive means 41 has been cooling and first actuates the closed hot switch 42 to open position. The closed cold switch 44 is next actuated to closed position however, this has no effect at the present time since the non-pickup holding circuit is open at the relay contact 23. The fact that the non-pickup holding circuit is open at this time prevents limited energization of the relay which would tend to cause the relay to hum or chatter.

A short time thereafter the closed cold switch 43 closes to complete the initial energizing circuit for the relay 17. As above mentioned, it is a characteristic of the bi-metal actuator 45 of combustion responsive means 41 to cause intermittent engagement of the closed cold switch 43 when they are first closed due to the actuator 45 cooling. However, once the relay armature 19 is moved to the energized position the above mentioned non-pickup holding circuit which includes the closed cold switch 44, the blocking resistor 120, and the in contact 23 and bridging bar 20 of relay 17, has been completed and the subsequent momentary opening of the closed cold switch 43 will not cause the relay 17 to be deenergized.

The energization of the relay 17 in the manner above described again causes the burner unit 10 to be cycled to establish flame at the unit. If for some reason flame is not established at the burner unit 10 the safety cutout device 31 is actuated to open the normally closed contacts 32 and 33 in the manner above described with reference to Figure 1.

From the above description of the operation of the present invention as applied to Figures 1 and 2 it can be seen that the burner control apparatus 13 provides an initial energizing circuit for the burner control relay 17 and provides a non-pickup holding circuit for the relay to maintain the relay energized after the flame responsive means 41 has responded to the presence of combustion at the burner unit 10. It can also be seen that this non-pickup holding circuit, because it is controlled by in contacts of the relay, is ineffective to supply even limited energization to the relay 17 when the relay armature 19 is in the deenergized position and thereby insures that no objectionable noise will be generated due to limited energization of the relay 17. It can also be seen that since the energizing circuit for the actuator 40 of timer 37 is completed through in contacts of the relay 17, a

possibility of a shortened ignition period due to premature energization of the actuator **40** is prevented and actuator **40** can be energized only when the burner control apparatus **13** is going through its cycle of operation in the normal manner.

While the present invention has been shown with reference to a first and second modification it is understood that the invention is limited solely by the scope in the appended claims.

I claim as my invention:

1. A burner control apparatus for use with a fuel burner and means responsive to the need for operation of the fuel burner, comprising: a safety switch having an electrically energizable actuator and a normally closed switch, said switch opening after a predetermined time period of energization of said actuator; a fuel burner control relay having a winding and switching means having at least one switch; flame responsive means having first and second switches closed in the absence of combustion and a third switch open in the absence of combustion, said third switch being connected in parallel with said second switch; a source of power; energizing circuit means for said relay including said winding, the normally closed switch and actuator of said safety switch, said first switch of said flame responsive means, and leads adapted to be connected to means responsive to the need for operation of the fuel burner; current limiting impedance means; and non-pickup holding circuit means for said relay including said winding, the switch of said safety switch, said one switch of the switching means of said relay, and said second and third switches of said flame responsive means.

2. Burner control apparatus comprising, burner control means having an electrically energizable actuator and having switching means having a first switch adapted to be connected to energize a fuel burner when said actuator is energized; a safety cutout device having an electrically energizable actuator and a normally closed switch which opens after a predetermined time period of energization of said actuator; bimetallic flame responsive means having first and second overlapping switches which are closed in the absence of combustion and having a third switch which is open in the absence of combustion, said second and third switches being connected in parallel; said flame responsive means operating upon the establishment of flame to close said third switch, then open said first switch, and then open said second switch; said flame responsive means operating upon the subsequent failure of combustion to first open said third switch, then close said second switch, and then close said first switch; energizing circuit means for said burner control means including said burner control means actuator, the normally closed switch and actuator of said safety cutout device, said first switch of said flame responsive means, and means responsive to the need for operation of the fuel burner; current limiting impedance means; and a non-pickup holding circuit for said burner control means including said burner control means actuator, the normally closed switch of said safety cutout device, said second and third switches of said flame responsive means, said current limiting impedance means, a second switch of said switching means of said burner control means which is closed when said burner control means is energized, and said means responsive to the need for operation of the fuel burner.

3. A burner control apparatus comprising: a burner control relay having a winding and switching means having a first switch adapted to be connected to energize a fuel burner when said relay is energized; a safety switch having a relatively low impedance actuator and a normally closed switch which opens after a predetermined time period of energization of said actuator; flame responsive means of the type having a bi-metal actuator responsive to the heat produced by the establishment of combustion at the fuel burner, said flame responsive means having first and second pairs of closed cold contacts and a third pair of closed hot contacts, said second and third pair of contacts being connected in parallel; said flame responsive means operating upon the establishment of flame to first close said closed hot contact pair, then open said first closed cold contact pair, and then open said second closed cold contact pair; said flame responsive means operating upon the failure of combustion to first open said closed hot contact pair, then close said second closed cold contact pair and then open said first closed cold contact pair; energizing circuit means for said relay including said relay winding, the normally closed switch and the relatively low impedance actuator of said safety switch, said first closed cold contact pair, and means responsive to the need for operation of the fuel burner; relatively high impedance current limiting means; non-pickup holding circuit means for said relay including said relay winding, the normally closed switch of said safety switch, said first and third pairs of contacts of said flame responsive means, said relatively high impedance current limiting means, and a second switch of said switching means of said relay which is closed when said relay is energized; said non-pickup holding circuit means being substantially short circuited by said energizing circuit means because of the relative impedances of said safety switch actuator and said current limiting means until said first closed cold contact pair of said flame responsive means is opened and being ineffective because of said second switch of said relay switching means to supply even reduced power to said relay winding upon recycle until said first closed cold contact pair closes as the bimetal actuator of said flame responsive means cools.

4. A burner control apparatus for use with a fuel burner having ignition means, comprising; a burner control relay having switching means having a first and a second switch; safety cutout means having a low impedance actuator and a normally closed switch; flame responsive means having first and second closed cold contact pairs and a third closed hot contact pair, said second and third contact pairs being connected in parallel; energizing circuit means for said relay including said actuator and normally closed switch of said safety cutout means, said first closed cold contact pair of said flame responsive means, and means responsive to the need for operation of the fuel burner; ignition timing means having a high impedance actuator and a normally closed switch; non-pickup holding circuit means for said relay including said normally closed switch of said safety cutout means, said second and third contact pairs of said flame responsive means, said first switch of said switching means of said relay which are closed when said relay is energized, and said actuator of said ignition timing means; said non-pickup holding circuit means being substantially shunted by said energizing circuit means so long as said first contact pair of said flame responsive means is closed, said actuator of said ignition timing means being effectively energized upon said first contact pair of said flame responsive means opening to thereby subsequently deenergize the ignition means for the fuel burner; a power energizing circuit for said apparatus including said normally closed switch of said ignition timing means, and a power holding circuit for said apparatus including said second switch of said switching means of said relay which is closed when said relay is energized.

5. A burner control apparatus for use with a fuel burner having ignition means, comprising; a burner control relay having first and second in contacts; a safety switch having an electrically energizable actuator and a normally closed switch; flame responsive means having first and second pairs of closed cold contacts and a pair of closed hot contacts, said closed hot contacts being connected in parallel with said second pair of closed cold contacts; energizing circuit means for said relay including

the actuator and normally closed switch of said safety switch, the first pair of closed cold contacts of said flame responsive means, and means responsive to the need for operation of the fuel burner; current limiting impedance means; non-pickup holding circuit means for said relay including said second closed cold contacts of said combustion responsive means, said current limiting impedance means, and said first in contacts of said relay; ignition timing means having an actuator and a normally closed switch, an energizing circuit for said ignition timing means actuator including said first in contacts of said relay, said actuator opening said normally closed switch of said ignition timing means after a predetermined time period of energization of said actuator; an initial power energizing circuit for said apparatus including said normally closed switch of said ignition timing means; and a power holding circuit for said apparatus including said second in contacts of said relay.

6. A burner control apparatus for use with a fuel burner having ignition means, comprising; a burner control relay having in contacts; a safety switch having an electrically energizable actuator and a normally closed switch; flame responsive means having first and second pairs of closed cold contacts and a pair of closed hot contacts, said closed hot contacts being connected in parallel with said second pair of closed cold contacts; energizing circuit means for said relay including the actuator and normally closed switch of said safety switch, the first pair of closed cold contacts of said flame responsive means, and means responsive to the need for operation of the fuel burner; current limiting impedance means; non-pickup holding circuit means for said relay including said second closed cold contacts of said combustion responsive means, said current limiting impedance means, and said in contacts of said relay; ignition timing means having an actuator and a normally closed switch, and an energizing circuit for said ignition timing means actuator including said in contacts of said relay, said actuator opening said normally closed switch of said ignition timing means after a predetermined time period of energization of said actuator.

7. A burner control apparatus for use with a fuel burner and means responsive to the need for operation of the fuel burner, comprising; an electromagnetic actuator, switching means controlled by said actuator and having a first switch adapted to be connected to energize a fuel burner when said electromagnetic actuator is energized, an electrically energizable safety cutout actuator and cutout switching means controlled thereby, flame responsive means having first and second switches closed in the absence of flame and a third switch open in the absence of flame, said third switch being connected in parallel with said second switch, a source of power, energizing circuit means connecting said electromagnetic actuator to said source of power including said safety cutout actuator, said cutout switching means, leads adapted to be connected to the means responsive to the need for operation of the fuel burner, and said first switch of said flame responsive means; current limiting impedance means; and a non-pickup holding circuit for said electromagnetic actuator connecting said electromagnetic actuator to said source of power including said second and third switches of said flame responsive means, said impedance means, and a second switch of the switching means of said electromagnetic actuator.

References Cited in the file of this patent

UNITED STATES PATENTS

2,075,289	Judson	Mar. 30, 1937
2,086,823	Shaw	July 13, 1937
2,370,847	Dempster	Mar. 6, 1945
2,604,148	Witherspoon	July 22, 1952