June 26, 1951 C. E. MARKHAM 2,558,658

BURNER SAFETY CONTROL

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Fig. 1.

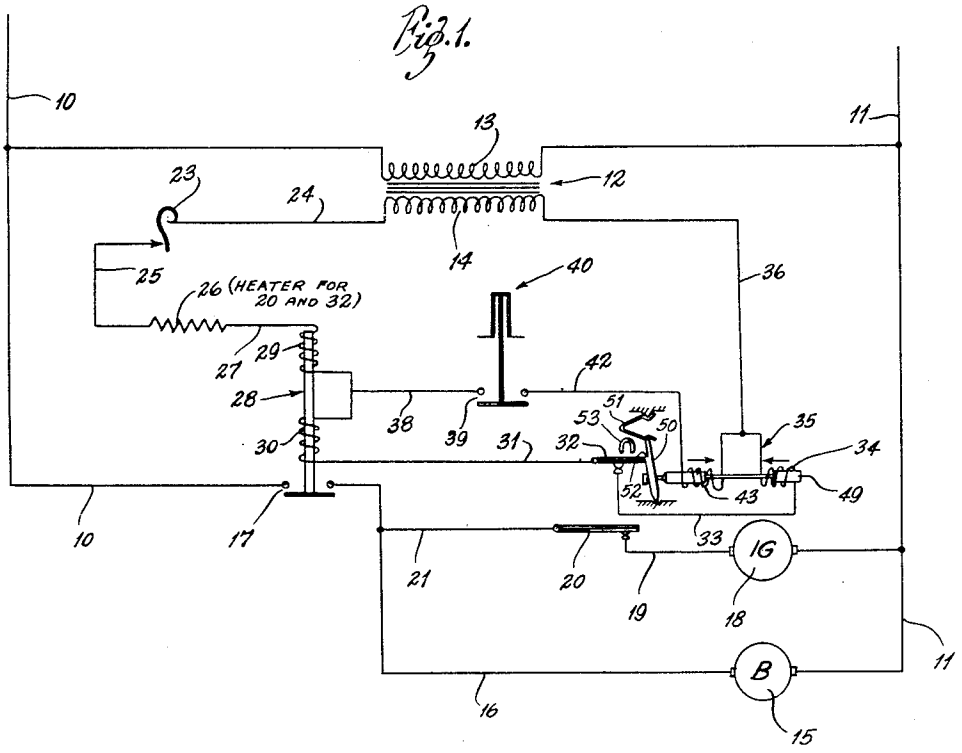
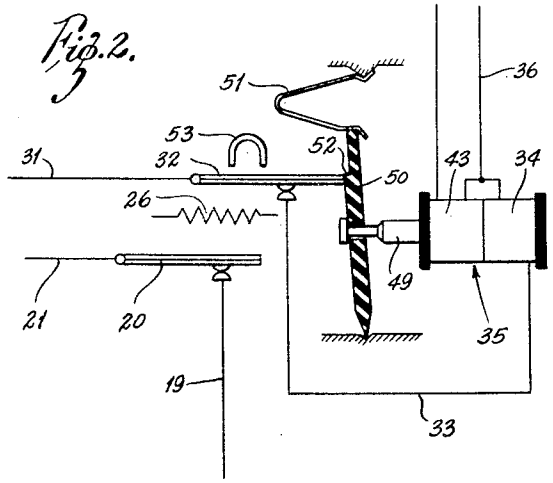


Fig. 2.



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BURNER SAFETY CONTROL

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14 Claims. (Cl. 158—28)

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The present invention relates to a burner control.

It is an object of the invention to provide a control for flame type burners, especially oil and gas burners, which provides adequate safety features to prevent explosions.

It is a particular object of the invention to provide a control having a combustion safety switch and holding means under control thereof to prevent the burner from restarting, without recycling, upon power failure occurring during an operation and upon flame failure during an operation.

It is a particular object to accomplish the foregoing without requiring a double-throw switch operated by the combustion safety mechanism.

A further object is to provide a control of this kind in which a combustion-failure, timing, safety switch is caused to operate each cycle, thus preventing the condition wherein a safety switch may corrode and stick in one position because of long disposition in that position.

Fig. 1 is a wiring diagram of the present invention; and

Fig. 2 is an enlarged view of the locking mechanism.

Referring particularly to Fig. 1, two power lines are shown at 10 and 11. A transformer 12 has a primary 13, located across the two lines 10 and 11, and a secondary 14.

A burner device 15 is connected at one side directly to the line 11 and is connected by a line 16 through a relay switch 17 to the line 10. An igniter device 18 is connected at one side to the line 11, and the other side is connected by a line 19 to a thermostatic relay in the form of a warp switch 20, which, in turn, is connected by a line 21 to the line 16.

The transformer 12 operates a low voltage secondary circuit. In it, a room thermostat 23 is connected by a line 24 to the secondary 14. The other side of the thermostat switch 23 is connected by a line 25 to a heater 26, which is adapted to operate certain bimetal warp switches, as will appear. The other side of the heater 26 is connected by a line 27 through a split relay coil 28 comprising a first coil section 29 and a second coil section 30, connected in series. The other end of the coil 30 is connected by a line 31 to a bimetal switch 32. The switch 32 is closed when cold and open when hot. It is also connected by a line 33 to a pull-in solenoid coil 34 of a latch mechanism. The latch coil, as a whole, is designated 35. The other end of the coil 34 is connected by a line 36 to the secondary 14.

The relay coil 28 is tapped by a line 38 that leads to a combustion safety switch 39 operated by a combustion safety thermostat 40, preferably of the rate-of-change type. It will be understood that the element 40 is located in a furnace in such wise as to be influenced quickly by the existence or non-existence of flame at the burner.

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The switch 39 is also connected by a line 42 into a pull-out coil 43 of the latching solenoid. The other end of the coil 43 is connected to the line 36 that leads back to the secondary 14. The two coils 34 and 43 act oppositely upon an armature 49 of the solenoid.

Referring to the drawings, it will be seen that the armature 49 is connected to a latch member 50. This latch member forms part of a spring over-center toggle mechanism. The other part is formed by a hairpin spring 51. It will be understood how this toggle mechanism operates, when pulled over center. In the position shown, the latch member 50 bears against the bimetal 32. When the bimetal rises, the toggle will automatically shift the latching shoulder 52 beneath the bimetal. The bimetal switch is preferably of the snap-acting type, illustrated diagrammatically by the magnet 53.

Fig. 2 shows also that the heater 26 is adapted to operate both the bimetal 32 and the bimetal 20. When either of the bimetals 20 or 32 heats, it warps into open position, wherein the contact is broken.

Operation

With the room conditions satisfied, the control will be in the condition shown in Fig. 1. Upon heat demand, the room thermostat 23 closes its switch, and a circuit is completed from the secondary 14 through the line 24, the thermostat 23, the line 25, the heater 26, the line 27, both parts 29 and 30 of the coil 28, the line 31, the bimetal switch 32, the line 33, the pull-in coil 34, and the line 36 back to the secondary.

The two coils 29 and 30 of the relay 28 are wound in series. When both are energized, as in the circuit just described, they will provide enough power to lift the armature and close the switch 17. Closure of this switch establishes a circuit from the line 10 through the switch 17, the line 16 to the burner motor 15, and thence to the other power line 11. As, at the start, the bimetal switch 20 is closed, being cold, a circuit is, at the same time, completed through the line 21, the switch 20, and the line 19 to the igniting device 18, which is thereby put in parallel with the burner device 15. The burner device 15 typifies a valve or motor that is energized to deliver fuel to a burner, wherein combustion may occur. In certain cases, the burner device may deliver only one fuel ingredient, and in others it may deliver all components of a combustible mixture, as is known in the art. The

igniter may be any known type. Under certain conditions, constant ignition may be used, eliminating the igniter from the control, as where a gas pilot is employed, or eliminating the bimetal switch 20 where a device such as a spark igniter is used.

In normal operation, combustion will take place in a predetermined short time after the burner device 15 is energized. The combustion safety element 40 is preferably one of the type that responds very quickly to the existence of flame, although this control will work with one of the slower acting types. As soon as the reaction of the flame upon the element 40 causes the switch 39 to be closed, an additional circuit will be established, partly shunting the circuit through the bimetal switch 32. This new circuit passes through the room thermostat, the heater 26, and the upper or holding part 29 of the relay coil 28. Thence, it passes through the line 33, the now closed combustion switch 39, the line 42, the repulsion coil 43 of the solenoid, and the line 36 back to the secondary.

As already suggested, this new circuit, being in parallel with the part 30 of the relay coil 28 and with the pull-in part 34 of the coil 35, will reduce the power of the coil 30. Hence, when both circuits are energized, the total force acting to pull the relay 17 closed is reduced to a value sufficient to hold the relay closed, but insufficient to pull it in from an open position. This requires design of the relay coils and the various impedances and resistances of the circuit in a manner known in the art of electrical design.

When both coils 34 and 43 of the solenoid 35 are energized together, there is no net pull applied to the armature 49. It will, therefore, leave the latch 50 in the position it assumed at the start, which is that shown in Fig. 1.

As the heater 26 influences the two bimetal switches 20 and 32, tending to open them, they will ultimately be sufficiently heated to move into open positions. The time provided for opening must necessarily be greater than the time required for ignition to occur.

When the heater 26 causes the switch 20 to open, the igniter will be denergized. When the heater 26 causes the bimetal 32 to move to open position, the latter will occur with a snap action owing to the presence of the magent 53.

As the switch 32 opens, it breaks the circuit to the coil 30 of the relay switch 17 and to the pull-in coil 34 of the solenoid. When the part 30 of the relay coil 28 is deenergized, the coil 29 alone remains energized. This coil has sufficient power only to hold the relay switch closed, and has inadequate power to pull it in from an open position. When the coil 34 is deenergized and combustion exists, the repulsion coil 43 of the solenoid will be energized. This will pull the latch 50 over center toward a released position. Consequently, the bimetal switch 32 will remain open only under the influence of the heater 26, and can continue open only as long as that heater remains energized.

The foregoing represents the running condition of the system. In it, the relay switch 17 is held closed, but cannot pull closed from an open position. The heater 26 is energized, holding both of the two bimetals 20 and 32 open. The combustion switch 39 is closed, the pull-in coil 34 of the solenoid 35 is deenergized, but the repulsion coil 43 is energized, so that the toggle mechanism disposes the latch member 50 away from the bimetal 32.

When the room thermostat 23 is satisfied by the amount of heat delivered by means of the burner device, it will open. This will immediately deenergize the relay 28 and the switch 17 will open. This will stop the burner device immediately. The heater 26 will also be deenergized, and the solenoid cool 43 will be deenergized, so that the solenoid will remain in its retracted position and the latch member 50 will be away from the bimetal 32. The two bimetals 20 and 32 will then cool and return to switch closing positions. The time required for the bimetal 32 to cool and return to closed position assures a scavenging period after each operation. The combustion safety 40 will promptly open the switch 39. This will restore the parts to the starting position.

If, during the starting operation, combustion fails to occur, the switch 39 will remain open. The two switches 20 and 32 will then be opened by the heater 26 after the aforementioned fixed period of time. This will immediately break all of the circuits. As a result, the burner device will immediately stop operation, as will the igniter device, by the opening of the relay switch 17, assuming that the igniter device has not previously been opened by opening of the bimetal switch 20.

Until the opening of the switch 32, the pull-in coil 34 of the solenoid 35 will alone have been energized, while the coil 43 will have been deenergized owing to the open condition of the combustion safety 39. When the switch 32 opens with a snap action, it will deenergize the coil 34. However, the toggle mechanism will urge the latch 50 toward latching position against the edge of the bimetal 32. When this bimetal moves to its open position, it will pass above the shoulder 52 and the spring of the toggle mechanism will displace the latch 50 to dispose the shoulder 52 beneath the edge of the bimetal 32. Thereafter, the bimetal 32 cannot be reclosed until the latch member 50 is moved to released position.

It will be seen that holding the switch 32 open will prevent any pull in of the main relay switch 17 from an open position. Therefore, a closure of the room thermostat 23 will be ineffective to start the burner device. To restart, it will be necessary manually to throw the latch 50 out of latching position and over center, so that the bimetal 32 can close. This, of course, will be done after determination of the failure that prevented combustion from occurring.

If the combustion safety switch 39 fails in closed position after the relay has otherwise been released, as by opening of the room thermostat 23, or by power failure, the reestablishment of the starting circuit will not pull the relay switch 17 closed. When the starting circuit is reestablished, the running circuit through the combustion safety switch 39 will also be energized, and it will shunt the relay coil 28, or more particularly the part 30 thereof, to such an extent that the relay switch 17 cannot be pulled closed from an open position. As a result, the burner motor cannot be started until the combustion safety returns to open position. Aside from failures of the combustion switch, this prevents an immediate cycle when the combustion switch has not had an opportunity to cool.

After any cycle, the starting cycle cannot be reestablished until the bimetal switch 32 has had an opportunity to cool down. This provides a scavenging period for the elimination of any

combustible gases from the furnace prior to the reestablishment of ignition.

The effect of momentary power failure, followed by restoration of power, is the same in this mechanism as if the room thermostat momentarily opened and reclosed. It is necessary following such power failure to reestablish the starting condition.

Power failure prior to the establishment of combustion will, upon restoration of power, be followed by reestablishment of the starting conditions, because the latching effect is not produced until the bimetal **32** moves to its full open position.

Flame failure during a running operation will be followed by opening of the switch **39**. This breaks the relay coil circuit, and a restart is required, using the normal starting means, to reestablish burner operation.

What is claimed is:

1. In a control mechanism, a control switch means, locking means movable between locking and release positions to hold the switch in one position, first power means to move the locking means to release position, second power means to move the locking means out of release position into position wherein it may move to locking position, and means additional to the second power means to continue movement of the locking means into locking position from said last-mentioned position, said continuing means being adapted to be rendered ineffective upon energization of said first power means.

2. In a control mechanism, a control switch means, locking means movable between locking and release positions to hold the switch in one position, first power means to move the locking means to release position, second power means to move the locking means out of release position into position wherein it may move to locking position, and means to continue movement of the locking means into locking position from said last-mentioned position, said continuing means being adapted to be rendered ineffective upon energization of said first power means, said second power means being connected in series with the control switch means.

3. In a control mechanism, a control switch means, snap-action means on said switch means, locking means movable between locking and release positions to hold the switch in one position, first power means to move the locking means to release position, second power means to move the locking means out of release position into position wherein it may move to locking position, and means to continue movement of the locking means into locking position from said last-mentioned position, said continuing means being adapted to be rendered ineffective upon energization of said first power means, said second power means being connected in series with the control switch means.

4. In a control mechanism, a switch, means to operate the switch between two positions, latch mechanism engageable with the switch to hold it against return to one position, said latch mechanism including a two-position latch member, and yieldable means urging it into either position toward which it is moved, solenoid means to actuate the latch member both ways, including connections in series with the switch means to actuate the latching member toward latching position, and including other connections for actuating the same out of latching position.

5. In a control device for use with a burner device; a combustion safety switch, a tapped relay coil and a switch adapted to be pulled in by the full coil but held in only by one section of the coil, said relay switch being adapted to control energization of the burner device, a timing switch and timing means to open the same after a predetermined interval of time, latching means to hold the timing switch open, said latching means being operable to actuating and release positions, means urging the latching means into either position toward which it is displaced, first electrical means to displace the latching means from release position toward latching position, second electrical means to displace the latching means toward release position, first connections between the timing means, the full relay coil, the timing switch, and the first electrical means, whereby the relay switch may be closed and held closed for a starting interval, second connections between the timing means, the aforesaid one section of the relay coil, the second electrical means, and the combustion safety switch.

6. In a control device for use with a burner device; a combustion safety switch, a tapped relay coil and a switch adapted to be pulled in by the full coil but held in only by one section of the coil, said relay switch being adapted to control energization of the burner device, a timing switch and timing means to open the same after a predetermined interval of time, latching means to hold the timing switch open, said latching means being operable to actuating and release positions, means urging the latching means into either position toward which it is displaced, first electrical means to displace the latching means from release position toward latching position, second electrical means to displace the latching means toward release position, first connections between the timing means, the full relay coil, the timing switch, and the first electrical means, whereby the relay switch may be closed and held closed for a starting interval, second connections between the timing means, the aforesaid section of the relay coil, the second electrical means, and the combustion safety switch, said first and second electrical means comprising solenoid coils and armature means operated thereby and connected with the latching means.

7. In a control device for use with a burner device; a combustion safety switch, a tapped relay coil and a switch adapted to be pulled in by the full coil but held in only by one section of the coil, said relay switch being adapted to control energization of the burner device, a timing switch and timing means to open the same after a predetermined interval of time, latching means to hold the timing switch open, said latching means being operable to actuating and release positions, means urging the latching means into either position toward which it is displaced, first electrical means to displace the latching means from release position toward latching position, second electrical means to displace the latching means toward release position, first connections between the timing means, the full relay coil, the timing switch, and the first electrical means, whereby the relay switch may be closed and held closed for a starting interval, and second connections between the timing means, the aforesaid section of the relay coil, the second electrical means, and the combustion safety switch, the impedances of said relay coil sections and said first and second electrical means being designed to reduce the power of the relay coil to enough to hold the relay switch closed but not

enough to pull it closed, when both connections are simultaneously energized.

8. In a control mechanism for use with a burner device; a combustion safety device, a split relay coil and a switch closable upon full energization of the coil, and held closed, but not closable, by energization of one section of the coil, said relay switch being adapted to control energization of the burner device, a timing switch having timing means to open it, first connections between the full relay coil, the timing means, and the timing switch, to effect full energization of the coil for a predetermined period, latching means to hold the timing switch open, retracting means to render the latching means inoperative, and second connections between the aforesaid portion of the coil, the retracting means, and through the combustion switch, whereby the relay switch may be held closed and the latching means rendered inoperative upon existence of combustion, the impedances of said relay coil sections and retracting means being designed to reduce the power of the relay coil to enough to hold the relay switch closed but not enough to pull it closed, when both connections are simultaneously energized.

9. In a switch mechanism, a switch arm movable to closed and open positions, a locking member engageable to prevent return of the switch arm to closed position, opposed solenoid means to move the locking member to locking and released positions, first electrical connections between the switch in closed position and the solenoid means moving the locking member to locking position, and separate electrical connections for energizing the other solenoid means independently of the switch.

10. In a control mechanism, a burner control device movable to operable and inoperable positions, means to move the same, a combustion-responsive switch, a control switch operable between open and closed positions, timing means to open the control switch after a predetermined interval, means to hold the control switch open, electrical means to operate the holding means; starting circuit branch means including the means to move the burner control device, the control switch, the timing means, and the means to operate the holding means; means to render the holding means inoperative, and another circuit branch including the combustion-responsive switch and the means to render the holding means inoperative, the said other circuit branch being closed only when the combustion-responsive switch is in its position responsive to existence of combustion.

11. The combination of claim 10 together with electrical means to render the operating means for the holding means inoperative, connected in said other circuit branch to be energized therewith.

12. The combination of claim 11 wherein the means to render the holding means inoperative comprises a solenoid and in which the holding means includes a latching device operable as an armature to the solenoid.

13. In a control mechanism, a burner control device movable to operable and inoperable positions, means to move the same, a combustion-responsive switch, a control switch operable between open and closed positions, timing means to open the control switch after a predetermined interval, means to hold the control switch open, electrical means to operate the holding means; starting circuit branch means including the means to move the burner control device, the control switch, the timing means, and the means to operate the holding means; means to render the holding means inoperative, and another circuit branch including the combustion-responsive switch and the means to render the holding means inoperative, the said other circuit branch being closed only when the combustion-responsive switch is in its position responsive to existence of combustion, together with electrical means to render the operating means for the holding means inoperative, connected in said other circuit branch to be energized therewith, the burner control device and its movable means comprising a solenoid switch and a split coil therefor, the entire coil having power to operate the switch, and the split portion having only enough power to hold the switch operated, all of the coil being in the starting circuit means and the split portion being in the second circuit means.

14. In a control mechanism, a burner control device movable to operable and inoperable positions, means to move the same, a combustion-responsive switch, a control switch operable between open and closed positions, timing means to open the control switch after a predetermined interval, means to hold the control switch open, electrical means to operate the holding means; starting circuit branch means including the means to move the burner control device, the control switch, the timing means, and the means to operate the holding means; means to render the holding means inoperative, and another circuit branch including the combustion-responsive switch and the means to render the holding means inoperative, the said other circuit branch being closed only when the combustion-responsive switch is in its position responsive to existence of combustion, together with electrical means to render the operating means for the holding means inoperative, connected in said other circuit branch to be energized therewith, the burner control device and its movable means comprising a solenoid switch and a split coil therefor, the entire coil having power to operate the switch, and the split portion having only enough power to hold the switch operated, all of the coil being in the starting circuit means and the split portion being in the second circuit means, and said timing means comprising a heater and the control switch including a heat-responsive device, the switch being reclosable only after an interval following deenergization of the heater.

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