Nov. 19, 1929. G. D. SUNDSTRAND 1,736,141

SAFETY CONTROL DEVICE

Filed March 18, 1926

Fig. 1.

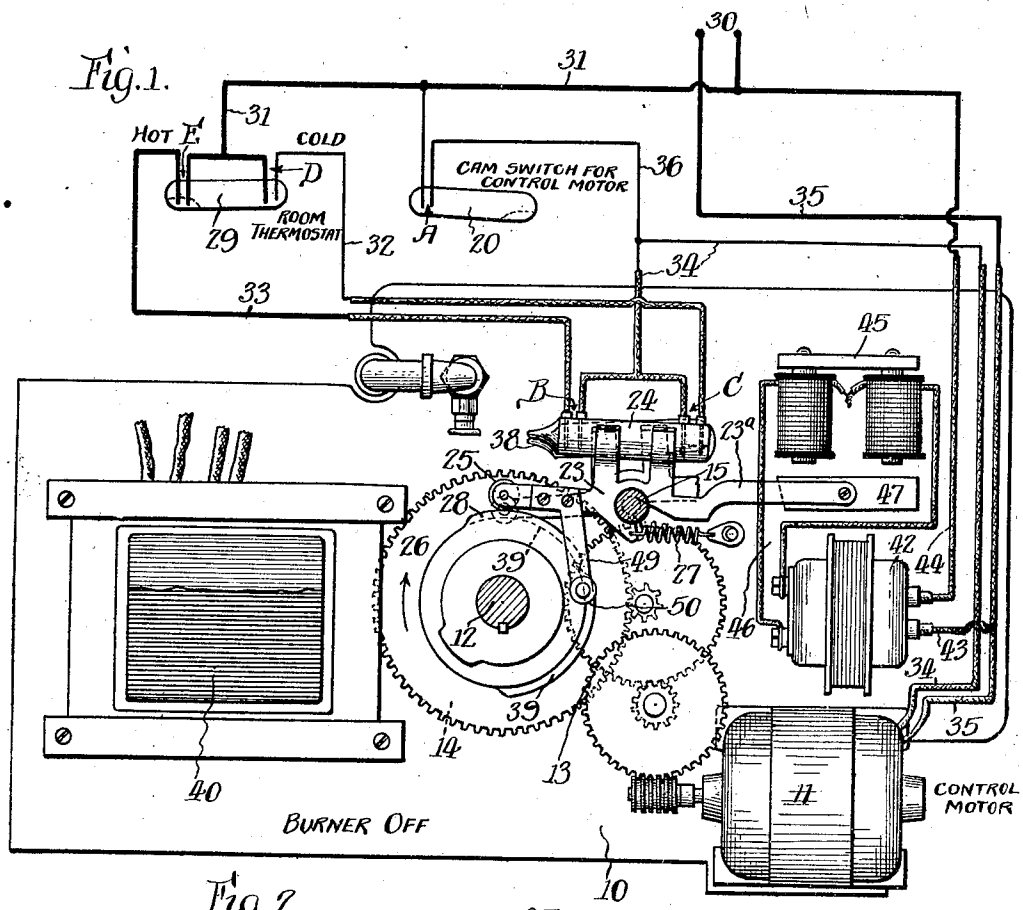


Fig. 2.

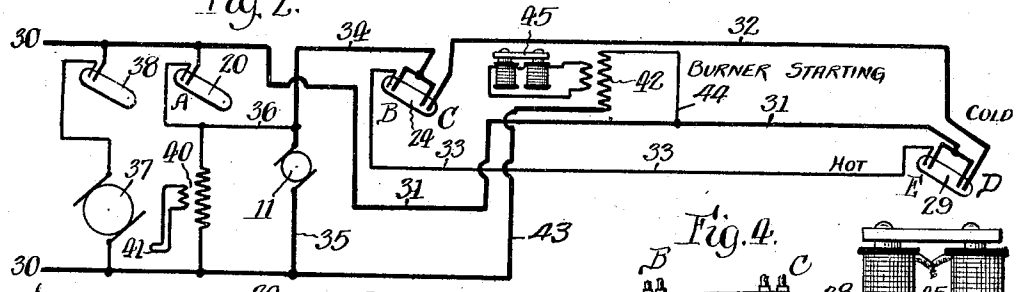


Fig. 3.

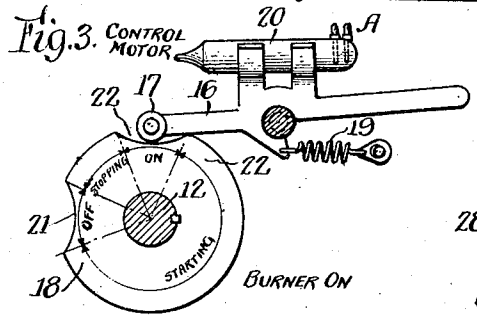
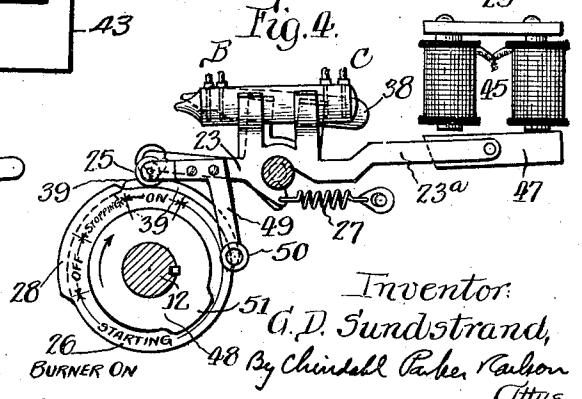


Fig. 4.



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UNITED STATES PATENT OFFICE

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SAFETY CONTROL DEVICE

Application filed March 18, 1926. Serial No. 95,541.

This invention relates to a protective control device for oil burners and the like. It has become customary to provide oil burners with automatic controls whereby they are started and stopped by means such as a thermostat to maintain a temperature at the thermostat between predetermined limits. These devices may be designed to effect fuel control, ignition and the like for the proper operation of a particular burner. In some of these devices when the power line becomes dead the operation is distributed and thereupon the device requires the services of an attendant to re-establish operation. In other cases when the power returns to the line the burner may be rendered operative only in part and therefore may supply fuel without ignition or otherwise function improperly.

The present invention is adapted for use in those types of controls which may be said to operate in a cycle of say two periods, one for starting the burner normally, and one for stopping the burner normally. When used with such a device, if the power line becomes dead in the operating condition of the burner, the present invention provides means which will on return of power to the line move the device to its normal stopped position and again through its normal starting action, thus recycling the burner.

An important object of the invention is to provide means operative in the device to shift its mechanism after the power line has become dead and to do so independently of the power so that on return of power the burner is stopped and then restarted through its normal starting operation.

A particular object is the provision of an electromagnetically held member releasable upon power failure to shift the mechanism of the control for stopping the burner on return of power.

Another object is to provide a releasable member so arranged that upon release it is not returned to its electromagnetically held position without mechanical intervention.

In the accompanying drawings there is shown a control device equipped with an exemplary embodiment of the invention particularly adapted for this type of control. It is, of course, to be understood that various other embodiments of the invention are contemplated which could be associated with this particular control or with any other control wherein such a protective device would be advantageous. Such other embodiments and arrangements of the parts which embody the invention are herein contemplated as will appear from the scope and character of the appended claims.

In the drawings, Figure 1 is a front elevation of a portion of a control mechanism embodying the present invention, the electrical connections to the device being shown more or less diagrammatically.

Fig. 2 is a diagrammatic representation of the complete electrical control system as used for a particular oil burner.

Fig. 3 indicates a portion of the mechanism used in association with the control motor thereof, this view showing a cam placed forward of the cams as viewed in Fig 4.

Fig. 4 indicates a portion of the control mechanism shown in Fig. 1 illustrating a different position of the cam-operated and electromagnetically-held switch.

The specific control device shown in the drawings is more fully described in a copending application Serial No. 706,240, filed April 14, 1924. A full description is not necessary for a complete understanding of the present invention.

Generally the control device comprises a motor driven cam shaft which in one rotation or cycle starts the burner and stops the burner, the cam shaft being stopped at a burner-operating or "on" position and being elsewhere stopped at a burner-idle or "off" position. A plurality of cams on the cam shaft is arranged to operate suitable mechanisms such as valves or switches for control of fuel, gas, ignition, motor or whatever other features are characteristic of the particular burner, the cams being arranged for a program of starting and stopping operations.

The control mechanism shown in the drawings is mounted on a vertical base 10 upon which there is a small control motor 11. A cam shaft 12 is connected to the motor for

slow rotation by the motor through a chain of reducing gearing generally indicated at 13, the gear 14 of which is rigid with the cam shaft near the base. A plurality of cams is carried by the shaft 12 for instituting a program of actions in starting and stopping the burner. Some of these cams will be particularly described hereinafter. A number of the cams of the complete device have been omitted in the drawings since they perform no function in this invention. Adjacent and parallel to the shaft 12 is a fixed pivot post 15 providing a bearing for arms or levers actuated by the various cams. Certain of the levers carry switches operative as elements of the present invention.

Among the levers actuated by the cams is one designated 16 (Fig. 3) having a cam roller 17 riding on a cam 18 carried by said shaft 12. A spring 19 tends to draw the roller into contact with the cam. A single point mercury switch tube 20, having a switch designated A, is carried on the arm 16 and controls the power to the motor 11. The cam has two recesses therein indicated at 21 and 22, which receive the roller 17 to permit opening the switch and stopping the control motor. The recess 21 corresponds to the "off" condition of the burner and the recess 22 corresponds to the operating or "on" condition of the burner.

There is a second lever 23 (Figs. 1 and 4) mounted on the pivot post 15, this lever carrying a two point shifting switch tube 24 of which the switches are designated B and C. The lever 23 has a cam roller 25 for a cam 26 on the shaft 12. A spring 27 acting on lever 23 tends to press the roller onto the cam. Cam 26 has a swell 28 which normally serves to tilt the mercury switch tube against the action of the spring thereby to open the switch B and to close switch C. In Figs. 3 and 4 the cam shaft 12 is shown in identical positions in the cycle of rotation. The cam swell 28 is designed to raise the roller 25 at the same time that the recess 21 receives the roller 17 in the "off" position, and also during the period that the roller 17 passes from the recess 22 to the recess 21, or in other words between the "on" and the "off" positions of the burner. In Figs. 3 and 4 there are indicated the various burner positions and periods of cam action, namely, "on", "stopping," "off" and "starting", the positions "on" and "off" being, of course, the resting positions of the cams.

A controlling room thermostat having a mercury switch tube 29 (Figs. 1 and 2) is provided in connection with the control device. The thermostat is of the two circuit type having switch D closed by a cold condition and a switch E closed by a hot condition of the room. The thermostat for the purpose of the present invention is preferably of the prolonged contact type in which the switch D or E after being closed remains closed until the temperature condition causes the other switch to close. This type of thermostat is well known and requires no specific disclosure.

A source of power is designated at 30 which has one terminal connected by wire 31 to a common terminal of the switches E and D in the thermostat. Wire 32 connects the second terminal of switch D to one terminal of switch C and wire 33 connects the second terminal of switch E to one terminal of switch B. The switches B and C have their other terminals jointly connected to a wire 34 leading to the control motor 11. The other terminal of the motor is connected by a wire 35 to the source 30. Switch A is interposed between wires 31 and 34, wire 36 connecting with wire 34, whereby switch A directly controls the motor 11.

In Fig. 2, 37 represents a main motor used for the oil burner and 38 a control switch for the motor 37 which switch is operated by a cam 39 on shaft 12 (Figs. 1 and 4). Connected in parallel with the control motor 11 there is an ignition device comprising a transformer 40 and an ignition element 41.

The controlling mechanism and thermostat above described constitute a type of control in which the present invention may be embodied. In order better to explain the nature of the invention, the normal operation of the controlling mechanism will now be described. This is desirable because the normal operation of the device described is independent of the invention, the purpose of which is to provide means to function under abnormal conditions, such as power failure.

In Figure 1, the control device is shown in the burner "off" position. The room is assumed to be sufficiently heated, switch E being closed in the thermostat. The cam swell 28 holds the switch C closed so that upon the room becoming cold switch D in the thermostat closes and E opens. This completes the following circuit: 30, 31, D, 32, C, 34, 11, 35, 30, thus causing the control motor to turn the cam shaft clockwise. Soon after starting, the cam swell 28 passes away from under the roller 25 leaving the lever 23 free to drop under the influence of spring 27, thereby to tilt the switch tube 24 and close contact B. Positive means later to be described compel a tilting of the switch prior to the stopping of the cams. At the beginning of the cam movement the cam 18 (Fig. 3) closes switch A and this permits the motor to run independently of the current passing through the thermostat circuit which opens upon the above mentioned tilting of the switch tube 24. When the roller reaches the recess 22 the current through the motor 11 will be cut off and the cams will stop. During this period the main motor 37 will have been started by its cam 39, the oil will have been turned on

by some suitable mechanism, which may likewise be a cam and lever, and ignition will have been established. Cams 18 and 26 will be in the resting positions shown in Figs. 3 and 4 corresponding to the "on" condition of the burner.

Under the conditions above stated, the burner remains in operation, the thermostat cold side switch D is closed, and the shifting switch tube 24 is positioned with switch B closed. When the room is heated to the predetermined maximum temperature switch D opens and switch E closes, thereby establishing a circuit as follows: 30, 31, E, 33, B, 34, 11, 35, 30. The motor then turns the cam shaft, and switch A is closed by the roller 17 passing from recess 22 toward recess 21. Shifting switch tube 24 is tilted by cam swell 28 to close switch C and open switch B. Cam 39 shuts off the main motor 37 and when roller 17 drops in recess 21 the parts come to rest in the position shown in Fig. 1.

From the foregoing it is apparent that with apparatus such as above described a failure of power in the line will stop the burner. On return of power the main motor 37 will resume its operation, idly and without ignition. It is desirable, therefore, that on return of power the burner be carried through its normal starting operation involving the igniting step to again set it into normal operation. For this purpose there is provided a power-held means to be released upon power failure during the burner operation whereby to bring the burner to its stopped or "off" position. From this "off" position it is normally restarted and thus set for continued normal control. In the present mechanism such means serves on return of power to acuate the control motor to carry the mechanism through the stopping period from the "on" to the "off" positions. Since the room thermostat under operating conditions will be demanding heat, it will normally restart the burner from "off" position by moving the mechanism through the starting period to the "on" position and therefore the means embodying the invention will have recycled the oil burner. The recycling means may be effective in various manners, but I prefer to operate upon the shifting switch 24 in order to close the control motor circuit by shifting it upon failure of the power. Normally in the "on" position the shifting switch 24 is set for carrying current when the heat side switch E of the thermostat is closed. The cool side switch D of the thermostat, being already closed when the burner is in operation, will, on shifting the switch tube 24, complete a circuit through the control motor so that upon return of power the motor will rotate the cams.

For releasably holding the recycling means there is provided an electromagnetic holding device connected into a line which is alive during the operating period of the burner. In the present instance the holding device comprises a transformer 42 connected by wires 43 and 44 to the source 30 and an electromagnet 45 connected by wires 46 to the secondary of the transformer. The source 30 is chosen as a power line for the holding device since the power consumption of the transformer is small and may be inconsiderable during the intermittent idle periods of thermostatically controlled burner operation.

In order to shift switch 24 on failure of power, the lever arm 23 is extended as at 23^a and is provided at its rear end with a magnetic armature 47 to be held by the electromagnet. The armature is arranged upon the cessation of current in the magnet to move away from the magnet and to be held away therefrom until mechanical intervention permits its return. This effect is accomplished by provding a weighted armature 47 sufficient to overcome the force of spring 27 on the arm 23. On power failure, gravity acting on the weighted armature tilts the switch tube 24. The armature and lever are so arranged that the armature drops out of the picking-up range of the electromagnet and the armature and lever are further arranged for raising the lever mechanically by the cam device.

For so raising the lever arm 23^a a special cam 48 is provided on shaft 12 which operates upon a projecting finger 49 on arm 23. This finger has a cam roller 50 riding the cam 48. The cams 26 and 48 thus operate separately to move the lever 23 positively in opposite directions. The cams, however, are so arranged that the lever arm 23^a is free to drop away from the magnets while the burner is operating normally.

It has been pointed out that the switch C is closed at the stopping and the "off" positions of the cam 26 and that the opposite switch B must be closed during normal operation of the burner, or the "on" position of cam 26. Therefore, a raised portion 51 of cam 48 is provided and so placed that it causes the armature to be raised to the magnet at some point during the starting period of cam action. This is necessary because the weighted armature 47 overcomes spring 27.

When the burner is operating, if power fails, the main motor stops, and the switch tube 24 is automatically tilted by gravity. The thermostat being closed at its cold side switch D, and the switch C having been closed by the release of arm 23^a, there is thus formed a closed circuit through the control motor as follows: 30, 31, D, 32, C, 34, 11, 35, 30. On return of power the main motor will again start operation and the control motor will rotate the cams. The rotation of the cams will move the parts in position to stop the whole device in a normal manner corre-

sponding to the burner "off" position; but the room still being cold, the thermostat is set for initiating operation of the burner. As a consequence the control mechanism will set the burner into operation under normal circumstances instituting the proper program of operations to supply and ignite the fuel. Just as the burner is restarted, the raised portion 28 of the cam 26 passes from under the roller 25, but the arm does not tilt under the influence of its spring 27 because it is overcome by the weighted armature 47. However, before the control device ceases its starting action the swell 51 on cam 48 will have moved the finger 49 to raise the armature to the magnet and switch B will be closed. The switch tube 24 is thus again set for a normal closure of the room thermostat switch E to effect a normal continuance of burner control.

It is thus clear that the improvements herein described for such controlling mechanisms provide a desirable safety device which is not limited in application to the particular type of control herein described, but which has a more general application to other devices of a similar nature.

I claim as my invention:—

1. In an oil burner control device for automatically starting and stopping an electrically operated oil burner, in combination, an electromagnet adapted to be energized during the period of burner operation, an armature releasably held by said electromagnet, a switch arranged to be closed upon release of said armature by a failure of energizing power, said switch being adapted on return of power to cause the control device to stop the burner whereby the automatic control device may in its normal manner restart the burner, and a cam associated with said device to move the armature into the pick-up range of said magnet on re-starting the burner.

2. In an oil burner control device for automatically starting and stopping an electrically operated oil burner, in combination, an electromagnet adapted to be energized during the period of burner operation, an armature releasably held by said electromagnet, a switch arranged to be closed upon release of said armature by a failure of energizing power, said switch being adapted on return of power to cause the automatic control device to stop the burner, whereby the automatic control device may re-start the burner in the normal manner, and means to move said armature into its held position on re-starting the burner.

3. In combination with a motor-operated control device adapted normally and automatically to start and stop an electrically operated oil burner, a releasable member arranged on release to close a circuit to the motor, power controlled holding means arranged to hold said member and to release the same on failure of electric power for operation of the oil burner, and means associated with the control device to restore the released member to its releasable position after starting of the motor on return of power.

4. In an oil burner control device, in combination, an electromagnet energized by line power, an armature held by said electromagnet, an arm carrying said armature arranged to move when the power supply fails, said movement being such as to carry the armature out of picking-up range of the magnet, a motor, means to set the motor in operation after motion of said arm and on return of power, other means to continue operation of said motor, a burner-controlling member movable in cycles by said motor, means associated with said member to stop the motor on completion of one cycle from the return of power, and means to raise the armature to the magnet prior to the completion of the cycle.

5. In a control device, in combination, an electric switch, a pivotally movable member adapted to operate said switch, cam means controlled by said switch to move said member positively in both directions of its motion, said cam means permitting freedom of motion in one position of the parts, and power operated means to hold said member in a releasable position, said means being adapted to release said member for such motion on failure of power, whereby the switch is operated prior to the return of power.

6. In combination, a two circuit thermostat having two switches, one of which is closed until the other closes, an electrically operated element, a shifting switch to complete a circuit through the thermostat to the electrically operated element at each instance of thermostat switch closure, means under the control of said element to shift said shifting switch, and a power-held device releasable on failure of power, said means on release being adapted to shift said switch independently of said element, whereby to close a circuit to said element for actuation of said element on return of power, and means to return the power held device to its held position.

7. In a device of the class described, a weighted lever, a two point switch actuated between two positions on shifting said lever, an armature on said lever, cam means to move said lever positively in both directions, said means permitting freedom of motion in one position of the cam means, and an electromagnet operative on the armature to hold it releasably for said motion whereby a failure of power in the electromagnet releases the lever to shift the switch.

8. A protective device for use in conjunction with an oil burner having associated therewith means and mechanism to start and

stop the burner automatically comprising, in combination, an electromagnet adapted to be energized during operation of the burner, means releasably held by said electromagnet and associated with the control device, said means being adapted after release and on return of power to bring said mechanism into a condition to effect stopping of said oil burner, whereby the controlling means and mechanism may in the normal manner automatically re-start the burner, and other means associated with said controlling mechanism to return positively the released means to its electromagnetically held position.

9. A recycling means for an oil burner control mechanism which operates through a cycle, which automatically starts and stops an electrically operated oil burner in response to a controlling means and which has an "on" and an "off" position comprising, in combination, a member arranged to be released automatically upon failure of power when the mechanism is in the "on" position, said member upon release being further arranged to act upon said mechanism so that on return of power the mechanism moves to its "off" position, said controlling means being thereupon effective to move the mechanism again to its "on" position, and means associated with the mechanism to return said member to its held position preparatory to another release in the "on" position.

10. In combination with an oil burner control mechanism which operates through a cycle, which automatically starts and stops an electrically operated oil burner in response to a controlling means and which has an "on" and an "off" position, a releasable member arranged to be released automatically upon failure of power in the "on" position of the mechanism, said member on release being further arranged to act upon said mechanism so that on return of power the mechanism goes through a complete cycle from its "on" position through its "off" position back to its "on" position, and means associated with the mechanism and said member to replace said released member into its held position preparatory to another release in the "on" position.

11. In combination, an automatic control device arranged to start and stop an electrically operated oil burner in normal operation, a power-held member associated with said device automatically releasable upon a failure of power, said member upon release being arranged to move said control device into an operative condition to stop the burner upon a return of power whereby to permit a normal re-starting of the burner by said device, and means associated with said device to return said releasable member into its power-held releasable position.

12. In combination, a control means and mechanism arranged automatically to start and stop an electrically operated oil burner, and independent means operable on failure of power for said burner to position the control mechanism to stop the burner whereby said control mechanism on return of power operates to stop the burner, and means associated with said means and mechanism and operable thereby during the stopping of said burner to position said means and mechanism for automatically restarting said burner.

13. In combination, a control apparatus arranged automatically to start and stop an electrically operated oil burner, and means associated with said apparatus operable upon a failure of power to position the control apparatus for stopping the burner on return of the electric line power, and means operable during said stopping to position said control apparatus for automatically restarting said burner.

14. In an electrically operated burner controlling apparatus, the combination of a burner motor, a control motor therefor, an automatically operable control to start the control motor, an instrumentality operable by the control motor and comprising a plurality of contacts adapted to be electrically connected to the automatic control to render said control inoperative after starting of the control motor, and a recycling mechanism also electrically connected with said automatic control and said instrumentality and operable after temporary power failure during normal running operation of the apparatus, to cause said control motor to complete its cycle of operation to start the burner motor.

15. An electrically operated controlling apparatus having a cycle during which said apparatus is arranged, first to start and then to stop a power operated oil burner, means in said apparatus arranged normally to stop said apparatus after it has completed the starting or stopping portion of its cycle, a two switch thermostat, a burner starting circuit including one switch of said thermostat arranged when its switch is closed while the burner is stopped to cause said apparatus to operate through the starting portion of its cycle, a burner stopping circuit including the other switch of said thermostat arranged when its switch is closed during operation of the burner to cause said apparatus to operate through the stopping portion of its cycle, a third switch in said starting circuit, and means operable to open said third switch during the starting of the burner by said apparatus, to maintain said third switch open during operation of the burner, and to close said switch immediately upon failure of the burner operating power to complete a circuit to the thermostatic switch in said burner starting circuit whereby the return of power and the closing of the thermostatic switch in said starting circuit will cause said apparatus to operate through the burner stopping portion of its cycle.

16. In a motor operated control apparatus for a power operated oil burner, said apparatus having a cycle of operation comprising a series of operations to start the burner and a series of operations to stop the burner, a thermostat device for automatically causing said apparatus to perform said starting operations and said stopping operations, and a switch arranged to cooperate with said thermostatic device when said device is in a given position to cause said apparatus to perform said starting operations, said switch also being arranged to cooperate with said device in said given position after a failure of power to cause said apparatus to perform its stopping operations.

17. In combination, an electrically operated burner, a control device for starting and stopping said burner, said device being arranged to initiate combustion in the starting operation, one stopping and one starting operation constituting a cycle for said control device, means actuating said control device whereby to stop and start the burner, a switch normally ineffective upon said control device during operation of the burner, said switch being operable by a failure of the power operating said burner in such a manner that a return of power causes said switch to actuate the control device to stop the burner preparatory to restarting through the ignition stage by said actuating means, whereby the action of said switch on failure of power causes the control device to operate through a complete cycle.

18. The combination with an electrically operated oil burner controlling apparatus for starting and stopping an oil burner, one stopping and one starting operation constituting a cycle for said controlling apparatus, of means actuating said controlling apparatus whereby automatically to stop and start said burner, and a switch normally ineffective upon said controlling apparatus during operation of the burner, siad switch being operable by failure of power operating said burner in such a manner that a return of power causes said controlling apparatus to complete its cycle to stop the burner preparatory to restarting by said actuating means.

In testimony whereof, I have hereunto affixed my signature.

GUSTAF DAVID SUNDSTRAND.