A. C. PARKER

1,877,037

BURNER APPARATUS CONTROL MECHANISM

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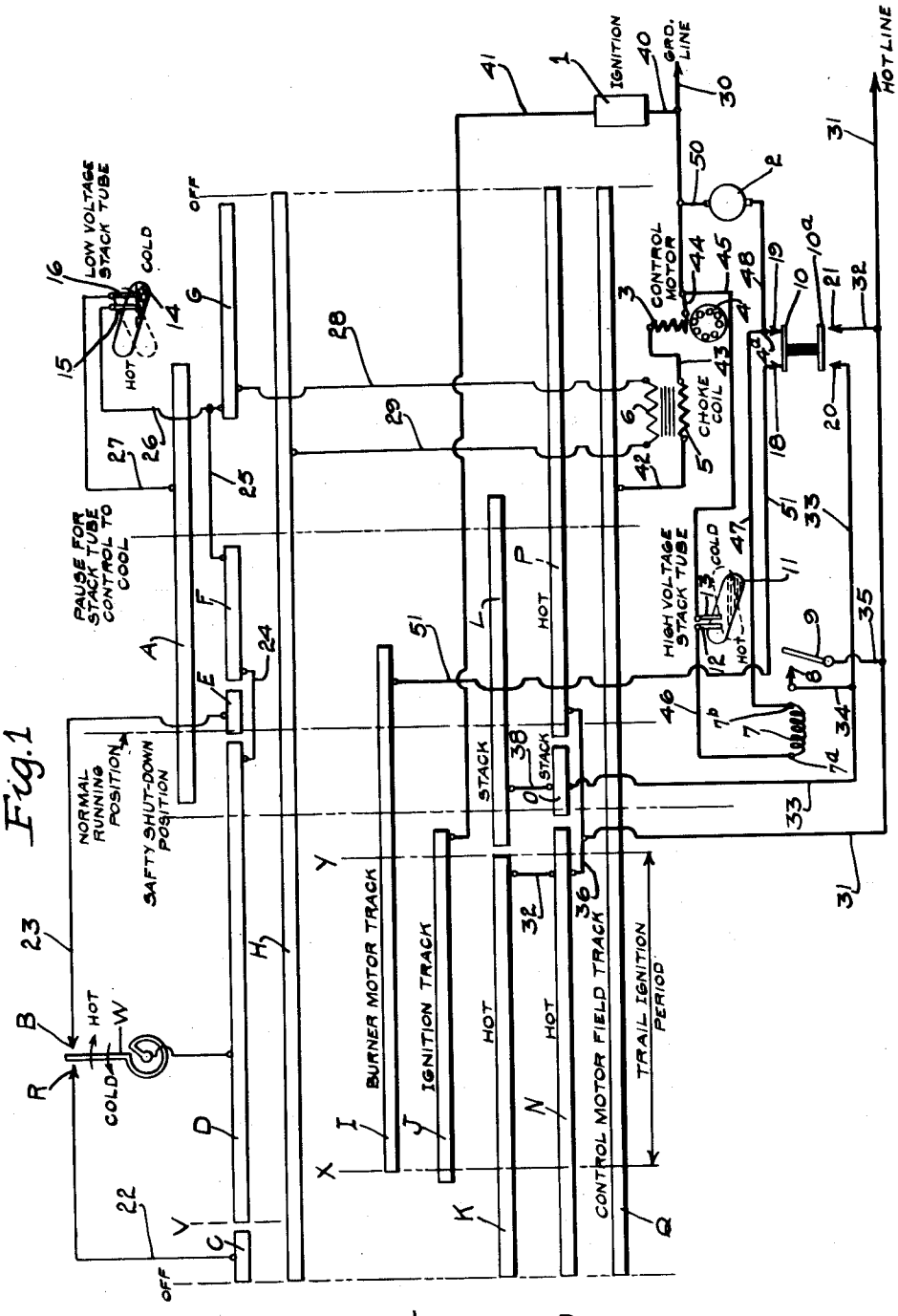


Fig. 1

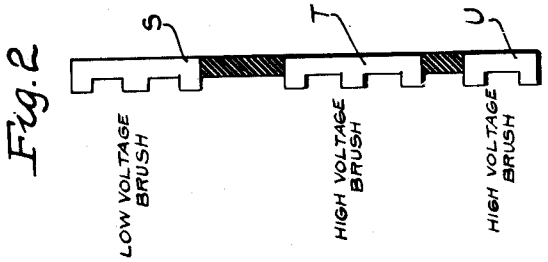


Fig. 2

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UNITED STATES PATENT OFFICE

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BURNER APPARATUS CONTROL MECHANISM

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This invention relates to improvements in controlling mechanism for heating plants, and has, among its objects, to provide a method and construction for controlling them to prevent explosions in the fire pot; to obtain trial ignition periods at the end of which if flame is not produced further operation of the apparatus is prevented; to test certain contacts and to stop operation of the apparatus if the contacts are not in proper working condition; and to provide various useful combinations and sub-combinations of the parts illustrated, which can be used with various apparatuses and in various environments relating to this art.

In certain types of electrically controlled oil burning apparatus if there is a momentary power failure, oil is thrown into a hot combustion chamber, and accumulating therein, frequently causes explosion. This condition arises particularly on momentary power failure which causes flame extinguishment. On resumption of power, during the period when the ignition means is inactive, and oil is being discharged into the combustion chamber, ignition will frequently take place as the result of deposit of oil on the hot refractory lining of the chamber, or from some incandescent deposit of carbon, the result being puff or explosion. These explosions often violently open the doors, sometimes breaking them from their hinges. Frequently the stack piping is blown off. It is therefore one of the objects of this invention to prevent these explosions after momentary power failure.

The present device is well adapted to prevent explosions after momentary power failure, and the invention also includes combinations and sub-combinations of elements useful for other purposes.

In devices which include an ignition apparatus there is ordinarily a period of about fifteen or twenty seconds after a momentary power failure, when there is no electrical spark to cause ignition. It is during this period that the fire pot becomes filled with vaporized oil which is caused to ignite by the heat of the pot, or by means other than the regularly operable ignition means.

A feature of the invention relates to the method of controlling current through the switch control motor by the use of a choke coil or equivalent device the circuit of which is in turn controlled by a room thermostat. Another feature relates to the allowance of a small time interval between the shutting down of the burner motor and the shutting down of the control motor. Another feature relates to testing of the contacts.

Other objects, advantages and features will be set forth in the description of the drawing forming a part of this application, and in said drawings

Figure 1 is a diagrammatic view of the system; and

Figure 2 is a diagrammatic view of the brushes.

The operation of the device herein described, is controlled by means of a switch. In this instance, the switch is of the circular type, providing a plurality of properly insulated tracks as conducting elements and further providing brushes which engage the tracks to control the circuits therethrough, and in the present embodiment these brushes move in unison. There is no intention to be limited to this particular type of switch, although it appears as an element of the specific form in some of the claims because it is a structure well adapted to the use herein. The brush is moved by a control motor and the brush or brushes in turn control the circuit to the control motor, as well as to a burner motor, and certain heat responsive control devices. The brushes and tracks also control the ignition and/or fuel control circuits, as well as the circuit to one element of a choke coil as a means operable by induction for controlling energization of the control motor. In this instance the hot and cold contacts of a room thermostat control the choke, and the control is regulated by the first mentioned switch.

For convenience, the brush and track elements and parts of the room thermostat are referred to by capital letters, and the other portions of the apparatus by numerals.

In this embodiment of the invention certain of the tracks control the high voltage

side of the apparatus, and certain other tracks the low voltage side. The low voltage tracks are respectively indicated A, C, D, E, F, G and H, and the brush for these tracks is indicated at S. Tracks C, D, E, F and G are aligned in direction of brush movement.

The high voltage tracks are respectively as follows: I the burner motor track; J the ignition track; K is a track connected with the hot side of the line, and brush T connects tracks K, J and I, under the proper conditions. A "stack" track is indicated at L, and M connects with the hot side of the line. Tracks K, L, M are aligned also in direction of brush movement. The brush element T cooperates with the last mentioned series of tracks.

Track N, stack track O, track P, and control motor field track Q are engageable by brush U. Tracks N, O, P are aligned. It will be understood that the brushes S, T, U move in unison, in this instance. These brushes are diagrammatically shown in Figure 2.

The control motor 4, at present used, is of the squirrel-cage single-phase type. The winding is indicated at 3. In series with the winding 3 is one element 5 of the choke coil, the other element of which is indicated at 6. In this case, element 5 is the primary, element 6 the secondary. The choke is controlled by means of room thermostat, in this instance of the type having the thermostatic element W alternately engageable with contact R—B, under the proper conditions to short-circuit the coil 6 and obtain sufficient current flow through 5 to operate the control motor 4.

One element 5 of the choke coil is in series with the field 3. The choke coil provides a simple means for obtaining low voltage control of a high voltage motor without the use of a relay. In this instance the choke coil is a standard transformer with a low voltage secondary, and when this secondary is short-circuited, it has the same effect as the short-circuiting of the primary of the choke and obtains current flow through the motor.

The function of the room thermostat is to short-circuit one element of the choke or more specifically to control the secondary of the choke whenever the temperature reaches a predetermined level at the thermostat. Short-circuiting of the secondary takes place when there is a call for heat, by closure at W—R.

Connected in parallel with the burner motor leads, is a circuit including a high voltage stack tube 11 as a switch, including contacts 12, 13, a relay, the coil of which is indicated at 7, and a switch operated by the relay herein indicated as having the contact 8 and the armature 9 which latter element acts as a current carrier. The function of the circuit including the elements just mentioned is to maintain circuit through the burner motor if flame is successful, and after the control motor has been de-energized as a result of production of flame, to cause the brush to remain in the normal running position, and maintain electrical connection for the burner apparatus until sufficient heat has been supplied to cause W of the room thermostat to make at B.

The ignition means is indicated at 1 and is electrically connected in the high voltage section of the control motor switch. There are also employed two switches of the mercury type, which are arranged to be affected by heat supplied at the burner. The numeral 2 diagrammatically indicates the burner motor and/or burner apparatus. One of these switches 11 is a high voltage switch and when cold is open. The other is a low voltage switch 14 which is closed when cold. The switches are tipped in a well known manner by means of a thermostatic element (not shown) when the temperature in the stack (in which the devices are generally placed) reaches the proper level. On production of flame at the burner the tubes assume the dotted line positions. In the case of the tube 11 having contacts 12 and 13, when the dotted line position is reached the coil 7 is energized and the switch 9 closed, as will more fully appear in the description of the operation. The function of this switch 11, therefore, is to control the closing of the switch 9 and to only cause it to close when flame is produced at the burner, so that under these conditions the motor 2 will continue to operate. The function of the tube 14 as a switch is that of a safety device which only permits the control motor 4 to move the brushes S, T, U, to their off position after the element 14 assumes the cold position at which time, if either of the contacts 15 and 16 have been injured when the device was in hot position (or if the switch 14 fails to act for any reason) no further operation of the motor 4 can occur because under these conditions the coil 6 of the choke cannot be short-circuited.

The wiring connections between tracks and the various devices previously described are referred to only in the description of the operation, to avoid repetition.

It will be understood that any magnetically operable device equivalent to the relay 7 will be used and it is to be also understood that any other thermostatically operable elements or equivalents may take the place of the high and low voltage mercury tubes. It is also conceivable that other types of room thermostat may be used. There is therefore no intention to be limited to the exact construction of any of the elements as long as elements which are their functional equivalents are used.

The coil 7 of the relay is connected in parallel with the burner motor leads, so that whenever the burner motor line is energized the coil 7 is energized. Coil 7 can, however, only be energized when the high voltage stack tube 11 has assumed the dotted line position so that the mercury establishes circuit connection between contacts 12—13. Of course, it is understood that other forms of thermally or automatically controlled switches can be used.

Operation

Assuming a starting the operation of the apparatus: the brushes S, T, U, occupy a position at the left side of the figure, indicated "off", and in conducting engagement with respective tracks. When the element W of the room thermostat has cooled sufficiently contact will be made at R. This results in short-circuiting of the secondary coil 6 of the choke to start the control motor 4. The circuit is as follows: 6, 29, H, S, C, 22, R, W, D, 24, F, 25, G, 28 to 6.

The circuit for motor 4 which controls brush movement is as follows: 30, 44, 3, 43, 5, 42, Q, U, N, 36 to 31. On continued operation of motor 4 and movement of the brushes from left to right, the switch S leaves the track C, and passes to track D, as the result of which the circuit connection through contact R of the room thermostat is broken, but the short-circuit through the secondary 6 is maintained through the following elements 6, 29, H, S, D, 24, F, 25, G, 28 to 6. The brushes now continue their travel in the same direction and the brushes eventually arrive at the position X. Just before this position is reached, the ignition means has been energized through the following circuit: 30, 40, 1, 41, J, T, K, 32, N, 36 to 31. When the brushes arrive at the position X, the burner motor is energized through the following circuit: 30, 50, 2, 48, 19, 10, 18, 51, I, T, K, 32, N, 36 to 31.

The point X represents the beginning of the trial ignition period, which ends at the point Y, the circuit being broken by the passage of the brush T off of the track K. It will be seen that the ignition track extends slightly beyond the right hand end of the track K. During the period represented between the lines X—Y, fuel and ignition are being supplied and the burner motor is energized. The fuel supply means is not shown, but it will be understood that it is present and that it may be controlled in any suitable manner. Therefore during this period represented by the interval between X and Y both control and burner motors are operating and ignition and fuel is being supplied. If at the end of this predetermined time, ignition is successful, or in other words if flame is produced, the high voltage stack tube 11 will move from the position shown in full lines in the figure to that shown in dotted lines. This movement will close the circuit between contacts 12 and 13, coil 7 will be energized and switch 9 closed against contact 8. This closure is for the purpose of maintaining burner motor operation through an independent circuit, so that the burner apparatus will operate until sufficient heat has been supplied to the room. The control motor 4, however, continues to operate and the brushes therefore continue their movement in the same direction passing to that line designated "normal running position", at which point the control motor circuit is or has been broken, and the switches remain stationary until on a call for less heat, W makes at B. In passing to that line marked "normal running position", the shunt circuit to the secondary 6 of the choke coil is broken, and the control motor 4 and brushes stop. That the short circuit has been interrupted will be seen by attempting to trace the circuit as follows: 6, 29, H, S, E, 23 to B where the circuit cannot pass because the element W has not made contact with B, which it will only do when sufficiently hot. However, the motor is conditioned for operation through the following circuit: 30, 44, 3, 43, 5, 42, Q, U, P, 36 to 31, when contact is made at B—W to short-circuit coil 6 of the choke, in the following manner: 6, 29, H, S, E, 23, B, W, D, 24, F, 25, G, 28 to 6. With this energization the control motor is energized through the circuit previously traced and the brushes again move towards the right. When the brushes have arrived at the line marked "Pause for stack tube control to cool", the short-circuit to the secondary coil 6 is again broken and the control motor stops. That this is true is found by attempting to trace the circuit as follows: 6, 29, H to S, but since S is not engaged with F the tracing of the circuit cannot be completed. Nor is there a circuit through A, 27, 16, 15, 26, G, 28 to 6, because the low voltage stack tube is hot (see dotted line position) and circuit through 16, 15 is broken. The brushes remain at the position just mentioned until the stack tube cools or, in other words, until 14 assumes the position shown in full lines in the drawing. As the low voltage stack tube assumes the cold position shown in full lines, coil 6 is again short-circuited in the following manner: 6, 29, H, S, A, 27, 16, 15, 26, G, 28 to 6, and the control motor is again started, and the brushes move without interruption to the "off" position. This off position is represented both at the right and left hand ends of the diagram. The whole apparatus is now conditioned for a restart when W again makes at R, due to sufficient cooling of element W, or, in other words, due to a need for heat in the room or enclosure. The above description applies to the normal operation, in which ignition is successful, and until sufficient heat has been supplied.

Let us suppose that ignition is not success-

ful, by the time the brushes have arrived at the position Y. In that instance, the ignition apparatus, and motor 2 are rendered inoperative. It is the function of this device, if ignition is unsuccessful, to stop operation of the entire apparatus, or in other words to obtain a "safety shut-down". The maintenance of burner motor operation after arrival of brushes at point Y is dependent on the closure of contacts 12, 13 of the high voltage stack tube, as the result of production of flame, since this closure obtains energization of coil 7, to close switch 9 so that this motor circuit can be maintained while the brushes travel from the point Y to the normal running position. It is between these points that the burner motor will be de-energized if ignition is not successful. That the burner motor circuit is interrupted when the brushes move beyond the point Y in direction to the right is shown by attempting to trace the circuit through the burner motor as follows: 30, 50, 2, 48, 19, 10, 18, 51 to I. The circuit cannot be traced through T to K, 32, 36 to 31 because the brush T is now connecting tracks I and L, and the current cannot pass to 31, by way of 33, 34, 8, 9, 35 because control device 11 has not moved to close 12, 13 as a result of production of heat at the burner. The motor 4 continues to operate until the safety shut down position is reached, at which position the high voltage circuit for the motor 4, namely: 30, 44, 3, 43, 5, 42, Q, U, O, 33, 34, 8, 9, 35, to 31, is broken at 8—9 because the stack switch 11 has failed to close due to failure of ignition.

The apparatus cannot now again be operated until the push button switch or equivalent device 10 is operated to break circuit at 18—19 and close the circuit at 20—21 through switch 10^a to establish a circuit for the control motor 4 as follows: 30, 44, 3, 43, 5, 42, Q, U, O, 33, 20, 10^a, 21, 32 to 31. With the establishment of this circuit the control motor 2 operates to move the brushes to the position where the brush U bridges Q—P to close the circuit 30, 44, 3, 43, 5, 42, Q, U, P, 36 to 31 and motor 4 operates; continuously to the line marked "off", independently of the push button 10 which may then be released, the short-circuit for the coil 6 being maintained through the circuit 6, 29, H, F, A, 27, 16, 14, 15, 26, G, 28 to 6 because the tipping control means for tube 14 has not been affected to move the tube from the full line position shown.

That the burner motor circuit is opened by the breaking of circuit at 18—19 is shown by attempting to trace the circuit as follows: 30, 50, 2, 48 to 19 and after the above noted release of push button switch 10, the circuit for the motor 2 continues to be broken, since as long as brush T bridges tracks I to L, the circuit is broken at 8—9, and when brush T rides off of track I all possible circuits for motor 2 are broken. Therefore in the case of the safety shut down, the entire apparatus is made inactive until the switch 10 is operated in the manner before mentioned.

In the safety shut down position coil 6 is short-circuited through the following circuit: 6, 29, H, S, D, 24, F, 25, G, 28 to 6. The choke is thus conditioned to allow passage of current through the control motor, as soon as contact is made at 20—21.

When the brushes are in the position marked "safety shut down", the only way in which energization of the motors 2 and 4 can be maintained is through the switch 9 in case this switch is closed. If ignition has not been successful and after passage of the brushes from the point Y to the point marked "safety shut down" the supply circuit will fail as will be seen by tracing the following circuits, first for the control motor and then for the burner motor: 30, 44, 3, 43, 5, 42, Q, U, O, 33, 34 to 8, and 30, 50, 2, 48, 19, 10, 18, 51, I, T, L, 38, O, 33, 34 to 8. Therefore, it will be seen that only when 9 is making contact with 8 can the circuits be made to the other side of the line through element 35 to 31.

In case of a momentary power failure there is a complete shut down followed, after a predetermined interval of time, with a normal starting cycle with a trial ignition period, and in case of flame failure the shut-down again follows just as it always does in case of failure of ignition at the end of a predetermined time.

The means provided for obtaining a pause in control motor operation, to permit the stack tubes to cool, is important because if it were not for the opening of the shunt to the coil 6 the brushes would continue their movement to off position although the high voltage tube might be stuck at its hot position, resulting in continued operation of the burner with no means for obtaining a safety shut down in case of flame extinguishment. Since the continued operation of the control motor 4 from the brush position "Pause for stack tube control to cool" depends only on movement of the tube 14 to cold position, means is provided to absolutely prevent the tube 14 from moving to cold position unless and until the tube 11 so moves. The tubes are, therefore, so mechanically interconnected that it is impossible for tube 14 to move to the illustrated full line position while tube 11 sticks in the illustrated dotted line position. This is accomplished by any suitable mechanism, such as by placing tubes 11 and 14 on a common support, which is thermostatically controlled by stack temperature, see Figures 2, 4 and 5 of the Shivers Patent No. 1,707,193.

When the brushes S, T, U have reached the "normal running position" and stopped there during normal operation of the control, upon closure at W—B the control motor is again energized and the brushes are moved again to the right toward the off position. The brushes will then run to that position indicated

"pause for stack tube control to cool" and will remain in this position until the stack tubes again assume the cold position shown in full lines in the diagram.

Suppose that the burner apparatus is running normally, with brushes at the line marked "normal running position". Under these conditions flame is present, both of the thermostatic devices 11 and 14 are in the hot positions indicated by dot-and-dash lines, and relay 9 is closed. Now assume a power failure of, (for example) two seconds duration. During this interval the power has been discontinued just long enough for the oil burner to stop delivering oil. If it were not for relay 9, and if the motor current were carried through the high voltage stack tube (and on resumption of power) the oil burner motor would again operate and oil would be sprayed into a white hot fire pot, with no means for igniting it in time to prevent explosion. With the present device if this momentary power failure occurs under the conditions above mentioned, relay 9 is de-energized resulting in opening of switch 8—9 and no start is possible because the burner motor and coil 7 cannot receive current. That this is true is seen by attempting to trace the circuit as follows: 30, 50, 2, 48, 19, 10, 18, 51, I, T, L, 38, O, 33 to 20. Switch 10^a being open current cannot reach 31 through 10^a, 21, 32. Moreover, with the brushes at the normal running position the control motor 4 cannot be energized because the coil 6 cannot be short-circuited which is found to be true by attempting to trace the circuit as follows: 6, 29, H, S, E, 23, B. The circuit cannot be closed because W, at this time being cold, is making at R, or at least could not be making at B. Since the switch tube 14 is in open circuit (hot) position, at this time the circuit 6, 29, H, F, A, 27, 16, 14, 15, 26, G, 28 to 6 is open, but upon cooling of the furnace, the resultant closing of the tube switch 14 will cause the noted circuit to close, resulting in operation of the brushes S, T, U. by motor 4 to the "off" position whereupon W, being cool and closed on R, the starting cycle will be repeated.

When the device is in the normal running position, indicated by the line in the drawing, and if there is flame failure, the stack tubes as switches will move to cold position as shown in full lines in the drawing, de-energize coil 7 and thus prevent further operation of the burner motor. However, at the normal running position the control motor field is energized from segment P, through brush U to segment Q, and then through the connection 42, choke coil 5 and motor field 3, so that the short-circuit of the secondary of the choke which occurs at this normal running position and which is caused by the movement of the low voltage stack tube to cold position results in operation of the control motor to move the brushes to the off position. If the thermostat is still making at W—R, or in other words, calling for heat, the motor will run on through the off position and re-cycle, giving a trial ignition period at the end of which if the apparatus is not working properly, a safety shut down will occur when the brushes reach the position so marked. Thus on flame failure in the normal running position, there will be a re-cycling under the conditions mentioned.

During the trial ignition period one side 7^a of the relay coil 7 is connected through the high voltage stack tube directly to the ground line. The side 7^b is connected to the hot side 4^a of the burner motor.

Up to line Y, which designates the end of the trial ignition period, we want burner and burner motor operation to continue whether flame is produced or not. The tracks are so arranged as to allow a certain interval of time between the shutting off of the burner motor, and de-energization of the control motor.

When the brush moves from C to D it maintains short-circuit of the element 6 of the choke until it arrives at segment E, after which the control motor is inactivated while the burner motor remains active to supply heat sufficient to cause a closure at W—B of the room thermostat.

I claim as my invention:

In combination, a motor operated burner and control means therefor comprising: a solenoid operated switch; switch means responsive to combustion to operate; a control motor of the type having switches operated thereby to control starting and stopping operation of both the control and burner motors; and electrical means so interconnecting the recited elements that successful initiation of combustion during starting operation causes (1) said switch means to energize said solenoid to close its switch, and (2) said control motor switches to establish the running circuit for said burner motor and the holding circuit for said solenoid through said solenoid switch, whereby momentary power failure results in opening said solenoid switch and the circuits of said burner motor and solenoid.

In witness whereof, I have hereunto set my hand this 17th day of March, 1930.

ARTHUR C. PARKER.