

July 16, 1940.

J. W. MYERS

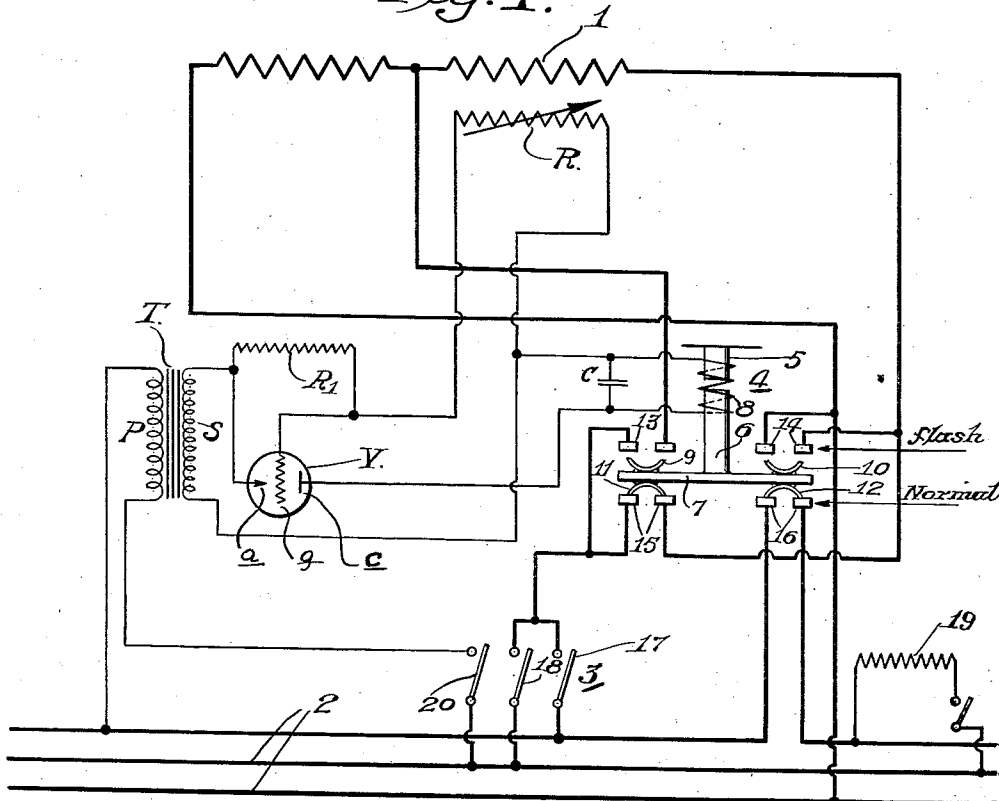
2,207,871

ELECTRIC RANGE UNIT CONTROL MECHANISM EMBODYING
MATERIAL OF CHANGEABLE CHARACTER

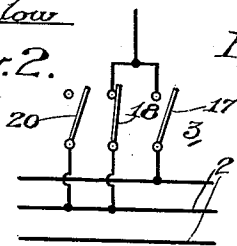
Filed June 4, 1938

4 Sheets-Sheet 1

Fig. 1.



low
Fig. 2.



high
Fig. 3.

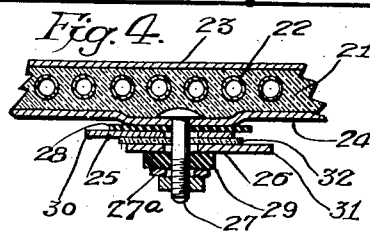
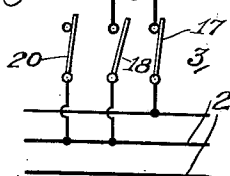
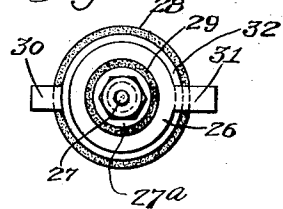


Fig. 5.



Inventor:—
Joseph W. Myers
by his Attorneys
Howson & Howson

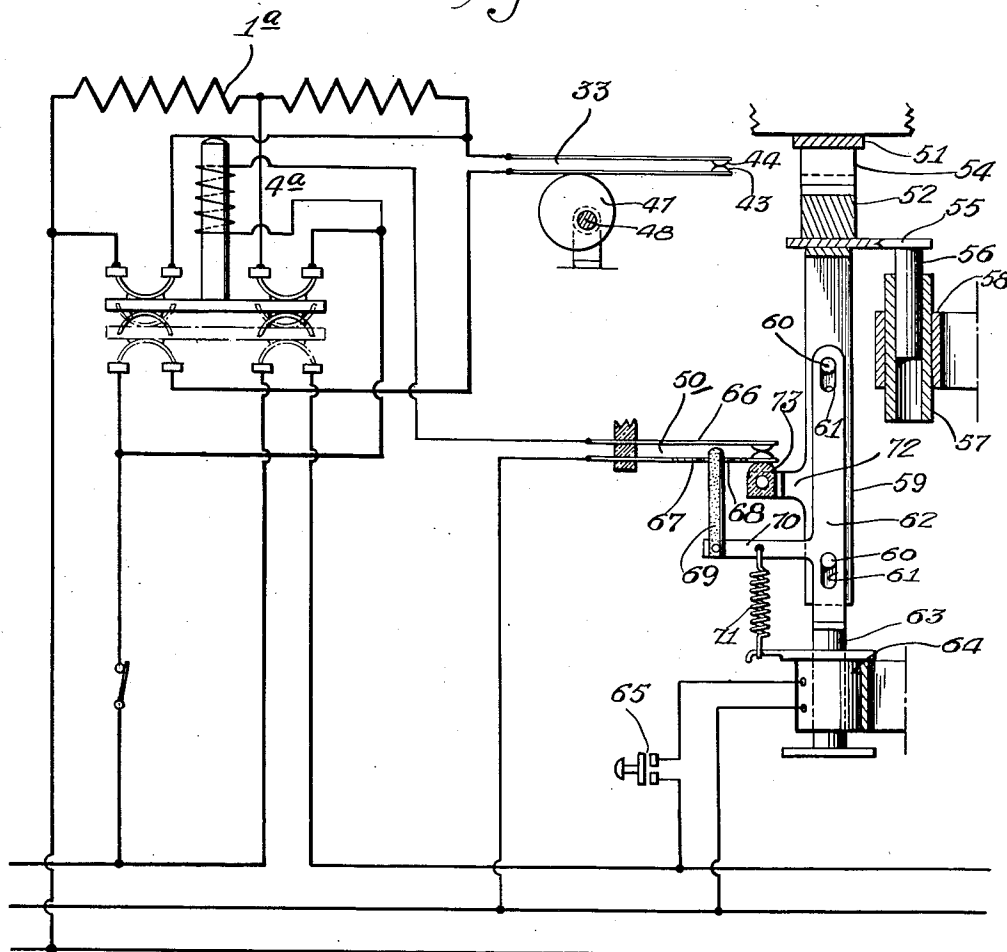
July 16, 1940.

J. W. MYERS
ELECTRIC RANGE UNIT CONTROL MECHANISM EMBODYING
MATERIAL OF CHANGEABLE CHARACTER
Filed June 4, 1938

2,207,871

4 Sheets-Sheet 2

Fig. 6.



Inventor:—
Joseph W. Myers
by his Attorneys
Hawson & Hawson

July 16, 1940.

J. W. MYERS

2,207,871

ELECTRIC RANGE UNIT CONTROL MECHANISM EMBODYING
MATERIAL OF CHANGEABLE CHARACTER

Filed June 4, 1938

4 Sheets-Sheet 3

Fig. 7.

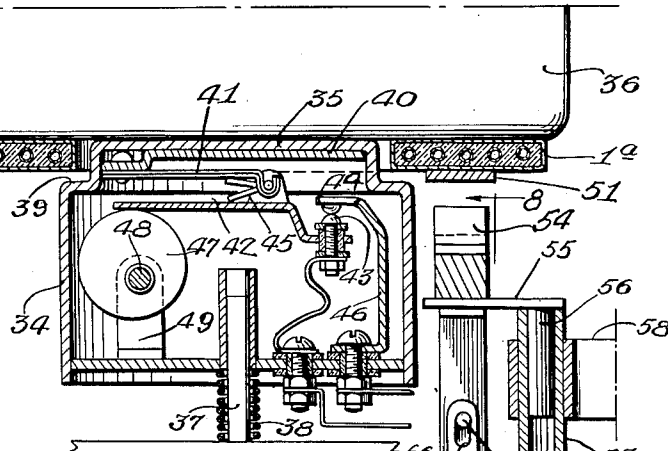


Fig. 8.

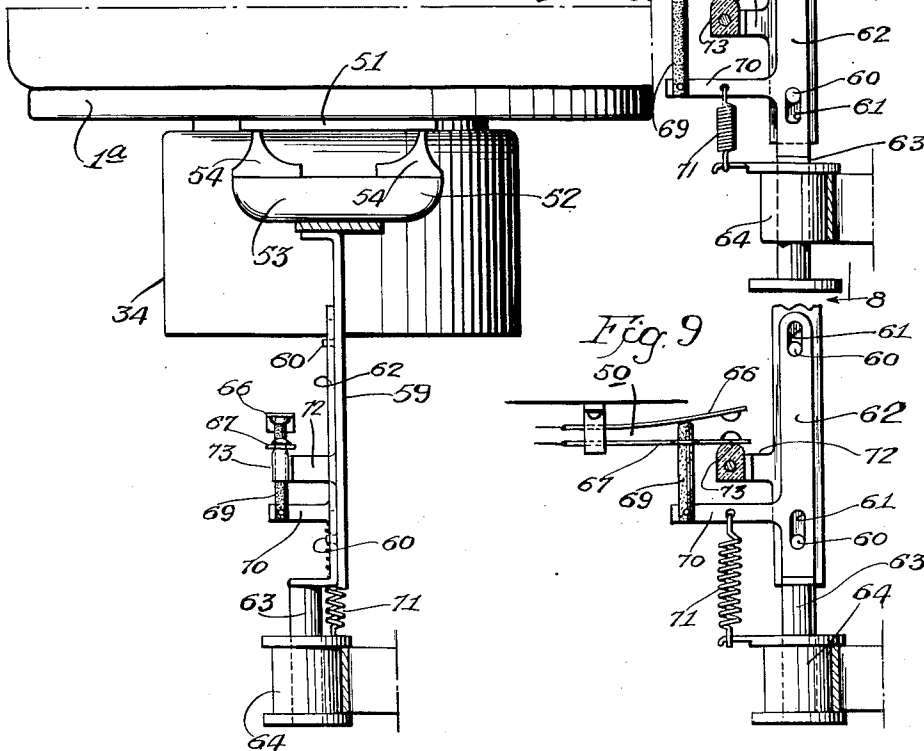
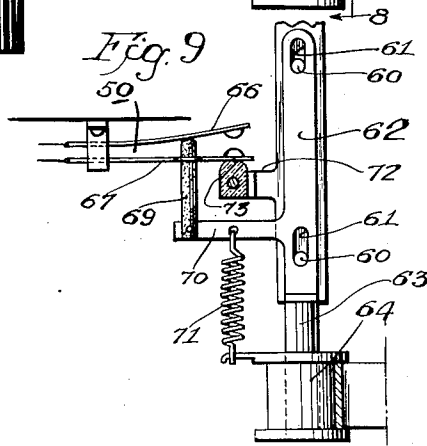


Fig. 9.



Inventor:—
Joseph W. Myers
by his Attorneys
Howson & Howson

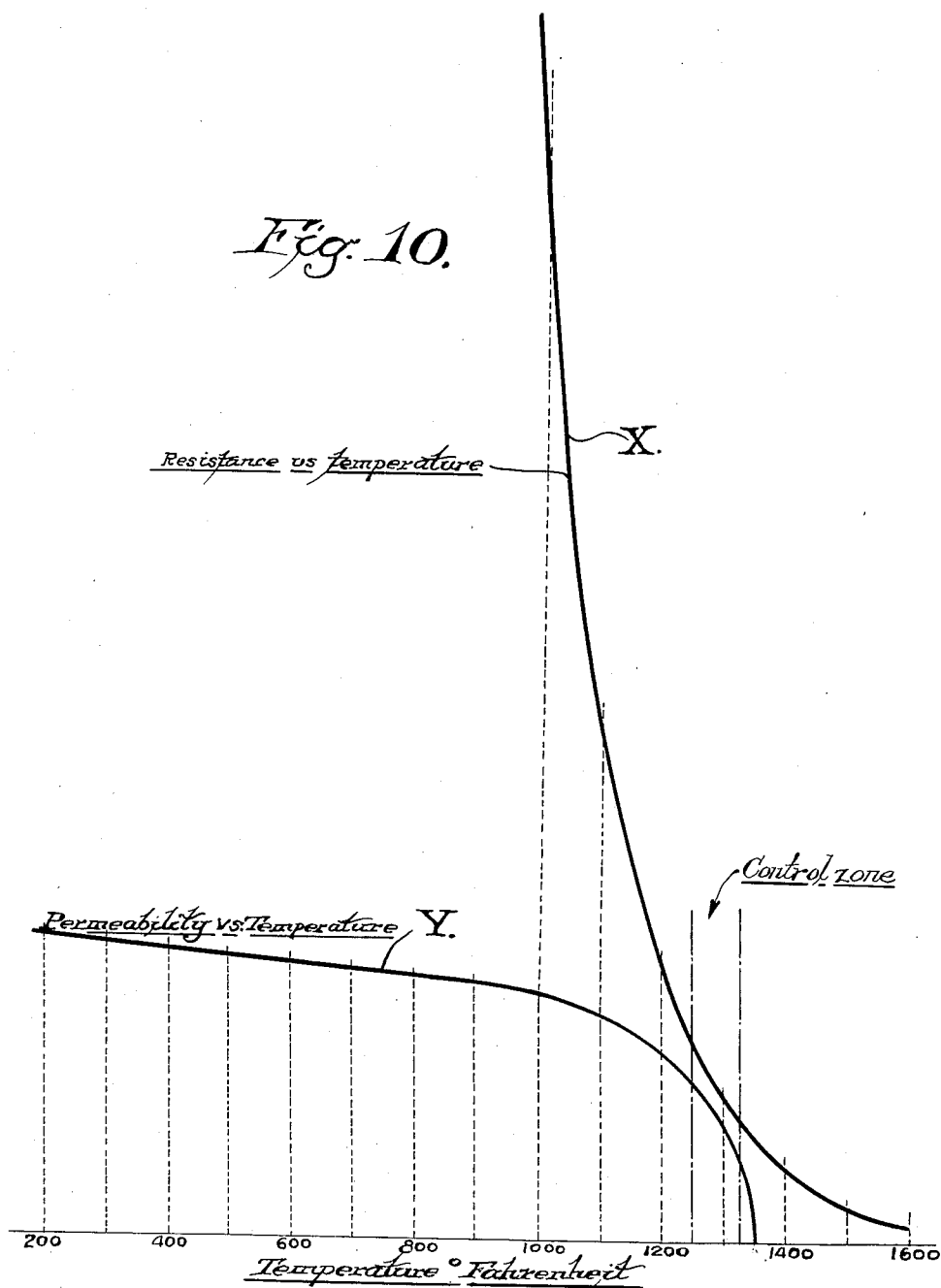
July 16, 1940.

J. W. MYERS
ELECTRIC RANGE UNIT CONTROL MECHANISM EMBODYING
MATERIAL OF CHANGEABLE CHARACTER
Filed June 4, 1938

2,207,871

4 Sheets-Sheet 4

Fig. 10.



Inventor:
Joseph W. Myers
by his attorneys
Howson + Howson

UNITED STATES PATENT OFFICE

2,207,871

ELECTRIC RANGE UNIT CONTROL MECHANISM EMBODYING MATERIAL OF CHANGEABLE CHARACTER

Joseph W. Myers, Philadelphia, Pa., assignor to Proctor & Schwartz, Incorporated, Philadelphia, Pa., a corporation of Pennsylvania

Application June 4, 1938, Serial No. 211,899

12 Claims. (Cl. 219—20)

This invention relates to electric range cooking units and the like, and more particularly to novel control means for effecting rapid heating of such units to a desired temperature level.

The use of electric ranges and other electrical devices employing surface cooking units or plates has been limited or retarded in the past by the fact that such devices require appreciable time to attain their normal operating temperature and heat output and in this respect are not comparable in operation to gas ranges. It is well known that electric ranges have certain definite advantages over gas ranges, but such advantages have heretofore been generally outweighed by the inherent inability of electric range units to rise rapidly to their normal operating temperature.

It has been proposed heretofore to temporarily overload or increase the energization of an electrical surface cooking plate unit by temporarily lowering the resistance of the unit to the supply voltage, and it has been proposed to employ a thermostat directly associated with the plate so as to be effected by the temperature thereof and arranged to restore the resistance of the heating unit to its normal value when the device has arrived at its normal operating temperature. It has also been proposed to decrease the resistance of the heating unit either by providing a normally short-circuited portion of the unit which is rendered effective by the thermostat when the unit has reached its normal operating temperature, or by providing a multi-section heating unit and initially connecting the sections in parallel relation and arranging the thermostat to connect them in series relation when the unit has reached its normal operating temperature. While these proposals have been improvements over the ordinary range unit, they have fallen short of providing a practical and commercially satisfactory range unit or surface cooking plate.

A thermostat necessarily involves a moving part or parts and for this reason it requires servicing from time to time. If it is located where it is subject to accumulation of food substances, it is apt to be deleteriously affected. A striking example of this is found in some bread toasters in which the thermostatic switch is not protected against accumulation of bread particles and such particles frequently become lodged between the switch contacts, preventing them from closing. The most convenient place to locate a thermostat for controlling a range unit or cooking plate is on the bottom surface of the plate, but experience has shown that it is difficult in practice to

so locate a sufficiently sensitive and rugged thermostat and, at the same time have it accessible for servicing and inspection and properly protected from inevitable spillage of food substances.

Furthermore, it is difficult to manufacture an accurate high temperature thermostat which will operate certainly at the highest safe temperature to which it is desired to heat a range unit rapidly. Obviously, it is important in this instance that the thermostat operate certainly at the desired temperature, since a delay of a few seconds occasioned by the failure of some moving part to operate at the proper time might well prove destructive to the heating unit.

Thus, it is manifest that a control device, such as a thermostat, which depends for its accuracy of control upon a sensitive movable part or parts, has serious limitations in practical use, at least so far as concerns the control of rapid heating of a range unit. The present invention eliminates the necessity of employing such a control device, and provides a novel control system employing a control device which is free of sensitive movable parts and which may be located on the bottom surface of the range unit or plate without deleterious effects from spilled food substances or the like. Further, the control device requires less servicing, if any, than the usual thermostatic device. This device functions by virtue of a heat-changeable character of an immobile element rather than by the movement or deflection of a mobile element as found in the conventional thermostatic device.

The principal object of the present invention, therefore, is to provide a novel control mechanism for effecting rapid heating of an electric range unit, which mechanism embodies a device or element having the property that a certain characteristic thereof is varied by heat. This device is used to control the rapid heating of the range unit, which may be aptly termed "flashing" of the unit, to its normal high temperature.

Another object of the invention is to provide a control mechanism of this character wherein it is impossible to flash the unit either willfully or accidentally to a temperature higher than the normal high operating temperature level of the unit.

A further object of the invention is to provide a control mechanism of the stated character wherein an electrical element whose resistance varies in response to heat is employed to control the flashing operation.

A still further object of the invention is to provide a control mechanism of the stated character

ter wherein a magnetic element whose permeability varies in response to heat is employed to control the flashing operation.

Other objects and features of the invention will appear hereinafter.

In the accompanying drawings:

Fig. 1 is a diagrammatic illustration of one form of control system embodying the principles of the invention;

Figs. 2 and 3 are detail views illustrating different positions of the control switch of Fig. 1;

Fig. 4 is a detail sectional view of the mechanical structure of the control device employed in Fig. 1;

Fig. 5 is a bottom face view of the control device;

Fig. 6 is an illustration of a control system embodying another form of the invention;

Fig. 7 is a view, partly in section and partly in elevation, of the mechanical structure of the heating unit and associated parts;

Fig. 8 is a view taken along line 8-8 of Fig. 7 showing the parts in different position;

Fig. 9 is a fragmentary view showing more clearly the disposition of the parts in Fig. 8; and

Fig. 10 is a graph showing performance curves of the control elements employed in the illustrated embodiments.

Referring first to Fig. 1, there is shown a heating unit 1 which preferably comprises a plurality of sections, there being two sections in the unit illustrated. The heating unit is energized from a conventional three-wire supply line 2 which provides different operating voltages, as will be well understood. For example, the voltage between adjacent conductors of the supply line may be 115 volts while the voltage between the two outer conductors may be 230 volts. The operation of the heating unit 1 is controlled by means of a control switch 3 which has a "low" operating position and a "high" operating position as shown in Figs. 2 and 3, respectively. This switch may comprise a plurality of resilient contact arms adapted to engage stationary contacts, as illustrated. The movement of the switch arms may be effected by cams on a common rotatable shaft, so that rotation of the shaft to different angular positions will effect the settings of the switch shown in Figs. 1 to 3. Since this general form of switch construction is well known, it is unnecessary to illustrate the details thereof and, for the sake of simplicity, only the contact elements and their different settings have been illustrated.

In order to effect flashing of the heating unit 1 to its normal high temperature level, there is provided an electrically operable switching device or contactor 4 which functions to change the normal series connection of the heating unit sections to a parallel connection, to thus increase the energization of the unit to above normal, as above mentioned. While it is preferred to employ a multi-section heating unit and to flash the unit by temporarily connecting its sections in parallel relation, the invention is not thus limited and the heating unit may be of any other suitable form and may have any suitable means associated therewith for flashing the unit to its normal high temperature. The contactor 4 comprises a stationary magnetic pole piece 5, a magnetic armature core 6 associated with the pole piece, a cross-bar 7 carried by the armature, and an energizing winding 8. The cross-bar 7 may be formed of insulating material and carries upper contact bridges 9 and 10 and lower contact bridges 11 and 12. The contact bridges 9 and 10

are adapted to engage stationary contacts 13 and 14, respectively, while the lower contact bridges 11 and 12 are adapted to engage stationary contacts 15 and 16. Normally, the contactor armature is gravitationally disposed in its lower position, as shown, with the lower contacts closed and the upper contacts open; but when the winding 8 is energized, the contactor armature is moved to its upper position, opening the lower contacts and closing the upper contacts.

It may now be noted that when the contactor 4 is in its normal position and when the switch 3 is in its "high" position illustrated in Fig. 3, the heating unit sections are connected in series relation across the high voltage conductors through a circuit which may be traced from the uppermost supply conductor, through contact arm 17, closed contacts 15, and the heating unit sections in series to the lowermost supply conductor. The heating unit is thus energized for normal high operation. When the switch 3 is in its "low" position, as shown in Fig. 2, the heating unit sections are connected in a series relation across the two lowermost supply conductors through a circuit which may be traced from the intermediate supply conductor through contact arm 18 and over the current path traced above to the lowermost supply conductor. The heating unit is thus connected for normal low operation.

By means of the mechanism to be described presently, the contactor 4 is actuated whenever the control switch 3 is thrown to its "high" position, unless the heating unit is already operating substantially at its normal high temperature level. Assuming that the switch 3 is in its "high" position and the contactor 4 is moved to actuated position, it will be seen that the heating unit sections are then connected in parallel relation across the high voltage supply conductors, through a circuit which may be traced from the uppermost supply conductor, through contact arm 17, closed contacts 13, through the heating unit sections in parallel and back to the lowermost supply conductor, one of the parallel branch circuits including the left hand heating unit section, while the other branch circuit includes the right hand heating unit section and the closed contacts 14. This connection of the heating unit effects rapid heating thereof until the contactor 4 is deenergized to restore the normal series connection of the heating unit sections for normal high operation.

The purpose of the contacts 12 and 16 on contactor 4 is to open one of the high voltage supply conductors during the flashing operation, to thus deenergize or prevent energization of any subsequent unit connected to the said supply conductor, as represented by the unit 19. This dropping of a subsequent unit or load during the over-energization of a flashable unit prevents overloading of the apparatus as a whole.

The control mechanism for contactor 4 in the specific form of the invention illustrated in Fig. 1 will now be described. A transformer T has its primary winding P connected as illustrated so as to be energizable by the contact arm 20 of switch 3. It will be noted that the switch arm 20 is closed only when the switch 3 is in its "high" position. One extremity of the secondary winding S is connected to the anode *a* of a grid-controlled rectifier tube V, while the other extremity of winding S is connected through winding 8 to the cathode *c* of tube V. The tube V is a grid-controlled rectifier of the cold cathode gas-filled type and this tube may be a so-called

"grid glow tube." A resistance R_1 of high value is connected between the anode a and grid g of the tube as illustrated. To effect the control action contemplated by the invention, there is provided a resistor R whose resistance is varied by heat, as described hereinafter. This resistor is connected as illustrated between the lower extremity of winding S and the grid of tube V . In Fig. 1, a conventional symbol has been employed to represent the variable resistor R and this resistor is shown adjacent a portion of the heating unit 1 to indicate that it is preferably arranged to receive heat from the heating unit.

In Figs. 4 and 5, there is illustrated a suitable physical embodiment of the resistor R in association with the heating unit. As shown in Fig. 4, the heating unit is preferably of the type employing highly compressed insulating material 21 completely embedding the wires 22 and having a metallic sheath comprising upper and lower metallic plates 23 and 24, respectively. Such a unit is capable of being flashed to its normal operating temperature level in 30 to 45 seconds by means of the system illustrated. The resistor R of Fig. 1 comprises a device which is preferably secured to the lower plate 24 as illustrated in Fig. 4. This device comprises electrode disks 25 and 26 which are electrically insulated from plate 24 and from the securing bolt 27 by means of insulating washer 28 and 29. The electrode disks 25 and 26 are provided with terminal lugs 30 and 31, respectively, for electrical connection to these disks. Between the disks 25 and 26, there is interposed a disk 32 which is formed of a material whose electrical resistance is varied by heat. This element should normally have very high resistance to current flow therethrough and its resistance-temperature characteristic should be of such character in relation to resistor R_1 and tube V that the tube is normally unblocked but becomes blocked when the heating unit reaches substantially its normal high temperature. A spring washer 27a may be employed to maintain good contact between the several disks.

Certain materials exhibit a negative resistance-temperature characteristic which changes rather critically within a certain temperature range at about the normal high temperature of an electrical heating unit. For example, in Fig. 10 there is shown a curve X representing substantially the resistance-temperature characteristic of ceramic materials, such as porcelain. Moreover, such materials may be made to perform electrically, in response to heat, in a desired manner by simply varying the content of electrically conductive constituents thereof, that is by adding varying quantities of electrically conductive material. In general, however, common forms of ceramic materials will serve the purpose of the invention.

Referring to the curve X , it will be noted this curve varies substantially exponentially or to a substantially greater degree than linearly over a temperature range including the normal high temperature of a range unit. The critical control range or zone may be selected, as represented for example by the dot-and-dash vertical lines, and the apparatus of Fig. 1 may be designed accordingly to effect the operation now to be described.

In considering the operation of the apparatus of Fig. 1, it should be borne in mind that a tube of the type shown is characterized in that a certain positive potential on the grid is necessary to start or fire the tube, after which the grid loses control, but the employment of alternating

current enables the grid to regain control and block the tube when the grid potential falls below the said positive value, since the anode current passes through zero during each cycle.

When the control switch 3 is thrown to its "high" position shown in Fig. 3, the voltage across the secondary of transformer T , which should be of sufficient magnitude to start the tube, is applied between the cathode and anode. Since the grid is connected to the anode through resistor R_1 , the grid is at substantially the same potential as the anode. Therefore, when the anode and grid go positive during the first cycle, the grid is charged positively with respect to the cathode sufficiently to start the tube, thus causing space current to flow in the tube and thus energizing the winding 8 which is included in circuit with the tube. Thereafter, the grid loses control in the presence of the anode current flow, which is a characteristic of tubes of this type. However, during each cycle of the alternating supply current, the anode current decreases to zero, thereby giving the grid an opportunity to regain control. The condenser C , which is shunted across the winding 8, becomes charged and maintains a continuous and stabilized current supply, so that a relatively steady current is applied to winding 8. This, together with the pole piece 5, prevents chatter of the contactor. The energization of contactor 4 connects the heating unit sections in parallel relation across the high voltage supply conductors, as above described. The heating unit is, therefore, heated rapidly. Due to the normal high resistance of the resistor R , the circuit through this resistor is substantially open-circuited, thus isolating the grid electrically from the cathode.

When the temperature of the element 32 approaches the normal high temperature of the heating unit, the resistance of this element decreases rather critically, as shown by curve X of Fig. 10, or in other words the conductivity of element 32 increases. When the resistance of element 32 decreases substantially to a predetermined value, the conductivity of this element causes the grid of tube V to more nearly assume the potential of the lower end of winding S . In other words, the potential of the grid approaches that of the cathode and reaches a value relative to the cathode potential below the positive value required to start the tube. Consequently, when the anode current decreases to zero during the cycle, the grid regains control and blocks the tube. This deenergizes the winding 8. The contactor 4 is thus deenergized, restoring the normal series connection of the heating unit sections for normal high operation. During the normal high operation, the tube V remains blocked because the grid potential remains below the starting value, so that the contactor 4 remains deenergized.

It will be apparent that by proper design of the apparatus, the tube may be easily made to cut-off within the control zone indicated on curve X . As may be seen from curve X , the resistance of R decreases by about 50% for each 100° temperature rise. In the vicinity of the control zone, the ratio of resistance change to temperature change is greater than two. Thus, for a temperature increase of 10%, the resistance of R decreases more than 20%. Such rate of decrease of R is ample to assure blocking of the tube V within a narrow temperature range, and therefore accurate operation of the tube to control the flashing operation is readily obtained, owing

to the resistance-temperature characteristic of R.

When the control switch 3 is thrown to its low position as shown in Fig. 2, the heating unit sections are connected in normal series relation across the low voltage supply conductors and the heating unit is, therefore, energized normally to raise its temperature to the low temperature.

It may now be noted that the resistor R prevents overflashing of the heating unit, that is, flashing of the unit to a temperature in excess of its normal high temperature level. Since the element 32 is always heat-conditioned according to the temperature of the heating unit, the resistance of this element decreases in the manner above described whenever the temperature of the heating unit approaches closely to the normal high temperature level. Consequently, the tube V is always blocked or cut-off whenever the temperature of the heating unit reaches substantially the normal high temperature level, and, therefore, the flash contactor cannot be energized to over-flash the heating unit. It will be noted further that over-flashing of the heating unit cannot be caused by any of the parts becoming defective. For example, if the tube V became defective, or if the transformer happened to burn out, the contactor 4, if it is energized, will be immediately deenergized, and it will be impossible then to flash the heating unit. In other words, if any part of the system becomes defective and ceases to operate, the heating unit may be operated only in the normal manner, thus preventing burning out of the heating unit. Furthermore, since the tube V is conductive only during the flashing operation, its life is much greater than would be the case if the tube were operated during normal operation.

The combination of the control operating by change of conductivity of a material, the relay or flash contactor 4 having an energized position for flash and a deenergized position for normal, and the load dropping contacts 12, 16 on the contactor, constitutes an important feature of the invention. If it were possible for the flash operation to continue due to some defective condition of the apparatus, the unit 1 would be burned out and the heating units subsequent to unit 1, such as unit 19, would be inoperative due to the open contacts 12, 16. But this cannot happen in the present device since any defective condition will cause the contactor 4 to return to normal, thus not only protecting unit 1 but also rendering the subsequent units operative. For example, if the voltage falls in the control circuit, the contactor 4 is restored from its flash position to its normal position.

Referring now to Figs. 6 to 9, there is shown an alternative form of the invention, wherein the control of the flashing operation is effected by means of a magnetic element whose permeability varies with temperature substantially as shown by curve Y of Fig. 10. The heating unit 1a is similar to that of Fig. 1 and is controlled in a similar manner by the contactor 4a (shown in flash position) of the same general construction as that employed in Fig. 1. In this instance, there is provided a thermostatic control switch 33 which controls the heating unit only during normal energization thereof. It will be noted from Fig. 6 that the switch 33 is in circuit with the heating unit only when the contactor 4a is deenergized, and, therefore, the switch 33 is ineffective to control the heating unit during flashing thereof. Consequently, the switch 33

cannot interrupt the flashing of the heating unit.

The switch 33 preferably takes the form illustrated in Fig. 7. Referring to that figure, there is provided a metallic casing 34, the upper portion 35 of which projects through the annular heating unit 1a and is adapted to engage the bottom of a cooking vessel 36 placed on the heating unit, as illustrated. The casing 34 is slidably mounted upon one or more supports 37, and is seated upon a spring or springs 38 which urge the casing upward so as to maintain good contact with the cooking vessel. In the absence of the cooking vessel, the annular shoulder 39 of the casing abuts against the cooking plate or heating unit so as to receive heat by direct thermal conduction therefrom. Within the casing 34 there is provided a metallic supporting strip or plate 40 which is secured directly to the top 35 of the casing, and there is attached to the supporting strip a thermostatic element 41 which is preferably composed of bimetallic material. It will be seen, therefore, that the thermostatic element receives heat principally by direct thermal conduction from the cooking vessel; and in the absence of the vessel, the thermostatic element receives heat by direct thermal conduction from the heating unit or cooking plate by virtue of the abutment of the shoulder 39 therewith. At its free end thermostatic element 41 pivotally carries a contact lever 42, on one end of which there is mounted a contact 43 adapted to engage a stationary contact 44. A spring 45 serves to urge the contact lever 42 in counterclockwise direction as viewed in Fig. 7, thus urging contact 43 into engagement with contact 44. The latter contact is mounted upon a support 46 which is carried by the casing 34. The two contacts 43 and 44 constitute the switch 33 which is connected electrically in the manner shown in Fig. 6.

The other end of lever 42 is engageable by a cam 47 carried by a rotatable shaft 48 which in turn is journaled in support 49. By rotating the cam 47, the switch 33 may be opened manually, or the cam may be variously positioned to adapt the thermostatic switch to maintain a desired temperature within the cooking vessel 36. Assuming a given setting of the cam 47 other than the "off" position, as the thermostatic element 41 responds to heat principally from the cooking vessel, it flexes downward carrying the contact lever 42 with it, by virtue of the spring 45 and the pivotal mounting of lever 42, the contacts 43 and 44 are maintained in engagement until the opposite end of lever 42 strikes the cam 47, which causes clockwise movement of the lever 42 about its pivot to open the switch contacts. Obviously, the temperature of the cooking vessel at which the switch contacts are opened will depend upon the setting of cam 47. If there is no cooking vessel on the heating unit, the thermostatic element will respond to the temperature of the unit and will prevent it from being maintained above a certain temperature corresponding to the adjustment of cam 47. Thus, the thermostatic switch substantially prevents the heating unit or cooking plate from operating beyond a certain temperature during normal energization of the heating unit, and in addition, the switch controls the operation of the heating unit in response to the temperature of the cooking vessel.

Referring again to Fig. 6, the energization of the flash contactor 4a is controlled by means of a switch 50 which in turn is controlled by the mechanism now to be described. On the bot-

tom plate of the heating unit there is mounted a flat strip 51 which is formed of magnetic material having the characteristic that its permeability is not significantly affected by heat until it is heated to a certain temperature and then its permeability decreases abruptly. This strip may be formed of magnetic iron, the permeability of which decreases non-linearly or exponentially substantially as shown by curve Y of Fig. 10.

This curve is representative of the behavior of iron. In any case, however, a suitable performance characteristic may be readily obtained by alloying of materials. The strip 51 is mounted in thermal conductive relation with respect to the heating unit or cooking plate, so that the strip is always heat-conditioned according to the temperature of the heating unit or cooking plate. In cooperative relation with the strip 51, there is a magnetic yoke 52 comprising a permanent magnet 53 and soft iron pole pieces 54 which are adapted to engage the strip 51. Normally, the magnetic character of strip 51 will cause the magnetic yoke 52 to be held against strip 51, as in Figs. 6 and 8, whenever the magnetic yoke is moved into engagement with the strip or into close proximity thereto. It will be understood that the strip 51 normally furnishes a low reluctance path for the magnetic flux emanating from the permanent magnet 53 and the associated pole pieces 54. When the permeability of strip 51 decreases, however, it presents higher reluctance to the magnetic flux, and when the permeability of strip 51 decreases sufficiently, it interrupts the magnetic attraction between the yoke and strip 51, thus interrupting the flashing operation, as will be more clearly understood later.

The strip 51, being narrow and of relatively small area and mass, does not absorb any more heat from the heating unit than is necessary. Further, the slender pole pieces 54 absorb a minimum of heat and do not cause the permanent magnet 53 to heat to an objectionable degree.

The magnetic yoke 52 is carried by a plate 55 having a depending guide pin 56 slidably seated in a guide 57 supported by a stationary bracket 58. The plate 55 is carried by a bar 59 having projecting pins 60 which are seated in slots 61 of an adjacent bar 62. The bar 62 is carried by the armature 63 of an electromagnet or solenoid 64 which is energizable by means of the manual push button switch 65.

The switch 50 comprises an upper contact arm or spring finger 66 and a lower contact arm or spring finger 67 having an aperture 68 through which an insulating pin 69 may project. The pin 69 is carried by a lateral extension 70 of bar 62. A spring 71 is arranged as illustrated, to normally maintain the bar 62 in its lowermost position and to resist upward movement of this bar. On the bar 59 there is provided a lateral extension 72 carrying an insulating stop 73 against which the end of the contact arm 67 normally abuts, as shown in Fig. 7. The resilience of contact arm 67 normally maintains this arm against stop 73 in switch-opening position, as shown in Fig. 7.

Whenever the switch 65 is closed, the solenoid or magnet 64 is energized, thereby moving bar 62 upward. When the bar 62 has moved upward sufficiently to take up the lost motion of the pins and slots, it carries the bar 59 upwards, thus causing the magnetic yoke to move into engagement with strip 51, as shown in Fig. 8. The pin 69 passes through the opening 68 and engages

arm 66 deflecting this arm upward (see Fig. 9) to prevent closing of the switch until bar 62 returns to its lower position. When switch 65 is released, the magnet or solenoid is deenergized, causing bar 62 to move downward under the influence of spring 71, permitting arm 66 to return to its lower position, as shown in Fig. 6. The bar 59, however, is maintained in its upper position by the magnetic attraction between the magnetic yoke and the strip 51. Therefore, the contact arm 67 is maintained in switch-closing position, as shown in Fig. 6, and the switch 50 is closed. The contactor 4a is, therefore, energized to effect flashing of the heating unit, as previously described. When the heating unit has reached substantially the normal high temperature level, the permeability of strip 51 decreases abruptly, thereby permitting bar 59 to move downward gravitationally to effect opening of switch 50 by virtue of the lowering of stop 73. The consequent deenergization of contactor 4a restores the normal energization of the heating unit.

In Fig. 10, the relatively narrow control range or zone is indicated on curve Y by the dot-and-dash vertical lines. It will be apparent from the curve that accurate operation is readily obtained within the relatively narrow range of critical change of the permeability of the magnetic material. In the vicinity of the control zone, the ratio of percentage decrease of the permeability to the percentage increase of temperature is greater than two.

It may now be noted that the magnetic strip 51 controls the flashing operation and prevents over-flashing of the heating unit. It will be noted further that the pin 69 prevents over-flashing of the heating unit by the operator's holding the switch 65 closed. Since the pin 69 prevents closing of switch 50 until bar 62 has dropped to its lower position, the flash contactor 4a will not be energized until the push button switch 65 has been released. Therefore, it is impossible for the operator to over-flash the heating unit by holding the switch 65 in closed position, whether this action be willful or unintentional.

It will be seen that in each of the embodiments disclosed, the control is effected by an immobile solid element having the property that a certain character of the element varies negatively and exponentially to effect the control action, and the element is continuously heat-conditioned in accordance with the temperature of the heating unit. In other words, the temperature of the control element substantially "tracks" with the temperature of the heating unit. It is not necessary that the temperatures be the same but only that one be a function of the other and that the control action take place when the heating unit reaches substantially its normal high temperature level. While it is preferable to mount the control element on the bottom surface of the heating unit, this is not necessary; nor is it necessary that the control element receive its heat from the heating unit. For example, the control element could be mounted remote from the heating unit and could be heated by a separate heater connected in circuit with heating unit so as to heat the control element in relation to the heating of the heating unit, provided that the control temperature of the control element is reached when the heating unit reaches substantially its normal high temperature level.

Both of the disclosed embodiments are free of any sensitive movable control elements, such as employed in a thermostat, and therefore they

are not subject to the limitations of the thermostat above noted. In each instance the control is effected by a physical change that is incapable of accidental or intentional suspension. In the first embodiment, the conductivity of the control material increases progressively by a large factor if the control operation does not take place at the temperature desired, and therefore the control action increases exponentially until the flash is terminated. In the second embodiment, there can be no suspension of the change in permeability of the magnetic material and therefore the termination of the flash operation is bound to occur at or about the desired temperature.

Although two specific embodiments of the invention have been illustrated and described for the purpose of disclosure, it will be apparent that other forms of the invention are possible. In its broad scope the invention contemplates the control of a flashing mechanism by means of an element formed of material having a particular property which is critically or exponentially changed at a certain temperature. It will be understood, therefore, that the invention is not limited to the specific devices illustrated.

I claim:

1. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, a magnetic element whose permeability decreases critically from its normal value when the element is heated to a certain temperature, said element being arranged to be continuously heat-conditioned in substantial accordance with the temperature of the heating unit, electrically-operable means for increasing the energization of said unit to above normal, to thereby cause said unit to heat rapidly, a switch for controlling the energization of said last means, a magnetic member arranged cooperatively with said element but normally disengaged therefrom, pole pieces extending from said magnetic member and having portions of small area for engaging said element, means for moving said magnetic member to bring said pole pieces into magnetic attracted engagement with said element, the said small area portions of said pole pieces reducing the transfer of heat from said element to a minimum, and a switch-actuating member attached to said magnetic member and adapted to close said switch, whereby said switch is maintained closed until said magnetic member is released by said element when the permeability of the latter decreases substantially.

2. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, a magnetic element whose permeability decreases critically from its normal value when the element is heated to a certain temperature, said element being arranged to be heat-conditioned in substantial accordance with the temperature of the heating unit, electrically-operable means for increasing the energization of said unit to above normal, to thereby cause said unit to heat rapidly, a switch for controlling the energization of said last means, a magnetic member arranged cooperatively with said element but normally disengaged therefrom, manually operable means for moving said magnetic member into magnetic attracted relation with said element, a switch-actuating member attached to said magnetic member and adapted to close said switch, and means for preventing closure of said switch until said manual means is released.

3. In an electrical cooking apparatus, an elec-

trical heating unit, means for energizing said unit, a magnetic element whose permeability decreases critically from its normal value when the element is heated to a certain temperature, said element being arranged to be heat-conditioned in substantial accordance with the temperature of the heating unit, electrically-operable means for increasing the energization of said unit to above normal, to thereby cause said unit to heat rapidly, a switch for controlling the energization of said last means, a magnetic member arranged cooperatively with said element but normally disengaged therefrom, manually energizable electrically-operable means for moving said magnetic member into magnetic attracted relation with said element, a switch-actuating member attached to said magnetic member and adapted to close said switch, and means for preventing closure of said switch until said manually energizable means is deenergized.

4. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, thermal-responsive means engageable by a cooking vessel placed on said unit for controlling the operation of said unit during normal energization thereof, means for increasing the energization of said unit to above normal, to cause said unit to heat rapidly, and means including an immobile element of heat-changeable character arranged to be heat-conditioned in substantial accordance with the temperature of said unit for restoring the normal energization of said unit when the unit is heated substantially to its normal high temperature level.

5. In electric heating apparatus, an electric heating unit, at least one other electric heating unit, a supply line for supplying electrical energy to said units, an electric switch for each unit manually operable to render either or both of said units active at will, another electric switch operable from one position to another to increase the energization of said first unit above a level normally available through the contacts of said first switch, to thereby cause said first unit to heat rapidly to a predetermined temperature level, means controlled by said other switch for opening the supply line ahead of said other unit before the energization of said first unit is increased above normal, to thereby prevent energization of said other unit during abnormal energization of said first unit, and means including an immobile heat-changeable solid element for automatically effecting return operation of said other switch when said first unit reaches said temperature level, to thereby restore normal energization of said first unit and to close the supply line to said other unit, whereby prolonged overenergization of said first unit is prevented and prompt restoration of the energy supply to said other unit is assured.

6. In electric heating apparatus, an electric heating unit, at least one other electric heating unit, a supply line for supplying electrical energy to said units, an electric switch for each unit manually operable to render either or both of said units active at will, an electrically-operable switch operable from a normal deenergized position to an energized position to increase the energization of said first unit above a level normally available through the contacts of said first switch, to thereby cause said first unit to heat rapidly to a predetermined temperature level, a manually-closable energizing circuit for said last-mentioned switch, contacts at the normal position of said last-mentioned switch for opening the supply line

ahead of said other unit before the energization of said first unit is increased above normal, to thereby prevent energization of said other unit during abnormal energization of said first unit, and means including an immobile heat-changeable solid element for deenergizing said energizing circuit and thus effect automatic return operation of said last-mentioned switch when said first unit reaches said temperature level, to thereby restore normal energization of said first unit and to close the supply line to said other unit, whereby prolonged overenergization of said first unit is prevented and prompt restoration of the energy supply to said other unit is assured.

7. In electric heating apparatus, an electric heating unit, at least one other electric heating unit, a supply line for supplying electrical energy to said units, an electric switch for each unit manually operable to render either or both of said units active at will, an electrically-operable switch operable from a normal deenergized position to an energized position to increase the energization of said first unit above a level normally available through the contacts of said first switch, to thereby cause said first unit to heat rapidly to a predetermined temperature level, a manually-closable energizing circuit for said last-mentioned switch, contacts at the normal position of said last-mentioned switch for opening the supply line ahead of said other unit before the energization of said first unit is increased above normal, to thereby prevent energization of said other unit during abnormal energization of said first unit, a grid-controlled space discharge device for controlling said energizing circuit, an electrical resistance element of heat-variable character arranged to be heat-conditioned in substantial accordance with the temperature of said first unit, and a grid-control circuit including said resistance element for controlling the operation of said space discharge device so as to deenergize said energizing circuit when said first unit reaches said temperature level, to thereby effect automatic return of said last-mentioned switch to normal position and thus restore normal energization of said first unit and reclosure of the supply line to said other unit.

8. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, an electrical resistance element of heat-variable character arranged to be heat-conditioned in substantial accordance with the temperature of the heating unit, electrically-operable means for increasing the energization of said unit to above normal, to thereby cause said unit to heat rapidly, an energizing circuit for said last-mentioned means, a space discharge device comprising a cold cathode, anode and control electrode, means for including the space current path of said device serially in said energizing circuit, and a circuit for said control electrode including said resistance element and arranged to render said space discharge device substantially non-conducting when said heating unit reaches a substantially predetermined temperature, to thereby restore the normal energization of said unit.

9. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, an electrical resistance element of heat-variable character arranged to be heat-conditioned in substantial accordance with the temperature of the heating unit, electrically-operable means for increasing the energization of said unit to above normal, to thereby cause said unit to heat rapidly, an energizing circuit for said last-mentioned means, a grid-controlled gas-filled space discharge device comprising a cathode, anode and control electrode, means for including the space current path of said device serially in said energizing circuit, means for normally maintaining said control electrode at a potential sufficient to start said device but ineffective to stop the same and means including said resistance element for applying to said control electrode a potential effective to render said space discharge device substantially non-conducting when said heating unit reaches a substantially predetermined temperature, to thereby restore the normal energization of said unit.

10. In an electrical cooking apparatus, a cooking unit comprising a metallic casing, means for energizing said unit, a thin body of heat-variable resistance material, means for clamping said body in thermal conducting relation with said casing, electrically-operable means for increasing the energization of said unit to above normal, to thereby effect rapid heating of said unit, an energizing circuit for said last-mentioned means, and means including said body of resistance material for deenergizing said circuit when said unit reaches substantially a predetermined temperature, thereby restoring normal energization of the unit.

11. In an electric cooking apparatus, an electrical heating unit, means for energizing said unit, thermal-responsive means engageable by a cooking vessel placed on said unit for controlling the operation of said unit during normal energization thereof, means for increasing the energization of said unit to above normal, to cause said unit to heat rapidly, and means including an electrical resistance element of heat-changeable character arranged to be heat-conditioned in substantial accordance with the temperature of said unit for restoring the normal energization of said unit when the unit is heated substantially to its normal high temperature level.

12. In an electrical cooking apparatus, an electrical heating unit, means for energizing said unit, thermal-responsive means engageable by a cooking vessel placed on said unit for controlling the operation of said unit during normal energization thereof, means for increasing the energization of said unit to above normal, to cause said unit to heat rapidly, and means including a magnetic element of heat-changeable permeability arranged to be heat-conditioned in substantial accordance with the temperature of said unit for restoring the normal energization of said unit when the unit is heated substantially to its normal high temperature level.

JOSEPH W. MYERS.