Sept. 18, 1928. 1,684,942

R. A. CARLETON

ELECTRICAL HEATING APPARATUS

Filed Feb. 21, 1927 2 Sheets-Sheet 1

Fig. 1

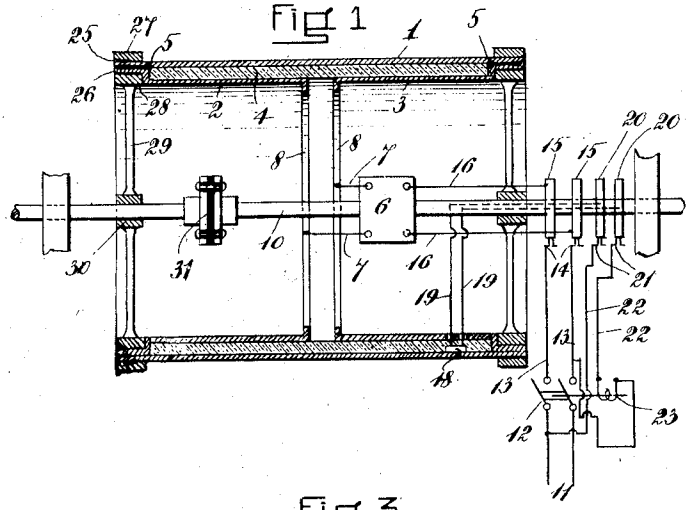


Fig. 2.

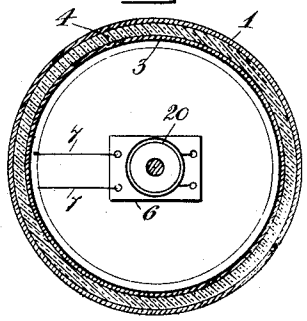


Fig. 3.

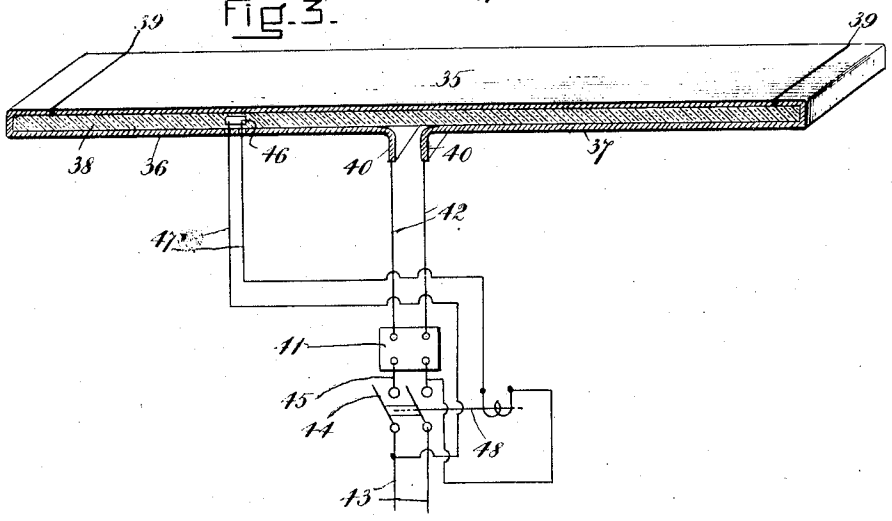
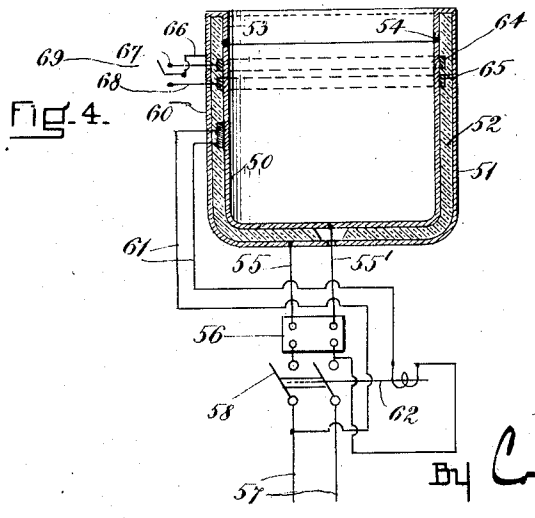


Fig. 4.



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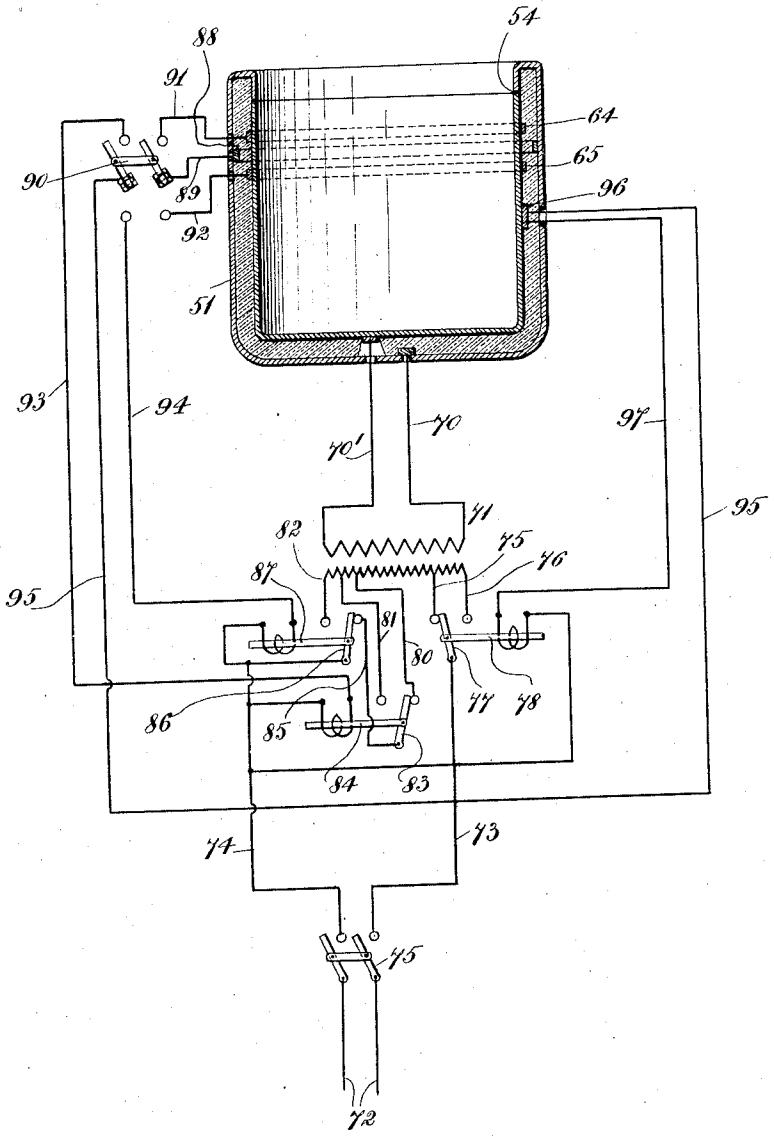
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Fig. 5.



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UNITED STATES PATENT OFFICE.

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ELECTRICAL HEATING APPARATUS.

Application filed February 21, 1927. Serial No. 169,698.

The invention relates to heating apparatus in which the heating element is an electrical resistance element in direct contact with the substance to be heated, but which element is itself heated by passing a low tension current directly through it thereby heating it to the desired temperature. An apparatus of this kind is typified in U. S. Patent No. 1,480,805 of January 15, 1924. As described in this patent the heating element is heated by passing a low tension current of electricity directly through it by means of low resistance conductors from the output or secondary side of a transformer.

In this method of heating it is convenient to use a transformer since by its use the secondary circuit which supplies the heating current may be kept electrically separate from the primary circuit which is usually connected to the power mains. In most systems one side of the primary is grounded so that if the secondary circuit had a direct contact with the primary circuit in any way, it would at times be dangerous to expose the uninsulated heating element since there would be danger of a short circuit or at least a ground. To avoid any danger of this nature, and also to reduce the voltage applied to the heating element, and thus eliminate further danger from high potential current, it is best to provide a step-down transformer with as small a secondary voltage as possible.

In some types of apparatus where the heating element is of considerable size considerable voltage is necessary to drive the current through the heating element because not only is the resistance to be reckoned with, but also the reactance due to the magnetic field set up by the current in the heating element. Where it is desired to employ only low voltage and where the current in the conductors is of considerable size the reactance drop due to this field set up by the current offers a real obstacle to the use of low voltage in obtaining sufficient heat. Under such conditions more voltage must be supplied not only with the resulting greater dangers but also with the resulting higher cost of heat.

It must be appreciated that with some of the voltage across the secondary going to overcome the reactance drop in the heating element higher voltages must be applied. Or, looking at the conditions another way, the actual power consumed by a circuit is the product of the current by the voltage multiplied by the power factor. Where there is no reactance drop in the circuit this is simply the product of the current by the voltage so that the power under these conditions is delivered most efficiently, while, where there is a reactance drop the power is less than the current times the voltage and therefore not delivered as efficiently as in the first instance. As the voltage in most systems is kept constant it means a larger drain of current for the same power on the supply system. This has become so troublesome on large supply systems that the consumer is charged more according to the current he draws regardless of the power than according to the power because the current is the element which taxes the capacity of the system more than the power.

The object of the invention is to overcome the difficulty above pointed out, and I have found that it may be overcome by so forming and arranging the current-carrying-conductors with relation to the heating element that the magnetic field caused by the flow of current will be neutralized both for the heating elements and the conductors, thus minimizing the effect of self-induction and permitting the circuit to operate at a high power factor. In this manner there is substantially no reactance and all the voltage is applied in overcoming the resistance of the heating element. In other words, the current is used most efficiently and there is substantially no so-called "wattless component" which does no work in the system.

The invention can best be seen and understood in the light of the drawings in which for purposes of illustration its application is shown to a variety of objects, and in which—

Figure 1 shows in longitudinal cross section a heated drum or cylinder.

Figure 2 is a cross section thereof.

Fig. 3 shows in perspective an electrically heated plate or table top.

Fig. 4 shows in vertical cross section an electrically heated kettle or tank and

Fig. 5 is a cross section of a kettle or tank fiilled with various heat controls to which reference will later be made.

The heated drum or cylinder shown in Figs. 1 and 2 is one adaptable for a great variety of uses in various arts. It comprises an outer annular shell 1, with which the matter to be dried or heated is in direct contact and is made of some relatively high resistance metal. It constitutes the heating element of the drum. Arranged inside the outer shell

or heating element and preferably in parallel relation to it, is an inner annular shell made in two parts 2 and 3 respectively. These parts are insulated from the outer shell or heating element by suitable material 4 such as asbestos felt which is preferably of a nature both to function as an electrical insulator and also as a heat insulator or backing to the outer shell or heating element. The parts 2 and 3 are made of some low resistance metal and are connected respectively all around their outer ends to the outer ends of the outer shell or heating element. 5 represents the edge along which the connection is made preferably by brazing. The parts 2 and 3 form conductors for conveying electrical current to the outer casing or heating element for heating it. In this connection it will be observed that the conductors are such that current passed through them will be supplied to the end or ends of the heating element all along such ends and will not be concentrated at any particular point or points, the current accordingly passing evenly through the entire body of the heating element so that every part of the element is heated by the passing of the current and not by the transmission of heat from one part to another due to the conductivity of the metal.

Current is fed to the low resistance conductors 2 and 3 by connecting the inner ends thereof with a source of low voltage current preferably by connection with the secondary of a transformer. 6 represents such a transformer while 7, 7 represent leads from the transformer connecting respectively with the inner turned ends 8, 8 of the respective conductors 2 and 3.

The transformer 6 is preferably arranged to turn with the drum and is supported by any suitable means (not shown) on the shaft 10 of the drum. The transformer is supplied with current from the mains 11 through a local switch 12 preferably one capable of automatic control. Beyond the switch 12 the current is conducted to the transformer by way of wires 13, 13 to brushes 14, 14 which fit rings 15, 15 arranged upon the shaft 10 and having connection through wires 16, 16 with the primary of the transformer. The transformer is preferably one of the step-down type and separates physically the potential of the primary system from that of the secondary system as well as stepping down the voltage which, through the conductors connecting with the secondary of the transformer, is to be supplied to the outer shell or heating element.

With the conductors 2 and 3 thus formed and arranged with relation to the outer casing or heating element not only will the current be supplied to the heating element evenly for heating its entire body as previously explained, but the current flowing at any moment in the outer casing or heating element is in a direction opposite that flowing through the inner casing or conductors and since moreover the conductors parallel the heating element and lie very close to it, the resulting magnetic fields set up by the currents are practically and for all purposes entirely neutralized.

The drum is provided with a thermal device 18 in intimate contact with its outer shell 1. From the thermal device 18 are leads 19, 19 which extend through the centre of the shaft 10 (made hollow) and connect with rings 20, 20 on the exterior of the shaft. Fitting these rings are brushes 21, 21 which by way of leads 22, 22 connect with a control magnet 23 which operates to open the switch 12 when the drum becomes heated to a determinate degree when the current will be shut off, the switch again opening to allow flow of current to be resumed when the drum cools to a point below the determinate degree of temperature at which the thermal device operates to shut off the current.

The drum may be mounted upon the shaft 10 in any suitable manner. A convenient method is by bringing together the metal along the edges of the shell 1 and the respective shells or conductors 2 and 3, at the opposite ends of the drum to form binding edgings 25, 26. These edgings are bound by rings 27 to rims 28 carried by spokes 29 extending from hubs 30 fixed to the shaft 10 and by which means the drum is fixed to the shaft to rotate it. To prevent current passing along the shaft, the shaft is split, the ends of the shaft at the points of the split in it being fastened together by a suitable insulating forming connection 31.

In Fig. 3 the invention is shown as applied to a hot table. 35 represents the table top or hot plate. This plate is made of comparatively high resistance metal and constitutes the heating element of the table. Arranged beneath the hot plate 35 preferably in parallel relation to it, is an inner shell or lining made in two parts 36 and 37 separated from one another preferably at about the middle of the table. The parts 36 and 37 are insulated from the hot plate by insulating 38 such as asbestos felt or an insulation having combined heat and electrical insulating qualities. The parts 36 and 37 are made of some low resistance metal and connect across their ends with the outer ends of the hot plate 35. 39, 39 represents the edges along which this connection is made, preferably by brazing. The parts 36, 37 form conductors for conveying current to the hot plate for heating it and it is preferred that the conductors make their connections with the hot plate at points inwardly removed from the ends of the table top effected by bending the conductors to form these ends which are accordingly kept cool.

As in the case of the drum previously described the conductors are so arranged with

relation to the hot plate or heating element that current passed through them will be supplied to the ends of the heating element all along its ends and will not be concentrated at any particular point or points, and consequently the current will pass evenly throughout the entire body of the hot plate which will become uniformly heated by the current without dependence upon heat transmission due to the conductivity of the metal.

Current is supplied to the low resistance conductors 36 and 37 by connecting the inner turned edges 40 thereof with the secondary of a transformer 41 through leads 42, 42. The transformer is supplied with current from the mains 43 through a local switch 44. Beyond the switch 44 the current to the transformer is conducted by way of leads 45. With the conductors 36 and 37 thus formed and arranged with relation to the hot plate or heating element it will be seen that at any moment the current flowing in the plate is in an opposite direction to the current flowing through the conductors beneath and paralleling it with the resulting effect that the magnetic fields set up by the currents are for all practical purposes neutralized.

The hot plate or heating element of the table is provided with a thermal device 46 connecting by leads 47 with a control magnet 48 which operates to open the switch 44 when the table becomes heated to a determinate degree, the switch then being operated to shut off the current.

In Figure 4 is shown an electrically heated kettle or tank useful in various kinds of cooking or processing operations. 50 represents the shell constituting the body of the kettle and within which is contained the mass to be treated. This shell is made of comparatively high resistance metal as it is a part which constitutes the heating element of the kettle. In spaced surrounding relation to the interior shell 50 is an exterior shell 51 of low resistance metal. The two shells are insulated from one another both electrically and thermally by any suitable insulating material 52 such as asbestos felt. The exterior low resistance shell 51 not only envelops the interior high resistance shell, but is extended upwardly beyond the top edge of the interior shell, thence turned to form the top of the kettle, the metal of the exterior shell then being turned to extend downwardly inside the kettle at the top by a part 53 where it makes connection with the interior high resistance shell at the point 54, preferably by brazing. The point 54 where connection is made between the two metals of different resistances is for present purposes an assumed point, being one below the extreme top edge of the kettle for a purpose to which a more detailed reference will later be made.

Electrical current of low voltage is supplied to the kettle by way of leads 55, 55′ from the secondary of a transformer 56 preferably a step-down transformer. The transformer in turn is supplied with current from mains 57 through a local switch 58. Of the leads 55 and 55′ the lead 55 connects with the outer low resistance shell at the bottom of the kettle while the lead 55′ connects directly with the inner high resistance shell at the bottom of this shell. The low resistance shell 51 functions as a conductor for the current, the current flowing through it by and around the top edge of the kettle and thence downwardly inside the kettle to where connection is made with the high resistance shell or body of the kettle to be heated. The connection of the conductors 51 with the body 50 of the kettle to be heated is a connection extending all around the top edge of the body so that current is supplied to flow evenly through the body, all parts thereof being uniformly heated by the flow of the electrical current and no one part thereof being heated any more than any other part and with no dependence upon the transmission of heat by conductivity of the metal. Not only this, but the arrangement of the two shells is such that at the moment the current is flowing upward on the outer shell it is flowing downward on the inner shell and as the outer and inner shells are very close to each other and separated only by a thin lining of insulating material the fields set up by the currents in the heaters are substantially neutralized as in the case of the drum and the table previously described.

For controlling the heating of the kettle its high resistance element or body is provided with a thermal device 60. This device is connected by leads 61, 61 with a control magnet 62 of the switch 58 and should the heat exceed the desired degree, will function to open the switch and disconnect the transformer from the source of current. Upon a cooling of the heated material below the desired temperature the thermostatic device will operate to again enclose the switch and the flow of current will be resumed in the heating element.

Reference was previously made to the fact that the low resistance shell or conductors 51 makes connection with the high resistance shell or body of the kettle or element to be heated at a point inside and below the top edge of the kettle. This is for the purpose that no part of the kettle lying above the material being heated or processed shall become highly heated as would be the case if the material heated or processed within the kettle did not cover all of the high resistance metal or the metal which is being heated.

Masses being cooked or processed within the kettle may of course be varying depths, and to the end that only a proportional part of the high resistance body of the kettle may be heated by the passage of the electrical

current depending upon the depth of the mass within the kettle so that the mass will at all times cover that portion of the kettle actually being heated by the passage of the electrical current, provision is made as follows: The interior high resistance shell or heating element of the kettle is provided on its exterior with conductor rings 64 and 65, respectively. These rings occupy different spaced positions below the top of the high resistance element or point 54 where the low resistance conductor makes connection with this element.

Current is directed to either one of the conductor rings 64 or 65 from the conductor 51 by way of the connection 66 to connections 67, 68 respectively, controlled by a common switch 69. When the switch 69 is closing the circuit between connection 66 and the connection 67, that portion of the heating element of the kettle lying between the top edge 54 of the heating element and the conductor rings 64 will be cut out, that portion only of the heating element being heated lying below the ring 64. On the other hand, when the connection 66 is in circuit with the connection 68 leading to the ring 64, then that portion of the heating element lying between its top edge 54 and the ring 65 will be cut out, the remaining part of the heating element only being heated by the passage of the current. In this way sectional portions of the kettle are heated depending upon the mass contained within the kettle, that portion of the kettle not covered by the material treated being left unheated by the passage of the electric current.

In a kettle of this kind it is also desirable, if not necessary, that the kettle be provided with a thermostatic device by which that portion of the kettle being heated may be kept at a determinate temperature. It is also necessary when fractional parts of the kettle only are being heated, as previously described, to cut down the voltage or potential of current flowing through the kettle for heating it, to compensate for the decrease of resistance, which if not compensated for would result in an increase of heat.

In Fig. 5 is shown an arrangement whereby the heating element of the kettle is provided not only with a thermostatic control by which it may be maintained at a determinate degree of temperature, but provision is also made whereby the current may be reduced as fractional parts of the heating element are cut out so that any remaining portion of the heating element will be heated to substantially the same degree of temperature as the entire heating element with no section cut out. In other words substantially the same flow of current and heating effect is maintained in any used portion of the heating element. As shown in this figure electric current of low potential is supplied to the kettle by way of leads 70, 70′ from the secondary of a step-down transformer 71. The primary of the transformer in turn is supplied with current from a main 72 by way of conductors 73, 74, the main being controlled by a local switch 75. The conductor 73 taps into the primary of the transformer at different points by way of leads 75, 76 respectively controlled by a common switch 77 which in turn is operated by a magnet 78. The primary of the transformer is also provided with separate taps 80, 81 and 82 connecting respectively with the conductor 74 through various electro control switches with intermediate connections. Thus the taps 80, 81 are controlled by a common switch 83 which in turn is controlled by an electromagnet 84. Connecting with the switch 83 is a connection 85 which connection together with the tap 82 is controlled by a common switch 86 which in turn is operated by an electromagnet 87. The heating element of the kettle itself, substantially the same as before described, is provided with separate conductors 64 and 65 by which current may be supplied to fractional parts of the heating element. The outside conductor 51 of the kettle is also fitted with a conductor ring 88. This ring connects by a conductor 89 with a switch 90. This switch is a switch common to and makes connection as the switch is turned with one or the other of the conductors 91, 92 respectively leading to the respective rings 64 and 65 on the heating element of the kettle. The switch 90 also operates as a switch for connections 93 and 94 respectively. As the switch makes electric connection to complete the circuit between the conductors 89 and 91 it will also complete the circuit with the conductor 93. On the other hand, when the switch is turned to complete the circuit between conductors 89 and 92 it also completes the circuit with the conductor 94. The conductor 93 controls the electromagnet 84, thence leading to connect with the conductor 74, while the conductor 94 controls the electromagnet 87, thence leading to the conductor 74.

Connecting also with the switch 90 is a connection 95 leading to a thermostatic device 96 through which the circuit is completed under determinate circumstances by way of a connection 97, which controls the electromagnet 78 and then extends to connect with the conductor 74. The thermostatic device 96 is one of common type in which the circuit is completed through it only in the event of a determinate rise in temperature above the normal temperature at which the device is set.

The general operation is as follows: In the normal setting of the parts the switch 77 will be in contact with the lead 75 leading to the primary of the transformer. The switch 83 will be in contact with the transformer

tap 80. The switch 86 will be in contact with the conductor 85. The switch 90 will be open. Under these circumstances when current is directed through the transformer by the opening of the switch 75 the entire heating element of the kettle will be heated by passage of the electric current. The thermostatic device 96 will be set for such degree of temperature as it is desired to maintain the heating element of the kettle. When the heat exceeds this temperature then the circuit will be completed through the thermostatic device by way of the connections 95 and 97 and thereupon the electromagnet will be energized to move the switch 77 away from the lead 75 of the transformer to the lead 76, when the electric current will be reduced in the secondary of the transformer, thereby reducing the current supplied to the heating element of the kettle. When the temperature of the heating element returns to normal, thereupon the circuit will become broken by the operation of the thermostatic device and the switch 77 will return to its original position making contact with the lead 75. In connection with the switch 77 any common form of spring arrangement (not shown) may be provided to supplement the electromagnet in the operation of the switch. It is also to be observed that in maintaining the heating element of the kettle at any determinate degree of temperature the operation is not to cut off the current entirely, but simply to reduce the current, thereby eliminating the objectionable features attendant upon the complete cutting off and cutting in of the current. It will also be noted that the operation of the thermostatic device is entirely independent of whether the whole or a part of the heating element of the kettle is being heated by the passage of the electric current.

Referring now to the operation of cutting out of portions of the heating element for effecting a corresponding relative reduction in the amount of current supplied the heating element of the kettle when the switch 90 is thrown: Assuming it is desired to heat the heating element only from below the point of the conductor 64, thereupon the switch 90 will be thrown over to make connection between the conductors 89 and 91. At the same time the switch makes connection with a conductor 93 when the electromagnet 84 will be operated to throw the switch 83 away from the tap 80 to the primary of the transformer into contact with the tap 81, thereby effecting a reduction of current in the secondary of the transformer and the current supplied to the kettle, which corresponds relatively with the reduced heating area. When the switch 90 is thrown for supplying current through the connections 89 and 92 to the ring 65 of the heating element, thereby effecting a further reduction in the area to be heated, then the switch will at the same time complete the circuit for energizing the electromagnet 87 which will throw the switch away from the conductor 81 into contact with the tap 82 of the primary of the transformer, when a further reduction of current will be effected in the secondary, the current supplied to the heating element of the kettle corresponding relatively to the reduced area to be heated. As in the case of the switch 77 the switches 83 and 86 may be supplied with any necessary spring members (not shown) as will assist the electromagnets in the operation of these switches to effect the results above pointed out.

Thus it will be seen that provision is made for maintaining the heating element or any fractional part thereof at any desired determinate temperature; also, when fractional parts of the heating element of the kettle only are being used, depending upon the amount of material within them, current is supplied in an amount relatively commensurate with the area to be heated.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States:—

1. In an electric heating apparatus, the combination comprising a comparatively high resistance heating element, a comparatively low resistance conductor element through which electric current is supplied to the high resistance element to pass through said high resistance element for heating it, said elements being so arranged that the current flowing in one element will always be in an opposite direction to that flowing in the other element whereby the magnetic field due to the currents will be substantially neutralized, and means for supplying electric current to said elements.

2. In an electric heating apparatus, the combination comprising a comparatively high resistance heating element, a comparatively low resistance condutcor element making edge connection with the high resistance element whereby current may be directed from the conductor element to pass evenly throughout the entire body of the high resistance element for heating it, said elements being in spaced insulated relation to one another and otherwise arranged so that the current flowing in one element will always be in an opposite direction to the flow in the other element whereby the magnetic field due to the currents will be substantially neutralized, and means for supplying electric current to said elements.

3. In an electric heating apparatus, the combination comprising a comparatively high resistance heating element, a comparatively low resistance conductor having substantially the same surface area as said high resistance element and making edge connection therewith, said elements being parallelly

arranged in spaced insulated relation to one another, comparatively near together so that the current flowing through one element will be in an opposite direction to the current flowing in the other element whereby the magnetic field due to the flow of the currents in the respective elements will be substantially neutralized, and means for supplying electric current to said elements.

4. In an electric heating apparatus, the combination comprising a plate of comparatively high resistance material forming a heating element, comparatively low resistance plate conductors connected respectively to the opposite ends of the high resistance plate, the low resistance plate conductors paralleling the high resistance plate in relatively close proximity thereto, insulated therefrom and presenting inner edges spaced from one another, means for conducting current to the adjacent inner edges of said low resistance plate to pass therethrough and through the high resistance plate so that the current flowing in the low resistance plates will at all times be in an opposite direction to the current in the high resistance plate whereby the magnetic field due to said currents will be substantially neutralized.

5. An electrically heated kettle comprising a comparatively high resistance interior body, a comparatively low resistance conductor in spaced enveloping relation to said body, insulated therefrom and making edge connection with said body, electrical connections with said conductor and body respectively by which an electric current may be directed to pass through said conductor and body in opposite directions, and means for supplying said current.

6. An electrically heated kettle comprising a comparatively high resistance interior body, a comparatively low resistance conductor in spaced enveloping relation to said body and insulated therefrom, said conductor being extended to form the top of the kettle with extension downwardly inside said kettle to make edge connection with said body along the top edge thereof below the top of the kettle, electrical connections with said conductor and body respectively by which an electric current may be directed to pass from the conductor through said body, and means for supplying said current.

7. An electrically heated kettle comprising a comparatively high resistance body, means whereby an electric current of relatively low tension may be directed to said body to pass therethrough for heating it from different determinate points below the top of the kettle, means for directing the current to any one of said points, and means for supplying the current.

8. An electrically heated kettle having a comparatively high resistance body, conductors extending around said body and making edge connection therewith around the body at different determinate points below the top of the kettle, means whereby an electric current of relatively low tension may be supplied to any one of the conductors and directed thereby to pass through said body for heating it, and means for supplying said current.

9. An electrically heated kettle having a comparatively high resistance interior body, a primary conductor of comparatively low resistance material enveloping said body in spaced relation thereto, insulated therefrom and making edge connection with said body, one or more secondary conductors extending around said body in electric contact therewith at different determinate points below the top edge of said body, means whereby an electric current of relatively low tension may be directed to pass from said primary conductor to any one of the secondary conductors, and means for supplying the current.

10. An electrically heated kettle having a comparatively high resistance body, a comparatively low resistance conductor surrounding said body in spaced relation thereto and insulated therefrom, said conductor making edge connection with said body, and means whereby an electric current of relatively low tension may be directed to pass through said conductor and body for heating said body, said last-named means comprising electric connections with said body and conductor respectively at the bottom of the kettle.

11. An electrically heated kettle having a comparatively high resistance body, a comparatively low resistance primary conductor surrounding said body, in spaced relation thereto and insulated therefrom, said conductor making edge connection with said body, means whereby an electric current of comparatively low tension may be directed to pass through said conductor and body for heating said body, said last-named means comprising electric connections with said body and conductor respectively at the bottom of the kettle, one or more secondary conductors extending around said body and making electric connection therewith at different determinate points below the top edge of said body, and means whereby an electric current may be directed from said primary conductor to pass to any determinate one of said secondary conductors.

12. An electric heating apparatus comprising a body of comparatively high resistance material, means whereby an electric current of low potential may be directed to said body to pass therethrough for heating it, a thermostatic device, and means associated with said device, automatically controlled thereby, whereby the current, continuously applied to said body, may be controlled in amount for maintaining said body at a determinate temperature.

13. An electric heating apparatus compris-

ing a body of comparatively high resistance material, a step-down transformer, connections of comparatively low resistance between the secondary of the transformer and said body, means whereby current may be supplied to the primary of the transformer, a thermostatic device, and means associated therewith, automatically controlled thereby, whereby the amount of current supplied to the body from the secondary of the transformer may be changed in amount for maintaining said body at a determinate degree of temperature by variation in the place of application of the current to the primary of the transformer.

14. An electrically heated apparatus comprising a body of comparatively high resistance material, means whereby an electric current of low potential may be directed to said body to pass therethrough for heating it, means whereby the current may be directed to pass through, for heating fractional parts of the body, and means whereby the amount of current supplied to the body may be varied in an amount substantially commensurate with the area to be heated.

15. An electrically heated apparatus comprising a body of comparatively high resistance material, a step-down transformer, means whereby the current from the secondary of the transformer may be directed to said body to pass therethrough for heating it, means whereby current from the secondary of the transformer may be directed to pass through, for heating fractional parts of the body, means whereby current may be supplied to the primary of the transformer, and means whereby current supplied to the primary of the transformer may be supplied thereto in a manner to effect in the secondary of the transformer a variation in the current supplied to said body relatively commensurate with the area of the body to be heated.

16. An electrically heated apparatus comprising a body of comparatively high resistance material, means whereby an electric current of low potential may be directed to said body to pass therethrough for heating it, means whereby the current may be directed to pass through, for heating fractional parts of the body, means whereby the amount of current supplied to the body may be varied in an amount substantially commensurate with the area to be heated, a thermostatic device common to said body or fractional part thereof to be heated, and means associated with said device, automatically controlled thereby, whereby the current, continuously applied to said body or fractional part thereof to be heated, may be controlled in amount for maintaining said body or heated fractional parts thereof at a determinate temperature.

17. An electrically heated apparatus comprising a body of comparatively high resistance material, a step-down transformer, means whereby current from the secondary of the transformer may be directed to said body to pass therethrough for heating it, means whereby current from the secondary of the transformer may be directed to pass through, for heating fractional parts of the body, means whereby current may be supplied to the primary of the transformer, means whereby current supplied to the primary of the transformer may be supplied thereto in a manner to effect in the secondary of the transformer a variation in the current supplied to said body relatively commensurate with the area of the body to be heated, a thermostatic device common to said body or fractional part thereof to be heated, and means associated therewith, automatically controlled thereby, whereby the amount of current supplied to the body or heated fractional parts thereof from the secondary of the transformer may be changed in amount for maintaining said body or heated fractional parts thereof at a determinate degree of temperature by variation in the place of application of the current to the primary of the transformer.

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