

Sept. 20, 1960

Filed July 1, 1957

W. D. KELLY
ENCLOSED RESISTANCE ELECTRIC HEATER
AND METHOD OF MAKING SUCH HEATER

2,953,670

4 Sheets-Sheet 1

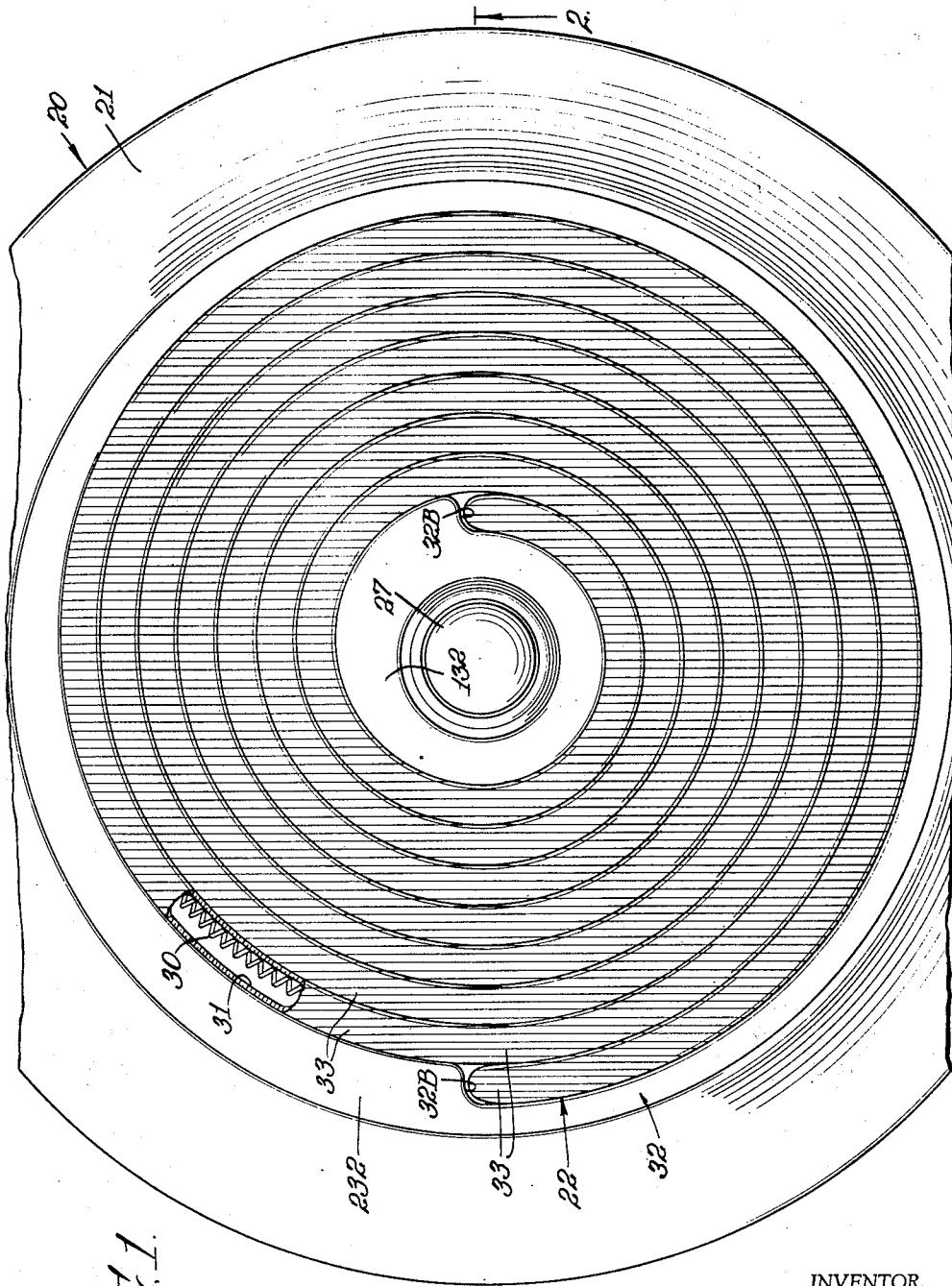


Fig. 1

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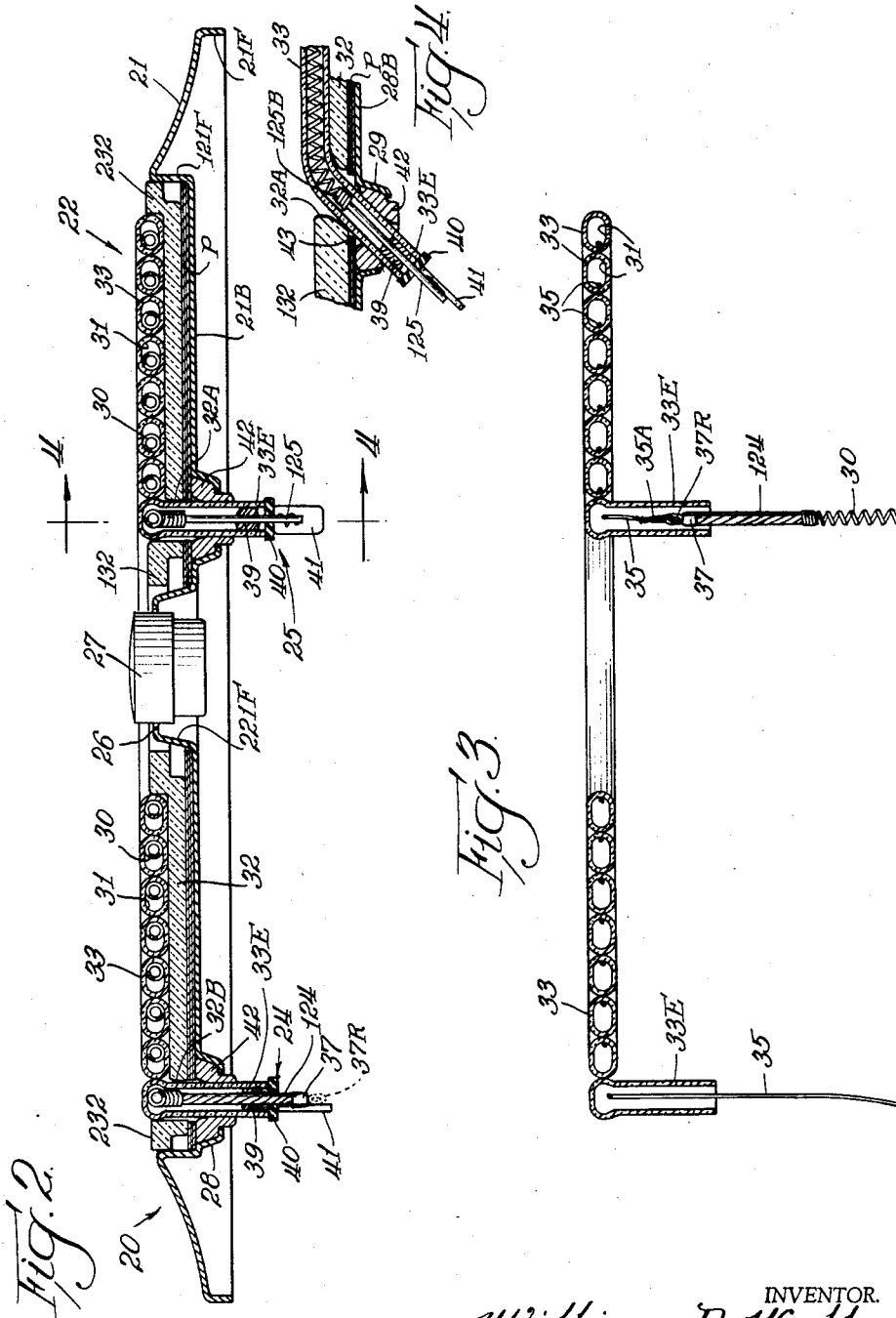
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4 Sheets-Sheet 2



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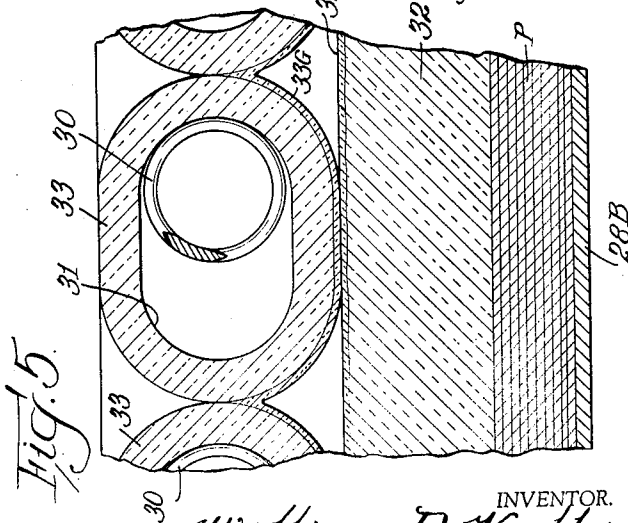
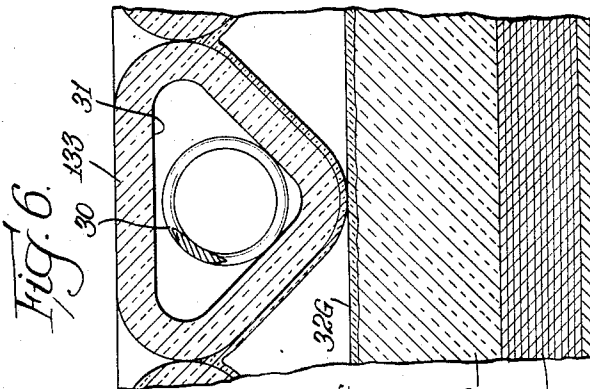
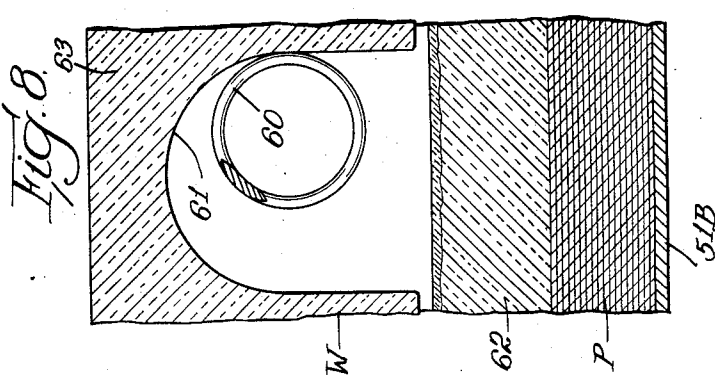
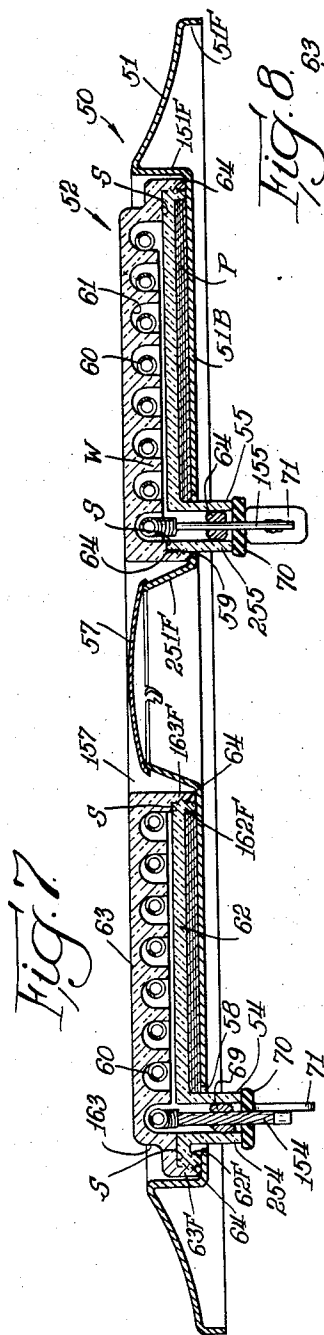
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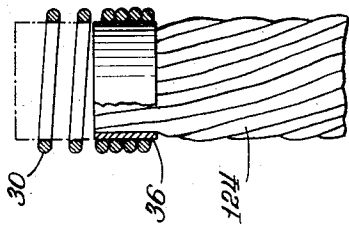


Fig. 10.

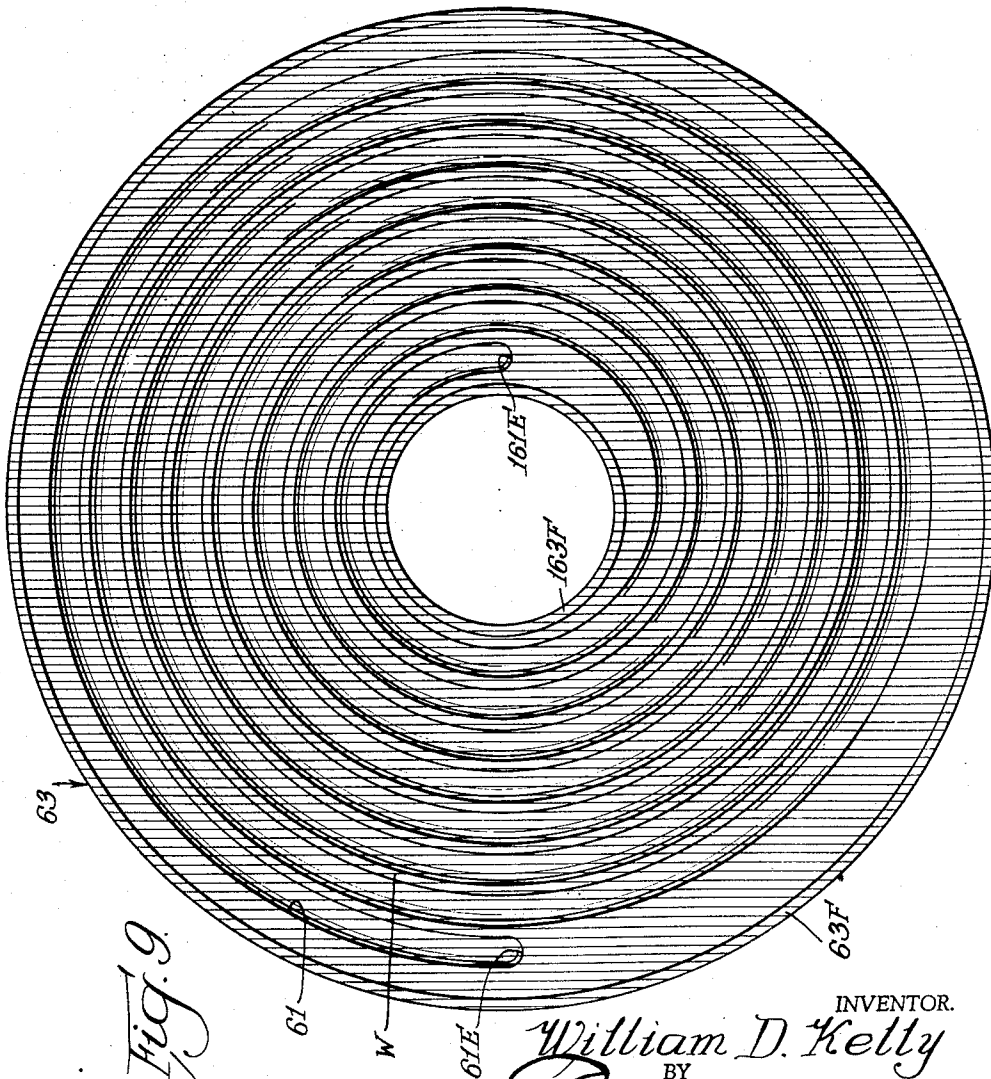


Fig. 9.

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ENCLOSED RESISTANCE ELECTRIC HEATER AND METHOD OF MAKING SUCH HEATER

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3 Claims. (Cl. 219—19)

This invention relates to electric heaters of enclosed resistance type, such as commonly employed for surface heating in electric ranges, wherein the heating resistance is enclosed in a body or container, usually of a spiral coil or plate form, which is adapted to support a pan or cooking utensil thereon, and has a spiral opening or other circuitous passage or passages therein to accommodate and maintain the heating resistance in a spiral or other circuitous form which will distribute the resistance heat throughout the area of the bottom of the pan or utensil supported on the spiral coil or plate, the invention having reference more particularly to a heater of the above mentioned circuitously arranged enclosed resistance type and method of making such heater, in which the body or container by and within which the resistance is enclosed and maintained in circuitous form, is a ceramic or ceramic-like material which is electrically non-conductive as well as heat transmissive so that it serves to safely insulate the resistance electrically and may be in contact with the resistor and is exposed directly to the heat thereof for efficient and rapid communication of heat there-through from the resistance to a pan or utensil on the top face thereof.

Because of the heating advantages of exposed heating resistances, and also lower cost thereof, heaters with exposed resistances, commonly referred to as open coil heaters, are usually preferred where they can be used safely, but because of possible shock and short circuit hazards they are not used extensively for general cooking purposes, although heaters with partially exposed resistances have been employed to some extent for some cooking operations.

In such heaters a pottery type block is usually employed having a circuitous groove in the top face in which the resistance coil is recessed and retained at such depth to avoid possibility of contact of the resistance with a pan or utensil placed on the top of the block, and the top of the resistance coil is thus exposed through the open top of the groove for heating the pan or utensil. A large portion of the heat generated by the resistance is, however, communicated to the block and transmitted therefrom to the pan or utensil thereon and as this block is usually relatively thick for adequate strength and to accommodate the resistance at a suitable depth therein, considerable time is required to heat the mass thereof before maximum heating of the pan or utensil is attained and because of this mass, heating is of rather prolonged duration after the resistance is de-energized.

Because open coil heaters are not practical for general cooking purposes as above mentioned, and even partially exposed resistance heaters also have disadvantages by reason of which they are not generally acceptable for the purpose, it has been customary to use for range surface heating and for similar purposes, heaters in which the resistance is completely enclosed, some of which are in the form of a tube containing the resistor and bent into flat spiral or other circuitous form and some of which are of plate type with the resistance spiral-

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ly or circuitously arranged underneath the plate, usually in grooves formed on the underside of the plate, in both of which types the resistance containing tube or the resistance covering plate is metal and the resistance coil or coils are embedded in a heat conductive electrical insulating material so that it is completely enclosed in the insulation and sufficiently separated thereby from the tube or plate to be safely insulated electrically therefrom.

In such heating units electrical insulating material of highly special character and exacting characteristics is required to insure adequate electrical insulation without objectionable mass, and to provide appropriate heat conductivity from the resistance to the metal sheath or plate, and difficult manufacturing problems are encountered in providing adequate electrical insulation with a minimum of mass of electrical insulation for desired cooking speed and even under the most favorable conditions there is a certain amount of undesirable heating up delay which cannot be avoided.

In accordance with this invention the need for such highly special electrical insulation is eliminated and the problems and disadvantages attendant upon the use thereof are avoided as a sheath or plate is employed, made from a material which is itself electrically non-conductive and a good heat conductor and capable of being molded or shaped readily in the required tubular sheath or heating plate form and thus the resistance or resistances may be merely installed in the tubular sheath or plate passages and in direct contact therewith so as to transmit heat directly thereto.

Sheaths or plates of glass or glass-like ceramics of high temperature type having the necessary strength and rigidity for the intended purpose and capable of being molded or shaped in the required form to accommodate the resistance or resistances in the desired circuitous configuration therein, may be employed and a transparent or translucent material is preferred which gives visual evidence of the rate or intensity of heating at which the resistance is operating, and especially one which efficiently transmits infra red rays.

The principal objects of the invention are to provide an improved electrical heater which is particularly adapted for range surface heating and for similar purposes; to minimize the heater mass; to insure more direct and efficient application of the generated heat to the ultimate pan, utensil or other object or material intended to be heated by the electric heater; to permit visible observation of the heated resistance; to facilitate construction of such heaters; and to provide a simple and convenient method for construction thereof, these and other objects being accomplished as pointed out more particularly hereinafter and as shown in the accompanying drawing in which:

Fig. 1 is a fragmentary plan view of an enclosed resistance electric heater made in accordance with the invention;

Fig. 2 is a vertical sectional view of the heater taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a vertical sectional view of a portion of the heater as it appears during the assembly process;

Fig. 4 is a fragmentary sectional view taken substantially along the line 4—4 of Fig. 2;

Fig. 5 is an enlarged fragmentary vertical sectional view illustrating a portion of Fig. 2 in greater detail;

Fig. 6 is a fragmentary vertical sectional view similar to Fig. 5 and illustrating a different cross sectional form for the means that enclose the heating element;

Fig. 7 is a vertical sectional view similar to Fig. 2, but illustrating an alternative embodiment of the invention;

Fig. 8 is an enlarged portion of Fig. 7;

Fig. 9 is a bottom plan view of the top plate of the structure shown in Figs. 7 and 8; and

Fig. 10 is a fragmentary cross sectional view illustrating the terminal connection at one end of the heater coil.

In the embodiment of the invention illustrated in Figs. 1 to 5 of the drawings the invention has been embodied in an enclosed resistance electric heater 20 adapted for use as a surface heating unit on the top of the usual electric cooking range, and the heater 20 has a frame in the form of an annular supporting ring 21 that actually rests on the stove top. It may, however, be otherwise supported.

The ring 21 has an enclosed electric heating unit 22 supported thereon with an intermediate heat insulating pad P and with terminal ends 24 and 25 extended downwardly therefrom in spaced relation. The heating unit 22, as herein shown, is intended for use on a cooking stove, but for other uses, the mounting means corresponding to the ring 21 may take other forms as required. As herein shown, the mounting ring 21 is annular in character and slopes downwardly and outwardly with a depending flange 21F at its outer edge, while at the inner edge of the ring 21 a downward flange 121F is provided and a bottom or supporting wall 21B spans the lower edge of the flange 121F to provide a horizontal cross wall or pan within which the heating unit 22 is disposed. At its center the cross wall 21B has an upwardly extended annular flange 221F that is open at its upper end, as at 26, to enable a heat-sensing control device 27 to be centrally mounted in an exposed relation in a known manner. Depressed mounting cups 28 and 29 are also formed at the bottom wall 21B to provide for downward extension of the terminal ends 24 and 25, as will be described, through the bottom wall 21B.

The heating unit 22 comprises a rigid body that is formed from a ceramic material that is, of course, an electrical insulator and which is relatively strong and has good heat conductivity, and the ceramic body is arranged to fully enclose an elongated electrical resistance that is herein shown as a heating coil 30 that extends loosely through a meandering or circuitous passage 31 formed in the ceramic body so that terminal wires 124 and 125 may extend downwardly at opposite ends of the passage so as to form parts of the terminal ends 24 and 25 of the heating unit.

The rigid transparent ceramic body serves, under the present invention, as a holder for the elongated electrical resistance so that the resistance is fully enclosed and electrically insulated in a distributive relation such that there is an even and efficient conduction of heat from the resistance to the upper face of the body where heat is to be dissipated or transferred.

As will become apparent from the following description, the resistance 30 engages the walls of the circuitous passage 31 so that the heat of the resistance is conveyed by conduction, as well as radiation, to the ceramic body and by transmission through the ceramic body to the upper heating face thereof and to the cooking vessel resting on the ceramic body.

In the form of the invention shown in Figs. 1 to 5, the rigid ceramic body of the heater rests on a separately formed ceramic base plate 32, and the rigid body that provides the circuitous passage 31 is made from a tubular member 33 formed from ceramic material and wound into a flat spiral having a plurality of consecutive turns so that adjacent turns of the passage 31 are in proximate collateral relation to each other and to the heat-delivery face or surface defined by the upper face of the flat coil. The flat coil has its ends turned downwardly and preferably sloped, as indicated at 33E in Figs. 2, 3, and 4, so that these ends may extend downwardly through the openings 32A and 32B in the plate 32 and then through the pad P and the cups 28 and 29 of the wall 21B to form part of the terminal ends 24 and 25.

The coiled tubular member 33 has the coils thereof arranged in edge to edge contact to prevent spilled food

from passing therebetween, and this may be accomplished by imparting a slightly flattened or oval form to the tubular member 33, as in Figs. 1 to 5, whereby the member 33 has a relatively great area of flat top surface for heat-transmitting contact with a cooking vessel to be heated.

In Fig. 6 of the drawings an alternative form of tubular member is illustrated at 133 where a tubular member of generally triangular cross sectional form is shown. One flat side of the triangularly formed tube is disposed as the flat top surface for heat-transmitting engagement with a cooking vessel.

The coiled tubular member 33 is recessed slightly into the top of the plate 32 by providing upward flanges 132 and 232 at the inner and outer edges of the plate 32, and these flanges vary in width so that the edges adjacent the coiled tubular member 33 conform with and engage the inner and outer coils, as illustrated particularly in Fig. 1 of the drawings.

After the coil 33 and the base plate 32 have been formed by the usual forming and shaping procedures applicable to the particular ceramic material that is being used, these two elements may have a coating of glaze material applied to the bottom surfaces of the coil, as at 33G in Fig. 5, and to the top surface of the plate 32 as at 32G.

The heating coil 30 is threaded into and through the slideway provided by the meandering or circuitous passage 31 after completion of the ceramic body, and in accomplishing this, a flexible member such as a wire or cord 35, Fig. 3, is first threaded through the passage 31 as shown in Fig. 3. One end of the flexible member 35 is then attached to the terminal wire 124 which is to serve as the leading end in the threading or drawing-in operation and to facilitate such use, the terminal wire 124 is made from stranded conductor as shown in Fig. 10 so as to be extremely flexible. One end of the strand 124 has a ferrule 36 thereon embraced by several coils of the heating element, and the ferrule is welded or brazed to the strand and to the embracing coils. At its other end, the strand 124 has a ringed ferrule 37 welded or brazed thereon and this ferrule has a projecting ring 37R thereon through which one of the ends of the flexible member 35 may be anchored as at 35A in Fig. 3.

The other terminal 125 may be a solid wire and has several of the end coils of the other end of the heater coil 30 surrounding one end and fixed thereto as by welding or brazing at 125B.

After the leading end of the terminal wire 124 has thus been attached to the cord or wire 35, the other end of the wire 35 is pulled so as to draw the heating coil 30 through the circuitous passage 31 and as this is done additional feeding or advancing forces may be manually applied to the coil 30 as it passes into the end 33E of the tubular member. In the threading operation the coil 30 is extended somewhat in the manner of a coil spring, the heater being originally wound with the adjacent coils tightly engaged, and hence when the drawing-in of the heater coil has been completed so that the terminal wires are located as shown in Fig. 4, the coil 30 will be extended as shown in Figs. 1 and 4, with adjoining coils separated from one another, and will be under endwise tension so that throughout its length it will be engaged firmly with the radially inward sides of the passage 31. The resistance 30 thus is not fixedly secured in the passage or channel 31 but is loose therein and capable of relative movement restrained solely by the end connections of the resistance and the tension of its frictional engagement with the passage or channel walls.

The terminal wires 124 and 125 are then anchored and sealed with respect to the ends 33E of the tubular member 33, and the sealing action is accomplished by a heat resistant material such as a silicone compound inserted into the ends 33E around the respective terminal wire. Washers 40 of silicone compound are also inserted on the terminal wires 124 and 125 and clamped against the outer

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extremity of the ends 33E to close the latter. These washers 40 are fastened in the clamping position by welding cross plates 41 of metal on the sides of the respective wires 124 and 125 to hold the washers in place and these plates serve as convenient means for separable connection of current supply conductors to the terminal wires 124 and 125. The ring 37R having served its purpose, is preferably removed before attachment of the respective plate 41.

The completed heating unit 22 may then be put in position on the ceramic plate 32, the insulating pad P and the pan or ring 21. In this operation, resilient silicone rubber plugs 42 are put in position in the cups 28 and 29 and the insulating pad P is put in place on the wall 21B with clearance openings 43 opposite such plugs 42. The ends 33E are then inserted through the openings 32A and 32B of the plate 32 and through the openings 43 and the plugs 42. This assembly is facilitated by the location of the two ends 33E so that they slope down in the same general plane. Also, it will be noted that the cups 28 and 29 are cut away on one side thereof, as shown at 29A in Fig. 4, so that clearance is provided for the ends 33E.

In Figs. 7, 8 and 9 of the drawing an alternative form of the invention is illustrated as embodied in a surface heating unit 50 that has a metal support ring 51 in which an enclosed electric resistance heater 52 is supported. The support ring 51 slopes downwardly and outwardly, and has an outer downwardly projecting flange 51F and an inner downwardly projecting flange 151F. A bottom wall 51B spans the lower edge of the flange 151F and at its center, the bottom wall 51B has an upward annular flange 251F which carries a closure cap 57. It is in the annular space between the inner and outer flanges 151F and 251F that the heater 52 is disposed, and the heater 52 has terminal portions 54 and 55 that project downwardly through appropriate openings 58 and 59 that are formed in the bottom wall 51B. The heater 52 rests in the pan that is provided by the wall 51B on an insulating pad P.

In the electric heater 52, an elongated electrical resistance that is herein shown as a coiled resistance heater 60 of the kind hereinbefore described in respect to Figs. 1 to 5 is loosely disposed within a circuitous passage 61 and has terminal wires 154 and 155, of the kind hereinbefore described, extend downwardly through the terminal ends 54 and 55, respectively, and this relationship will be described in further detail hereinafter.

In this embodiment of the invention, the meandering or circuitous passage 61 is formed in a rigid ceramic body which is initially formed as two separate parts or elements which are thereafter fused together to form the rigid body. Thus, the body of the heater comprises a bottom plate 62 and a top plate 63, and the top plate 63 has a flat upper surface and is circular in form with a central opening 157 formed therein which in the assembled heater embraces the upward central flange 251F of the ring 51 as shown in Fig. 7 of the drawings.

At its annular outer edge, the plate 63 is rabbeted downwardly at 163 and has an outer downwardly projecting flange 63F. At its inner edge, and as a continuation of the wall of the opening 157, the upper plate 63 has a downward annular flange 163F. In the lower surface of the upper plate 63, the circuitous passage 61 is formed, and as herein shown, the passage 61 is formed by a downwardly opening groove that is in the form of a flat spiral of a plurality of turns. The flat upper surface of the upper ceramic plate 63 thus constitutes the exposed heat delivery face of the ceramic body, and the adjacent turns of the spiral groove 61 are in proximate collateral relation to each other and to the heat delivery face so that even and widespread distributive communication of heat to such face is attained.

The other element of the rigid ceramic body is afforded by the plate 62 which is relatively thin and which has an outer downwardly projecting flange 62F and an inner

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downwardly projecting flange 162F, and these flanges are so sized as to diameter and vertical length that the plate 62 may be inserted upwardly into position where the flange 63F embraces the flange 62F, while the flange 163F is disposed inside of the flange 162F. When so positioned the plate 62 engages shoulders S formed adjacent the flanges of the upper plate 63 so that the upper surface of the plate 62 is spaced slightly from the division walls W that separate the adjacent turns of the groove or passage 61. Downward heat conduction from the walls W is thus presented.

The plate 62 also has downwardly projecting sleeves 254 and 255 formed thereon to afford the terminal ends 55 and 54 for the heater, and these sleeves are so located that when the two plates are assembled, the sleeves may be located opposite the ends 61E and 161E of the groove in the upper plate 63. The two plates 62 and 63, after assembly in such a relationship, are fused together as at 64 in Fig. 7.

When the plates 62 and 63 have been fused together, a unitary rigid body is provided, and the coiled resistance heating unit 60 may then be threaded through the slide-way provided by the passage 61. To enable this to be done, the leading terminal wire 154 has the flexible construction hereinbefore described in respect to the terminal wire 124, and a lead-in-cord is employed that is similar to the cord 35 hereinbefore described, but which is of greater diameter so that there will be no tendency of this cord to slip out of the circuitous passage 61 through the small space that is provided between the plates 62 and 63.

When the resistance unit 60 is in position within the circuitous groove 61, it is sealed about the terminal wires by inserted sealing material 69 and anchoring washers 70 are put in position about the terminal wires and against the ends of the tubes 254 and 255, and are held in position by soldering or welding cross plates 71 onto projecting ends of the terminal wires, as described in connection with the embodiment shown in Figs. 1 to 5.

The above heating units preferably have and are shown with the spiral tube and channel having more turns than generally used for heating units of comparable heating area and capacity, the increased number of turns being advantageous as it provides great length of tube and channel and a heating resistance of the same capacity may be stretched out to greater length to minimize the intensity of the heat thereof at any given portion of the length of the tube or channel without affecting the overall amount of heat thereof and thus the heat is distributed more evenly throughout the heating area. In some cases it may be desirable to stretch the resistance to approximately the required length before installation thereof in the heating unit.

From the foregoing description it will be apparent that the present invention provides an improved, fully enclosed resistance electric heater that is adapted for use as a range surface heat unit or for other purposes, and it will also be apparent that, under the present invention, the mass of the heater is minimized by loosely mounting the resistance within its insulating ceramic holder, and the heat of the resistance heater is transmitted efficiently by conduction directly to the holder and thence to the cooking utensils or the like that are supported on the heater.

It will also be apparent from the foregoing description that the present invention materially facilitates the construction of enclosed resistance-type electric heaters and that the production of such heaters is attained in such a way that efficient heat conduction takes place within the body of the heater and to the heat delivery face thereof.

While I have illustrated and described preferred embodiments and methods of my invention, it is to be understood that changes and modifications may be made therein without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A surface heating unit of the class described comprising a flat rigid one piece body of ceramic electrical insulating material having an exposed upwardly presented flat top face at one side thereof for direct reception of cooking receptacles thereon, the said body being formed with a long passage therein completely enclosed throughout its length within the ceramic body and distributively arranged circuitously underneath said flat top face at a substantially uniform distance therefrom, said body being formed at the bottom with tubular extensions which project downwardly therefrom and have respective openings therethrough which communicate with the passage and provide the sole means of access thereto, and an electrical heating resistance located within said long passage and extending lengthwise thereof in a relatively loose relation of slideability and having terminal conductors leading therefrom downwardly through the openings of said tubular extensions to the exterior of the body for connection of current supply conductors thereto for energization of the resistance, said body and resistance being exposed directly to one another and the resistance being held in place throughout its length solely by its engagement with the ceramic material of the body, said body being generally circular and the passage therein being of flat spiral form with a plurality of consecutive turns in proximate collateral relation to one another and the tubular extensions being at the inner and outer ends respectively of the spiral passage.

2. A surface heating unit of the class described comprising a flat rigid one piece body of ceramic electrical insulating material having an exposed upwardly presented flat top face at one side thereof for direct reception of cooking receptacles thereon, the said body being formed with a long passage therein completely enclosed throughout its length within the ceramic body and distributively arranged circuitously underneath said flat top face at a substantially uniform distance therefrom, said body being formed at the bottom with tubular extensions which project downwardly therefrom and have respective openings therethrough which communicate with the passage and provide the sole means of access thereto, and an electrical heating resistance located within said long passage and extending lengthwise thereof in a relatively loose relation of slideability and having terminal conductors leading therefrom downwardly through the openings of said tubular extensions to the exterior of the body for connection of current supply conductors thereto for energization of the resistance, said body and resistance being exposed directly to one another and the resistance being held in place throughout its length solely by its engagement with the ceramic material of the body, said body being a tube shaped in the form of a flat spiral with a plurality of consecutive turns in proximate col-

lateral relation to one another and the tubular extensions being end portions of the tube.

3. A surface heating unit of the class described comprising a flat rigid one piece body of ceramic electrical insulating material having an exposed upwardly presented flat top face at one side thereof for direct reception of cooking receptacles thereon, the said body being formed with a long passage therein completely enclosed throughout its length within the ceramic body and distributively arranged circuitously underneath said flat top face at a substantially uniform distance therefrom, said body being formed at the bottom with tubular extensions which project downwardly therefrom and have respective openings therethrough which communicate with the passage and provide the sole means of access thereto, and an electrical heating resistance located within said long passage and extending lengthwise thereof in a relatively loose relation of slideability and having terminal conductors leading therefrom downwardly through the openings of said tubular extensions to the exterior of the body for connection of current supply conductors thereto for energization of the resistance, said body and resistance being exposed directly to one another and the resistance being held in place throughout its length solely by its engagement with the ceramic material of the body, said body being a tube shaped in the form of a flat spiral with a plurality of consecutive turns in proximate collateral relation to one another and the tubular extensions being end portions of the tube and a plate of ceramic material is disposed underneath and supports the body and has openings through which the said end portions of the tube extend downwardly and the plate has an upwardly extending rim therearound by which the body is confined in supported position on the plate.

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