Sept. 20, 1960 W. D. KELLY 2,953,670

ENCLOSED RESISTANCE ELECTRIC HEATER
AND METHOD OF MAKING SUCH HEATER

Filed July 1, 1957 4 Sheets-Sheet 1

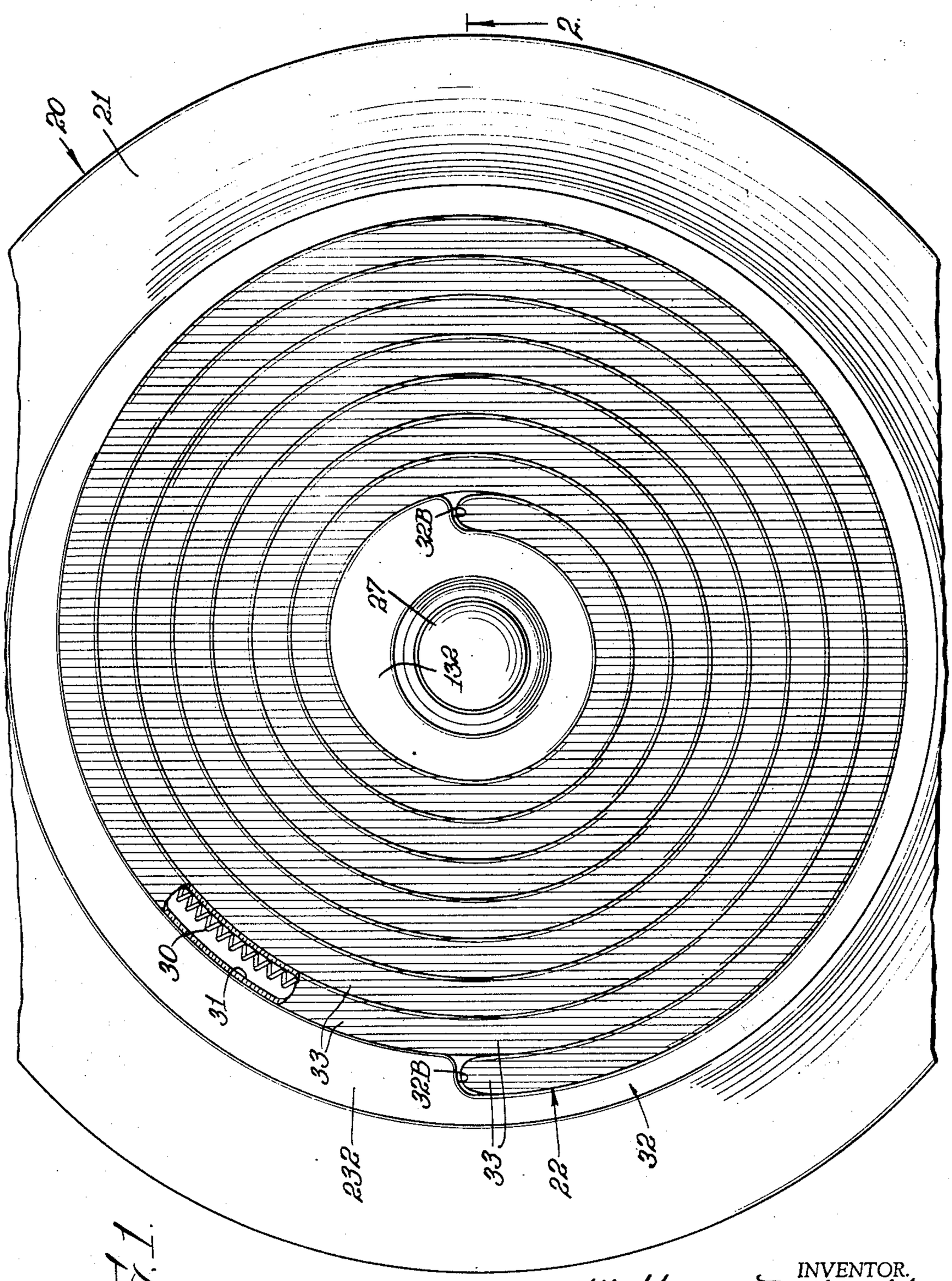

Fig. 1.

INVENTOR.
William D. Kelly
BY
Eugene M. Giles Atty.

Sept. 20, 1960 W. D. KELLY 2,953,670

ENCLOSED RESISTANCE ELECTRIC HEATER AND METHOD OF MAKING SUCH HEATER

Filed July 1, 1957 4 Sheets-Sheet 2

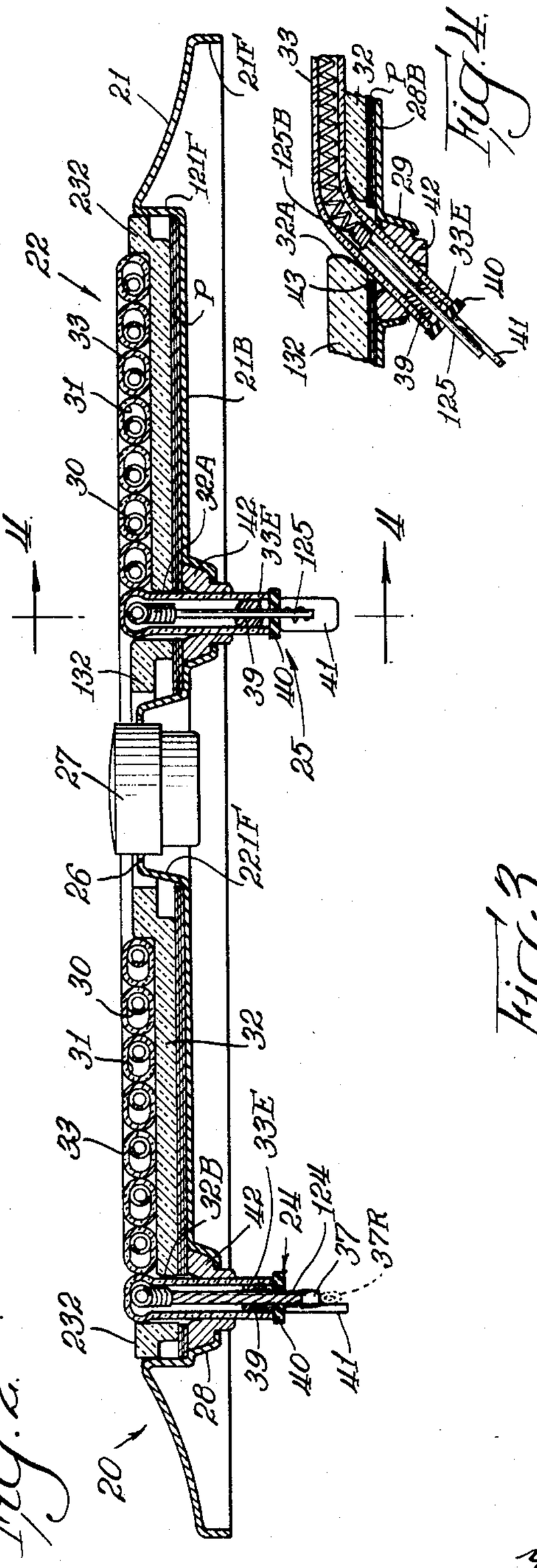

Fig. 2

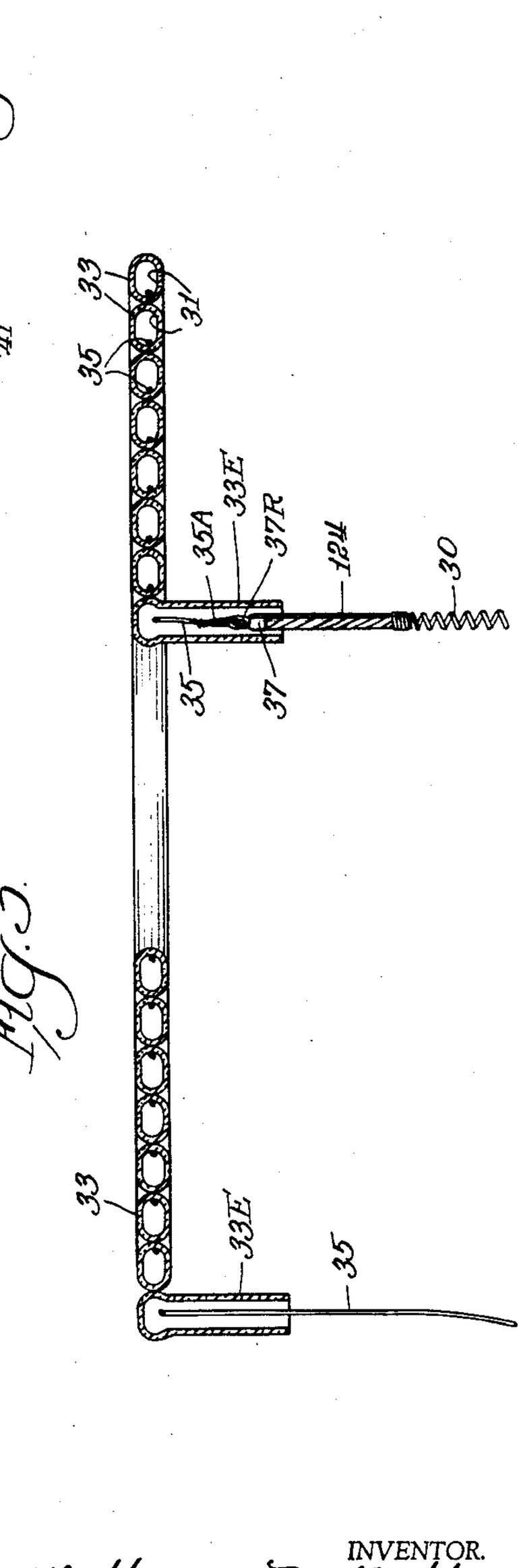

Fig. 4

Fig. 3

INVENTOR.
William D. Kelly
BY
Eugene M Giles Atty.

Sept. 20, 1960 W. D. KELLY 2,953,670

ENCLOSED RESISTANCE ELECTRIC HEATER
AND METHOD OF MAKING SUCH HEATER

Filed July 1, 1957 4 Sheets-Sheet 3

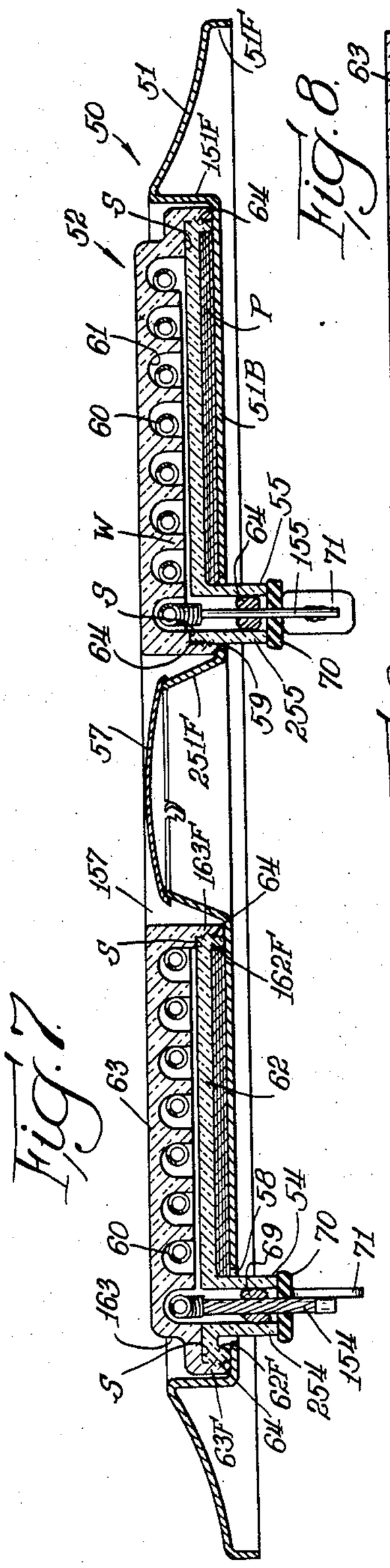

Fig. 7

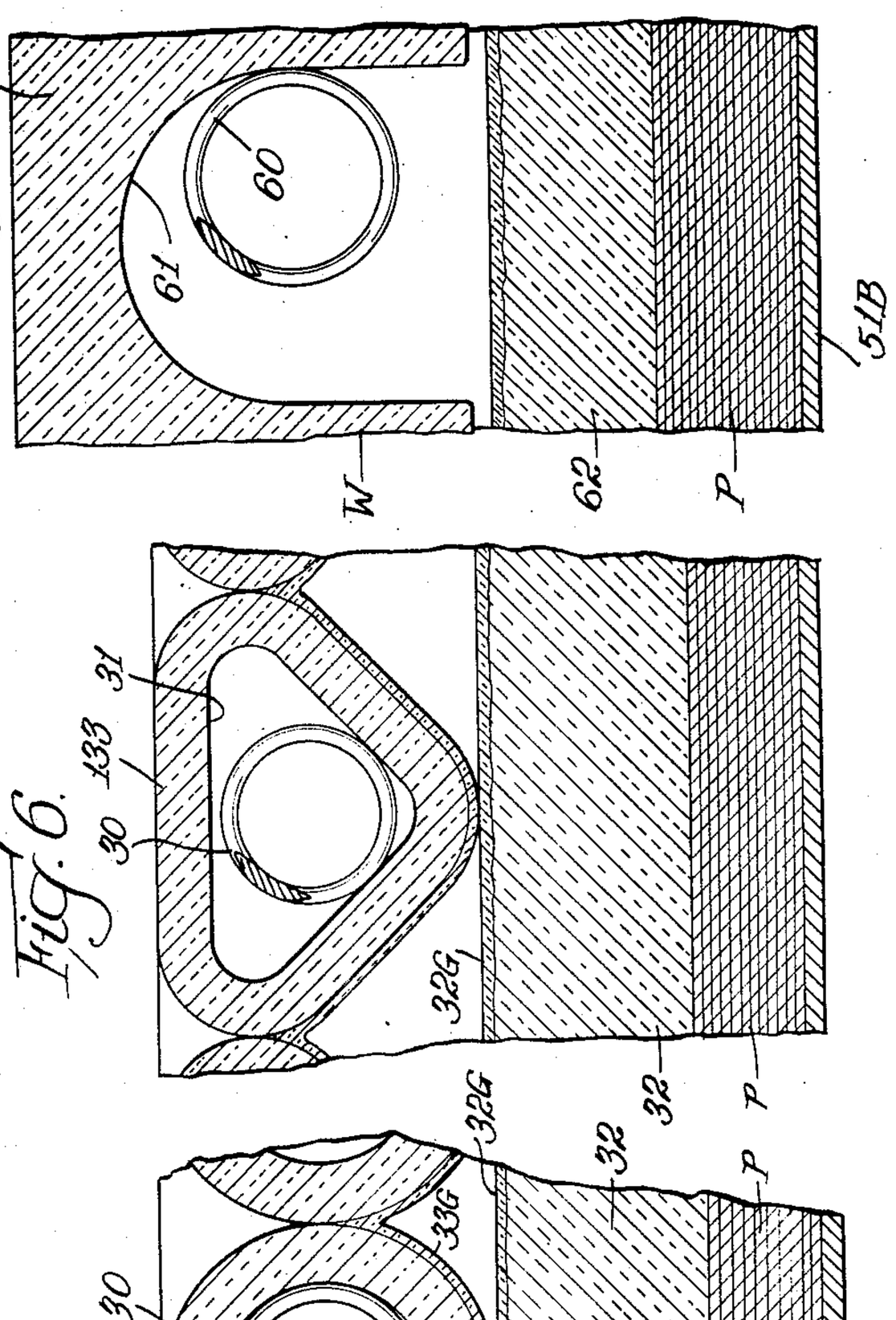

Fig. 8.

Fig. 6.

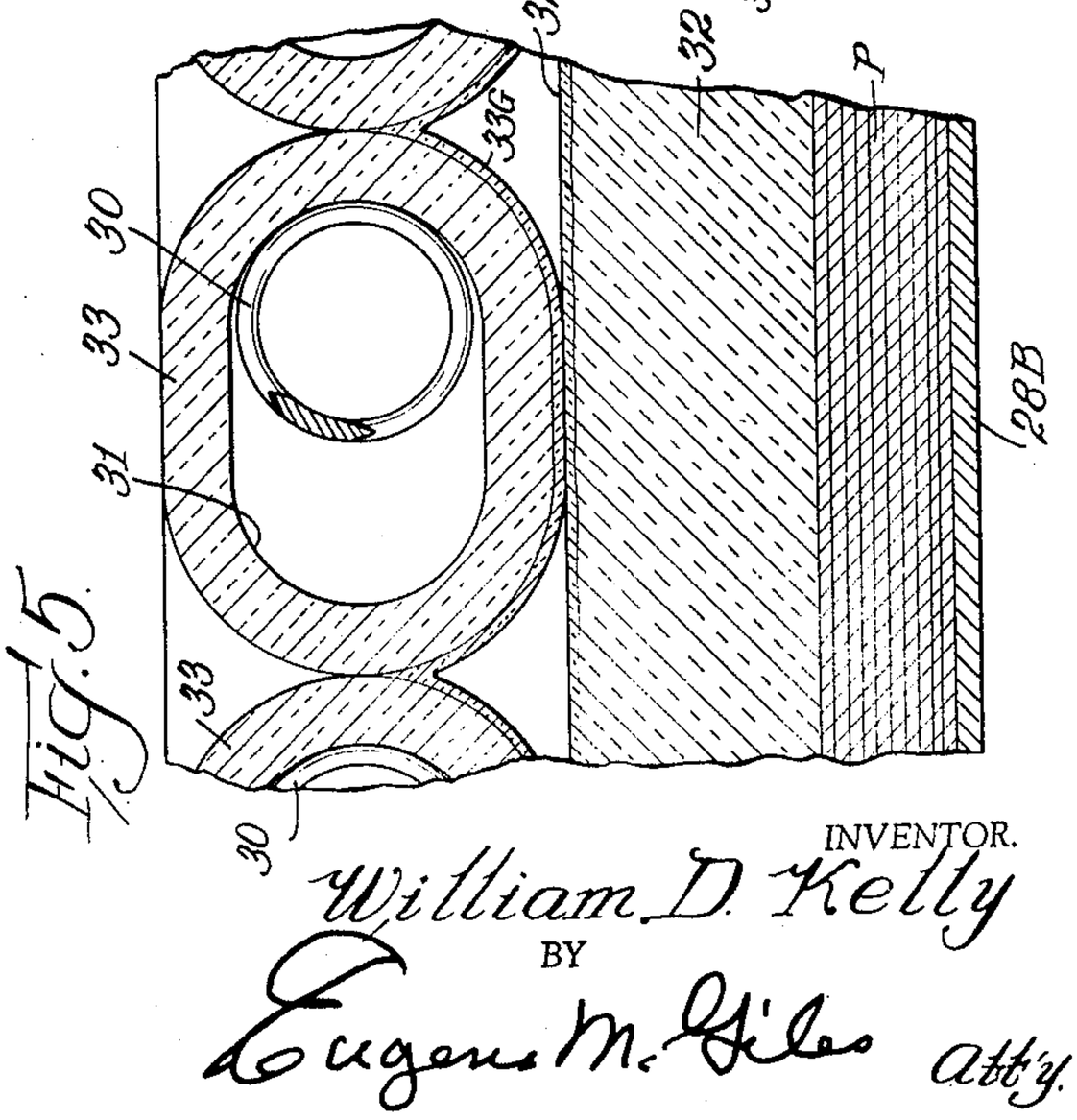

Fig. 5

INVENTOR.
William D. Kelly
BY
Eugene M. Giles atty.

Sept. 20, 1960 W. D. KELLY 2,953,670

ENCLOSED RESISTANCE ELECTRIC HEATER AND METHOD OF MAKING SUCH HEATER

Filed July 1, 1957 4 Sheets-Sheet 4

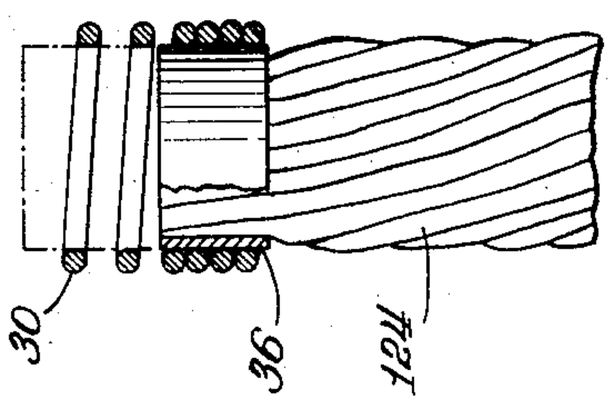

Fig. 10.

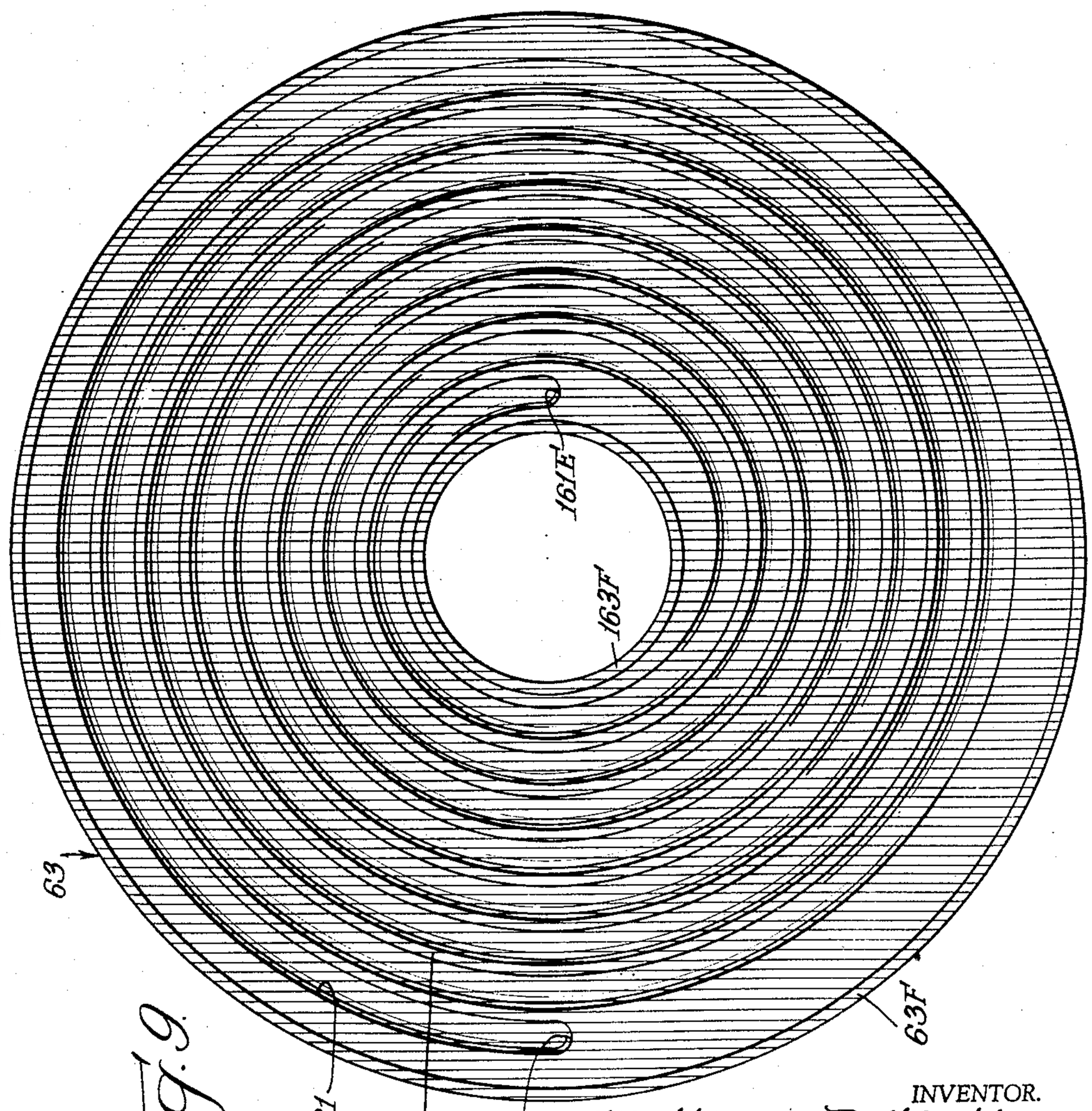

Fig. 9.

INVENTOR.
William D. Kelly
BY
Eugene M. Gelso Att'y.

United States Patent Office

2,953,670

Patented Sept. 20, 1960

2,953,670

ENCLOSED RESISTANCE ELECTRIC HEATER AND METHOD OF MAKING SUCH HEATER

William D. Kelly, Western Springs, Ill., assignor, by mesne assignments, to Ferro Corporation, Cleveland, Ohio, a corporation of Ohio

Filed July 1, 1957, Ser. No. 669,081

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 therethrough 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 spirally 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

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** 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

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 slideway 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 slideabilty 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 collateral 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.

References Cited in the file of this patent

UNITED STATES PATENTS

1,998,764	Jordan et al.	Apr. 23, 1935
2,026,797	Pierson	Jan. 7, 1936
2,042,203	Backer	May 26, 1936
2,179,934	Jones	Nov. 14, 1939
2,316,222	Butters	Apr. 13, 1943
2,652,622	Charbonneau	Sept. 22, 1953
2,790,885	Gomersall	Apr. 30, 1957
2,799,761	Tuttle	July 16, 1957
2,799,765	Jenkins et al.	July 16, 1957
2,803,054	Kohring	Aug. 20, 1957
2,813,962	Skala	Nov. 19, 1957

FOREIGN PATENTS

553,940	Germany	July 2, 1932
646,115	Germany	June 8, 1938