Feb. 11, 1941. J. WENTWORTH 2,231,236

HEATING MEANS

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Fig. 1.

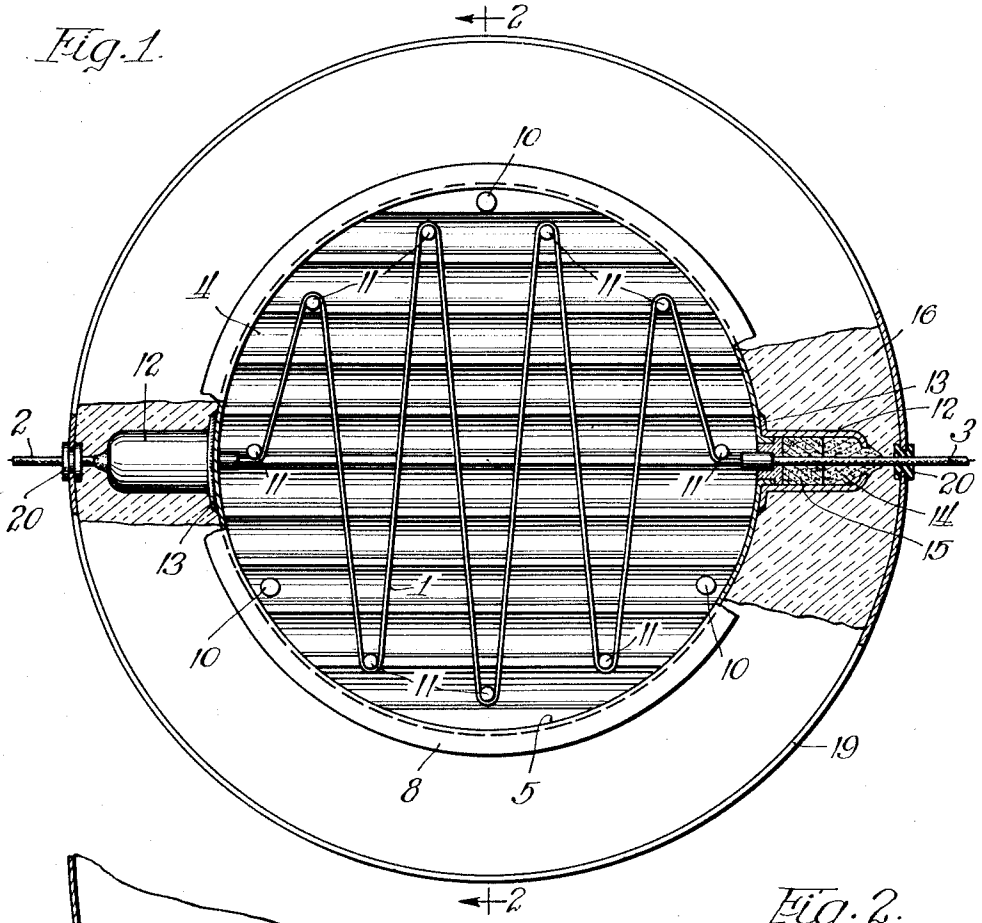
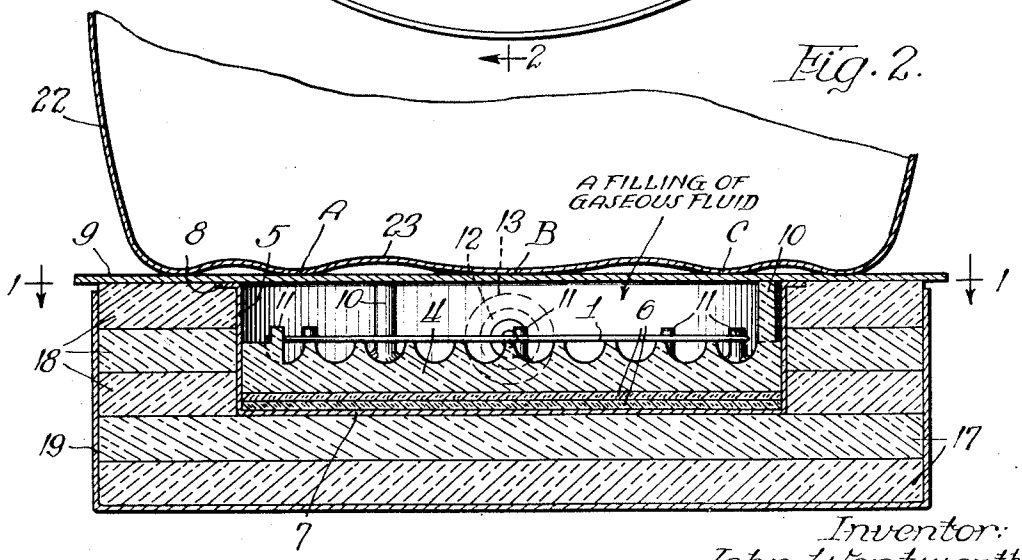


Fig. 2.



Inventor:
John Wentworth

By Brown Jackson Boettcher Dienner
Attys.

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UNITED STATES PATENT OFFICE

2,231,236

HEATING MEANS

John Wentworth, Chicago, Ill.

Application February 28, 1938, Serial No. 192,941

1 Claim. (Cl. 219—37)

My invention relates to electric heaters. The invention is peculiarly useful for the "burners" of electric cook stoves, but is not to be limited to that use nor to the specific embodiment which I have chosen for illustration.

The use of electricity for domestic cooking is well known. It has certain inherent advantages which render the idea attractive. In general, it is far safer than gaseous fuel. The heat may be applied more directly at the point of use; a relatively quick heat may be obtained, and the temperature may be under excellent control and regulation. It affords possibilities of cleanliness and freedom from contamination of the atmosphere either by leakage of fuel gas or by the products of combustion. In fact, it has many possible advantages. However, the use of the electric cooking range has not been widely accepted, chiefly because it is not economical.

I have made a study of the methods of applying electric heat in electric ranges and the like, and I have come to the conclusion that the chief reason for the uneconomical application of heat resides in the inefficiency of present burners. As at present constructed, such burners present a coil in the open air, which, even though placed close to the vessel to be heated, loses a great deal of heat by convection, radiation and conduction.

This coil cannot be heated to a high temperature because of the unavoidable oxidation of the metal of the coil by contact with the oxygen of the air, and even at lower temperatures a certain amount of scaling results. A relatively heavy wire is therefore required for the coil, and it is ill adapted for the purpose of giving off radiant heat, upon which action it mainly depends. It is known that a closely coiled conductor gives off substantially no more heat than would a solid rod of the same diameter as the coil. Hence, a large part of the surface of such a coil is ineffective. An exposed coil has no protection against injury or contamination from the outside, or to save it from oxidation. It is exposed to dirt, liquids which may be spilled on it, and the like.

The transfer of heat which it effects is mainly by radiation, but the coil is poorly adapted for this service, because of its shape, and because of the relatively low temperatures at which it must be operated and the lowering of its temperature by convection.

I propose, according to the present invention, to use a relatively fine wire for the heating element, with maximum surface exposure for radiation. Such a wire may be heated up to a very high temperature almost instantaneously. It is known that the transfer of heat by radiation is substantially in accordance with the fourth power of the difference in temperatures, or substantially the fourth power of the temperature of the high temperature body where the low temperature body is within the usual range of from zero to 100° C. Such a fine wire, exposed to the atmosphere and heated to a high degree of incandescence, would be easily injured by oxidation of the metal or by contact with foreign bodies, and I therefore enclose the same in a protecting shell or cell, which is made gas-tight. One wall of this cell is intended to be pervious to the travel of heat and the other walls are intended to be impervious thereto. While I might rely upon the reflection of radiant heat from the walls which are intended to be impervious, I find that, in practice, it is not possible to maintain a perfect reflector, and hence where a reflector only is utilized the building up of destructive temperatures cannot well be avoided.

I have conceived the utilization of a fixed body of a gaseous fluid to be contained within the cell to constitute a bath or surrounding medium for the high temperature wire. By lagging the walls which are intended to be impervious, and by the cooperation of the gaseous medium on the inside of the walls so lagged, a control of the temperature of such lagged walls, together with the direction of heat through the pervious wall, is attained. With the use of the gaseous body, a reflector or reflecting surfaces on the impervious walls is quite possible, since the reflecting surfaces cannot get appreciably hotter than the pervious wall.

The gaseous medium performs a unique function. First, it forms a protective bath for the hot wire, preventing oxidation and allowing the wire to be operated at a temperature much higher than it could be operated in the open air. Hence a much quicker heating up and a much greater delivery of the heat by radiation is possible. Second, this gas limits and substantially prevents the evaporization of metal from the incandescent surface of the wire. This prolongs the life of the burner by permitting high temperatures to be maintained over a greater period. Third, this body of gaseous fluid carries heat by convection from the wire or filament to the walls of the cell and particularly to the pervious wall or hot plate. Fourth, the gaseous medium, by convection, carries heat from the thermally impervious walls and delivers it to the thermally pervious wall or hot plate. In general, this gase-

ous medium, by convection, carries heat from any point of higher temperature to any point of lower temperature to which it has access.

The advantages of this construction are a surprisingly economical heater. The heater of my invention is not only economical in the use of electric energy, but it requires less time to heat up and deliver heat. Also, it can be operated at higher temperatures and at higher rates than previous burners. It reaches an operating temperature almost instantly and continues to deliver with minimum lag. It delivers the heat at the point of use, and supplies it only to the desired point of use. Waste of heat is therefore very low, enhancing the economical operation of the device.

The structure is simple, and of easy construction and low cost. The unit is capable of long life and may easily and cheaply be replaced. It may be operated at a temperature substantially as high as the well known incandescent lamp. In fact, my heater partakes of certain characteristics of the well known high intensity gas-filled lamp, but the object of my construction and mode of operation is to deliver heat through one specific wall only, and to deliver as much heat as possible. The production of light is not intended, and if the hot plate does throw a small amount of light, that is not intended for my purpose. In other words, the intent is to utilize the entire radiation from the filament as heat transmitted through the pervious wall or hot plate.

The burner of my invention will perform a given cooking operation more rapidly and with less current consumption than the best heater that I can find on the market.

According to the preferred form of my invention, the heat is developed by a resistance conductor such as a wire or open coil operated at high temperature within or in thermal contact with a body of gaseous fluid. This fluid is retained in a sealed chamber, one wall of which, preferably the top, is adapted to engage the vessel or other medium to be heated. The other walls of the sealed chamber are lagged or insulated heavily to prevent heat loss. In other words, one wall is pervious to heat flow and the other walls are not pervious to heat flow.

The heat is conveyed to the inside surfaces of the top wall or hot plate in two ways, first, by radiation of heat from the hot wire or coil, and second, by convection or circulation of the gaseous fluid. The gaseous fluid may be a gas or it may be a vapor, or both. Its function is unique in that it automatically carries heat from all points of higher temperature to all points of lower temperature. Thus it tends to carry the heat to the points which are cooled by loss of heat to the cooking vessel or other device to be heated.

The novel principle involved is the automatic transfer of heat from the generator of heat mainly to the point or points where cooling of the walls by a cooking vessel or other object to be heated is occurring. Thereby the heat is kept from building up a high temperature at places where no external escape for heat is provided, and is automatically delivered where the outlet for the same exists, i. e., the cooking vessel or the like. In other words, the use of this principle permits heat to be supplied in maximum quantity to the point or points of use and prevents heat being supplied at points where it cannot be used.

In case the gaseous medium is a vapor condensible by the cooking vessel to be heated or other thermal load, the heat of vaporization of the liquid is given up by contact with the hot plate and the transmission of heat to the cooking vessel or other thermal load is thereby accelerated. The heat carrying ability of the gaseous medium is thereby enhanced and the temperature of the hot plate will not be increased beyond the boiling point of the included body of fluid except with an increase in pressure of the vapor. The increase in pressure materially assists in the conduction of heat and hence the giving off of heat by the hot plate.

In the preferred form a fairly light gas is employed as the gaseous fluid, since it has been found that the conduction of heat by a gas of low molecular weight is much more rapid than that of a gas of greater molecular weight. It is also to be observed that in the preferred form of my device the resistance conductor is a small diameter wire, either not coiled or in a very open coil, for the reason that this enhances the area of contact between the gaseous medium and the hot conductor.

The ratio of radiant heat conveyed to the hot plate and the convection produced by the gaseous fluid should be such that within the range of the heating device the ability of the hot plate to give off heat at various points is substantially equalized. In explanation of this it may be noted that if the heat be delivered from the hot conductor to the plate solely by radiation, then the points where the greatest intensity of radiation occurs would have the higher temperature, but with the gaseous filling overheating at any particular point is prevented by the circulation or convection of the gaseous fluid. Also, if radiation were the sole means of transferring the heat, then the lagged or insulated parts would build up temperatures greatly in excess of the temperature of the hot plate.

In order to acquaint those skilled in the art with the manner of constructing and operating a device embodying my invention, I shall now describe, in connection with the accompanying drawing, a specific embodiment of the same.

In the drawing, which is largely diagrammatical for the sake of clearness—

Figure 1 is a section taken on the line 1—1 of Figure 2, showing the disposal of the terminals, the hot wire, and the supporting insulator of a heater embodying my invention; and

Figure 2 is a vertical cross-section taken on the line 2—2 of Figure 1.

The heater element proper comprises a resistance conductor 1 which may be of "Nichrome," "Chrome," tungsten, osmium, or like metals or alloys designed to withstand very high temperatures and presenting a fairly high resistance to the flow of current. This conductor, which is preferably a small diameter wire, is heated, preferably to a temperature greatly in excess of the temperature at which a coil in open air may be operated, by the passage of electric current therethrough. The terminals of the wire 1 are indicated at 2 and 3. Tungsten wire is preferable for this purpose, as it can withstand high temperatures with minimum damage or weakening. This conductor 1, in the form illustrated, is made preferably in the form of a flat, zig-zag winding, the wire being strung around posts or pins 11 which may be of insulation, or they may be integral with the body of the supporting insulator 4. They may be metallic pins or rods set into

the insulator 4 and supporting the wire at frequent intervals completely away from the surface of the insulator. The insulator 4 is preferably made of porcelain, lava, isolantite, or it may be made of any suitable inert heat-resisting material which is of low heat conducting ability and that can withstand high temperatures. The resistance conductor 1 and the insulator 4 are housed in a cup-shaped stamping preferably made of iron or iron alloy, such as stainless steel, silicon steel or the like, indicated at 5. Where the insulator 4 is made of a rigid material such as porcelain, several layers of a more or less fibrous insulation, such as asbestos sheets 6 may be disposed between the bottom wall 7 of the cup 5 and the bottom of the insulator 4. Preferably, but not necessarily, the surface of the insulator 4, when the wire rests thereupon, is grooved so as to give spaced support for the resistance conductor 1, but at the same time free access of the gas to the major part of the length of the conductor. The cup-shaped stamping 5 has a flange 8 thrown outward in a plane parallel to the bottom wall 7. A cover plate 9 is placed over the cup 5 and the flange 8 is welded to the plate 9 as by electric welding. This cover plate 9 forms the thermally permeable wall of the cell. It is preferably made of a metal such as stainless steel, "Silchrome," or other alloy which does not readily oxidize or scale when heated to a high temperature, i. e., substantially to incandescence. Suitable pins may be welded to the plate 9 on the bottom side thereof before the plate and cup are assembled, in order to insure the proper spacing of the central part of the plate from the resistance conductor. Any other suitable means for insuring this spacing may be employed. Projections 10 from the insulator 4 might be employed for this purpose.

The terminals of the conductor 1 are joined to the internal terminals 2 and 3 in any suitable manner for making a gas-tight seal preserving suitable insulation under the temperatures which are encountered.

I have shown a form of seal which employs a metallic nipple 12 flanged at its lower end 13 to be welded to the side wall of the cup 5. The margin of the hole formed in the cup 5 may be flanged outwardly to locate the nipple 12. A fusion insulating seal 14, preferably of a high melting point vitreous material, forms a gas-tight seal between the conductor of the external terminal and the nipple 12. Disposed inwardly from the fusion seal 14 is a packing or insulator 15 which serves as a means for preventing the transmission of heat to the fusion seal. This method of making the seal is optional. Any other suitable form of seal may be employed. The object is to have a gas-tight seal which is preserved against the high temperatures which prevail inside the cell. The nipple 12 is shown as being disposed within the body of insulation 16, but the nipple 12 may be extended out of the same and a ring-like external terminal joined to the conductor 3 may be disposed upon the projecting end of the nipple and thereby form a rigid terminal. The nipples 12—12 may extend outside the insulation and be provided on their exposed parts with fins or flanges, longitudinal or circumferential, to protect the seal 14 by dissipating the heat conducted along the walls of nipple 12 from the inside of the cell.

The body of insulation 16 herein shown consists of one or more circular discs of asbestos such as 17—17 shown in Figure 2, and one or more rings 18—18 surrounding the cup 5 and supporting the plate 9 suitably out of contact with the metallic binding which, in this case, is shown as a cup-shaped stamping 19. A mere circumferential binding of the sheet metal which holds the insulation in place may be employed. Such may consist of a flanged strip with the flange underlying the lowermost layer or disc 17 and the upper edge spaced vertically away from the plate 9 a suitable distance so that heat is not transmitted from the plate 9 to the walls of the binding 19. If desired, the metal sheath 19 may have an inwardly extending flange lying substantially in the plane of the plate 9 but out of contact with the same. In that case the plate 9 is of relatively less diameter so that it may be surrounded by such flange of the sheath 19. The particular method of insulating the cell may be varied. The object is to prevent the escape of heat from the cell in every direction except by way of the plate 9.

The conductors 2 and 3 are shown as being led through insulating grommets 20—20 but, as above pointed out, the manner of leading out these external terminals may be varied.

The operation of the device is as follows:

Assuming that the cell is provided with a filling of nitrogen gas and that a cooking vessel such as that indicated more or less diagrammatically at 22 is set upon the top plate 9, the top plate 9 extends beyond the margins of the cell to give a wider bearing surface than the surface which is heated. The effect of this is a central hot spot for heating the vessel 22 or any similar vessel which is placed upon the central part of the plate 9. Obviously, the ratio of central hot spot to unheated margin may be varied as desired.

I have shown the bottom wall 23 of the vessel 22 to be heated as being non-planar, that is, the bottom wall 23 bears upon the plate 9 only at localized spots such as indicated at A, B and C. While in the drawing this condition is shown as exaggerated, the fact is that in general the contact between a cooking vessel and the plate or burner surface is limited to spots or regions of considerably less extent than the complete surface of the bottom of the vessel. Under these circumstances it is apparent that conduction can be effected only at the points such as A, B and C, where contact between the bottom of the vessel and the hot plate occurs.

When the current is passed through the fine tungsten wire 1 the same becomes heated to a very high temperature. It gives off heat both by the radiant effect or principle and by contact with the gas filling. Radiation is more effective the hotter the wire, that is, the greater the difference between the radiating body and the receiving body. The transfer of heat by radiation is generally stated to be a function of the fourth power of the temperature of the hot body. However, if radiant heat alone were depended upon to convey the heat from the wire 1 to the vessel 22 through the wall 9, the points of contact such as A, B and C would receive radiant heat from the coil, but the radiant heat striking spots not cooled by the vessel 22 would be heated to a much higher temperature, but without particular utility in conveying heat to the vessel 22. That is to say, if the cell were to be heated by the radiant heat of the filament only, the lagged walls would heat up ahead of the plate 9 and would become very highly heated even though the plate 9 were relatively cold, because of loss of heat to its load, such as a cooking vessel. The temperature of the plate 9 should not much ex-

ceed the point where the central part of the plate 9 becomes red hot. That is, the plate may be heated to any temperature which it will stand without injury or serious deterioration. Heat radiation from a red hot surface is not very great, as radiation varies substantially as the fourth power of the difference in temperature between the radiating body and cold body. However, without the gas filling, the intermediate points not in contact with the vessel are rendered less effective. I do not intend to limit my invention to the use of a gaseous filling, since the structure I have disclosed is useful even if the cell be evacuated and radiation depended upon solely. In the preferred form of the invention, and in the embodiment of the principle which I have above discussed, the gaseous filling carries heat from the points of higher temperature to the points of lower temperature by convection. That is to say, assume that with the radiant heat projected from the wire 1 to the under surface of the central part of the plate 9, those points cooled by contact with the cooking vessel 22 are not able to receive heat except as they are reached by radiation. However, the gas filling, by convection, carries heat from the points where the temperature is higher, as, for example, those parts of the plate 9 which are not cooled by the vessel 22, and from the side walls of the cup 7 and from the insulator 4, and the heat so carried by the fluid is given up at the cold spots such as A, B and C, thereby maintaining a uniformity of temperature of the plate 10 and of the parts of the cell, and at the same time effecting a highly efficient transfer of heat through those spots which are cooled by the vessel 22. When the central part of the plate 9 is exposed, as in an oven, the whole surface gives off heat substantially evenly.

In turn, within the vessel 22, assuming that the same is filled with water or like liquid, convection carries the heat from the hot spots to the entire body of liquid in the vessel 22. Thus we have the situation of circulating or convecting fluid within the cell carrying heat to the point where contact or thermal connection is made between the cell and the vessel 22, and at these points the liquid in the vessel 22 receives the heat which is transmitted at these points and is distributed through the body of liquid in the vessel 22. This is only one specific instance, and is given by way of illustration only.

I have mentioned herein the use of nitrogen as a suitable gaseous filling. Other low molecular weight gases, such as helium, may be employed, or mixtures of gases which are relatively light and which are inert may also be employed. Rare gases, such as argon and the like, or mixtures of the same with nitrogen, may likewise be employed.

Instead of using a fixed gas, a vapor may be utilized and the choice of vapors may vary widely. Obviously, water vapor would convey the greatest latent heat of vaporization, but in order to produce the necessary gradient of temperature at the surface of the hot spot on the plate 9, a very considerable pressure would have to be carried in the cell. Pressure is not desirable, because of the tendency to distort the cell, and hence a medium liquid at normal temperatures and having a boiling point high enough to produce boiling of water in the cooking vessel at atmospheric pressure is desirable. The plate 9 should be capable of being heated to a temperature suitable for oven cooking, broiling, frying and the like. Hence a fixed gas is generally preferable.

A number of synthetic organic chemicals are available, for example, triethanolamine. The freezing point of this material is approximately 0° C. and the boiling point 277° C., at 150 mm. pressure. With the relatively high boiling point (277° C.) a suitable temperature differential or gradient is available to cause the travel of heat from the hot plate to the cooking vessel or other device to be heated.

It is to be observed that in the preferred form of my invention, wherein I use a tungsten wire resistor and a filling of nitrogen gas, the hot spot on the plate 9 comes up to temperature suitable for heating with surprising rapidity. Where a medium of greater heat content than the nitrogen gas is employed, the initial heating up period is extended but the transfer of heat thereafter is more advantageous.

The construction which I have shown, namely, a plate the central part of which is highly heated and the outer part of which is lagged with insulation, is highly desirable since the placing of a cooking vessel, even a small cooking vessel, over the burner results in the conduction of heat throughout substantially the entire heated surface without exposing the same for radiation or loss by convection.

I find by comparison of my burner with the best available burners on the market that I can bring a given body of water in a cooking vessel more quickly to the boiling temperature, with a lower current consumption and a lower wattage consumption, than has heretofore been accomplished in any device now available on the market. This is only one cooking operation selected by way of illustration. All other usual operations required of a stove burner are performed more quickly and economically with my burner than with burners now on the market.

The conductor 1 is exposed to maximum extent to free access of the gaseous medium so that very active circulation or convection can occur. This may be promoted by carrying the conductor upon wires or posts of small cross section and low heat conductivity, so that the incandescent wire is carried almost in contact with the plate 9 but still freely surrounded by the body of gas. While the burner is intended to be employed in a horizontal position and excellent results are obtained thereby, it is not necessary that the burner be so placed, for convection of the gaseous medium will still equalize the temperatures satisfactorily, regardless of the position of the burner. The grooved insulator is one method of giving support to the wire 1 while permitting free access to the surface of the wire for convection purposes. The walls of the cell which are intended to be impervious may be provided with reflecting surfaces in order to throw as much of the radiant heat as possible to the pervious wall.

The structure which I have disclosed is useful, even for an evacuated cell.

Where the bosses such as 12, 12 are allowed to extend beyond the confines of the insulation or lagging 16, they may bear the terminals for the device and the entire unit may be slipped in place by forcing the terminals into spring clips or the like which, due to the remoteness from the heated cell, are not overheated and do not lose their resiliency.

In my copending application for Electrical heating device, Serial No. 192,942, filed February 28, 1938, I have disclosed and claimed certain

structural improvements over the heating means of my instant application.

I do not intend to be limited to the details shown and described, but intend to cover the invention as broadly as is consistent with the prior art and within the scope and spirit of the appended claim.

I claim:

A gas-tight cell for an electric heater comprising, in combination, a conducting plate, an enclosing casing welded to the underside of said plate and leaving a peripheral margin of the plate extending therearound, a support of refractory material within said casing and heat insulated therefrom, and a heating element openly laid on and supported by said refractory support, the top surface of said refractory support being grooved, said heating element being supported on the ridges between the grooves thereby leaving said heating element substantially free and exposed.

JOHN WENTWORTH.