The invention relates to electric resistance heating elements for use more particularly in electric stoves for cooking purposes. Such elements in general utilize relatively high resistance resistors made of material such as a nickel chrome alloy which becomes ultimately red hot upon the passage therethrough of an electric current of suitable voltage and amperage, the resistors being suitably insulated and supported on frames or bases of the elements.

The most economical way to produce resistors for use in electric resistance heating elements for cooking stoves has been found to make helical coils of high resistance wire, one or more of which coils are arranged in a spiral, or in concentric rings, or paralleled back and forth, or otherwise positioned, so as to provide spaced turns or lengths of the coils relatively close to each other in order to provide the necessary concentration of heat in the cooking area of the element.

When the coils of elements are upwardly exposed, as in many usual electric cooking stoves, there is danger of short circuiting and burning out of the elements by accidental contact with the coils of utensils, such as forks, or by spilling solid food particles or liquids on the coils.

To overcome such dangers, the coils of certain elements for electric stoves have been entirely sheathed by embedding the coils in insulating material such as highly refractory cement of the nature of aluminum oxide, and sometimes by embedding the coils in magnesium oxide and enclosing such embedded coils in metallic tubes of steel or alloy steel, the tubes being sealed under pressure, thus subjecting the enclosed insulating material and resistors to pressure.

In other instances upper and lower sheath plates joining at their peripheries are used to enclose resistors embedded in insulating material.

Entirely sheathed coils are relatively high in cost and difficult to manufacture, and very frequently break down in use; that is, the insulating material is altered in its characteristics through contamination or influence of gas and vapor emitted from the coils, sheath, or both at certain temperatures, causing the insulating material to lose its di-electric strength, and to lower its voltage breakdown point.

In extreme cases a metallic film has been found on the insulating material and between the turns of the coils as a result of such chemical reaction or gassing and vaporizing of the enclosed members.

From the physical standpoint, in elements having resistor coils embedded in insulating material and entirely sheathed by metallic tubes or shells, the sheath, insulating material, and coils, each have a different co-efficient of thermal expansion, and there is set up in the element opposing strains in the several parts due to heating and cooling of the element in use, which strains frequently result in damage to the insulating material or coils requiring a replacement of the element.

From another standpoint the heat generated in a radiant electric resistance coil may be transmitted to a cooking utensil placed upon the element of which the coil is a part by the four different methods of heat transmission: namely, conduction, convection, radiation, and reflection.

In usual electric resistance heating elements having sheathed coils, one or more of the four modes of heat transmission are not utilized, but are utilized only to a limited degree, particularly convection, radiation, and reflection, with a consequent loss of a portion of the total heat generated.

From still another standpoint, electric resistance heating elements having sheathed coils do not give any visible evidence of the heat therein until some considerable period of time has elapsed after the switch of the element has been turned to pass current through the coils, so that the operator does not have any quick evidences that the element is functioning and heat is being emitted.

There is also danger of burns when the operator has forgotten that the current has been turned into the element and accidentally touches the hot element, or when more than one person is using the stove and one or more elements thereof may be turned on by one operator without the knowledge of one or more of the other operators, who may accidentally touch one of the hot elements.

The objects of the present invention include in general the provision of an improved electric resistance heating element particularly adapted for safe and efficient use in a cooking stove, having a simplified construction, and being economical to make.

More particular objects of the present invention include the provision of an improved electric resistance heating element in which are attained substantially all of the advantages of an element having totally sheathed resistor coils without being subject to the disadvantages of totally sheathed coils giving rise to a breakdown of the insulating and burning out or breaking of the coils, either as the result of the emission of gases or vapors, or expansion and contraction due to heating and cooling.
Further particular objects of the present invention include the provision of an improved electric resistance heating element having parts combined and operatively associated with each other so as to transmit the heat generated by the resistive element by all four methods of heat transmission: namely, conduction, convection, radiation, and reflection.

The foregoing and other objects are attained by the electric resistance heating elements, apparatus, parts, improvements, combination, and sub-combinations, which comprise the present invention, and the nature of which is set forth in the following general statement, and preferred embodiments of which, together with their mode of use are set forth in the following description, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

The nature of the improvements of the present invention may be described in general terms as including in an electric resistance heating element, a sheath plate, preferably made of either cast pressed metal, and having spaced apertures formed therein, which are preferably elongated.

In use, the upper surface of the sheath plate constitutes the cooking plane or area upon which the pan, kettle, or other utensil is placed for the purpose of cooking liquids or solids contained therein.

The improved element furthermore includes on the underside of the sheath plate an elongated resistor preferably made of a helical coil of high resistance wire such as nickel chrome alloy and which is located between the apertures.

Insulating means secure the resistor to the underside of the sheath plate, the sheath plate preferably having grooves on its underside in which the resistor is located and which are filled with an insulating ceramic material such as aluminum oxide which embeds and holds the upper portions of the turns of the preferably coil resistor, the lower portions of the turns of the resistor being exposed downwardly.

Reflecter means are spaced from the sheath plate and from the resistor at the underside or resistance side of the sheath plate, and the reflector means preferably include a member having a conical reflecting surface and preferably a central aperture formed in the member.

By way of example, several embodiments of the present improvements are illustrated in the accompanying drawings forming part hereof, in which:

Figure 1 is a top plan view of one form of electric resistance heating element embodying the present improvements, and including a cast metal sheath plate;

Fig. 2, an enlarged transverse sectional view thereof as on line 2—2, Fig. 1;

Fig. 3, a view thereof looking towards the underside of the sheath plate;

Fig. 4, a plan view similar to Fig. 1 of another electric resistance heating element embodying the present improvements and having a pressed mctal sheath plate;

Fig. 5, a transverse sectional view thereof as on line 5—5, Fig. 4;

Fig. 6, an enlarged fragmentary sectional view illustrating in detail the resistor coil of the element of Figs. 1 to 3 inclusive and the insulating material mounting the upper portions of the turns of the coil in one of the grooves of the sheath plate, the grooves having a flat bottom and flat sides; and

Fig. 7, a view similar to Fig. 6 illustrating a modified form of groove having a semi-circular cross-section.

Similar numerals refer to similar parts throughout the several views.

One embodiment of the present improvements is illustrated in Figs. 1, 2, 3, and 6 and consists of an electric resistance heating element indicated generally by 16 and including a metal sheath plate 11, which as shown is circular and has a flat top 12 with a cylindrical flange 13 extending downwardly from the outer periphery of the plate 11.

The plate 11 has formed therein a plurality of radially spaced elongated arcuate apertures 14 and a central circular aperture 15.

As shown, a cylindrical flange 16 extends downwardly from the plate 11 about the periphery of the central aperture 15, and also as shown there is provided a cylindrical flange 17 extending downwardly from the plate 11 radially spaced between the flanges 13 and the flange 16.

Between the apertures 14, the plate 11 has formed therein on its underside, a plurality of radially spaced elongated arcuate and downwardly opening grooves 18.

Elongated resistors 19, which as illustrated are helical coils of high resistance wire such as nickel chrome alloy, are located in the grooves 18, and the upper half portions of the turns of the coils 19 are embedded in insulating material 20 such as aluminum oxide which serves to secure the coils in the grooves 18 and to the underside of the plate 11. The lower half portions of the turns of the coils 19 are exposed and protrude from the embedding insulating material.

Reflector means indicated generally by 21 are located below the sheath plate 11 and spaced from the underside thereof and from the resistor coils 19.

As shown, the reflector means 21 is preferably a one-piece member 22 having a convex conical reflecting surface 23 formed on its inner surface opposite the coils 19.

The reflector member 22 also has formed thereina central aperture 24 and a side aperture 25.

The improved electric resistance heating element 10 as illustrated, and as best shown in Fig. 3 includes two separate resistor coils 19, one having terminals at 26 and 27, and the other having terminals at 28 and 29.

The terminals of the separate coils are connected in a usual manner by means not shown with conductors not shown of an electric power supply line, which may pass through the side aperture 25 of the reflector member 22.

The coil resistors 19 as shown are arranged between the apertures 14 on the underside of the sheath plate 11 in side-by-side circular grooves 18. The ends of some of the side by side grooves are connected with each other by elbows 30 so as to permit a desired continuous length of wire in each resistor coil 19.

In the electric resistance heating element 10, the downwardly opening grooves 18 have flat bottom faces 31 and flat side faces 32 and 33 as best shown in Fig. 6.

The sheath plate 11, with the apertures 14, the flanges 13, 16, and 17, and the grooves 18, are as illustrated in the form of a one piece casting indicated by 34, and which may be of metal, such as cast iron, or vitrified ceramic material.

In Fig. 7 is illustrated a modified sheath plate 75.
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111 having a modified groove 118 formed therein, which has a transverse, semi-circular cross-section, and side flanges retaining the insulation material.

5 Another embodiment of the present improvements is illustrated in Figs. 4 and 5 in the electric resistance heating element indicated generally by 210. The electric resistance heating element 210 is generally similar to the electric resistance heating element 10, but includes a one-piece punched and pressed member 234 including a circular sheath plate 211 having elongated arcuate apertures 214 formed therein, a central aperture 215 formed therein, and upwardly protruding downwardly opening troughs 218 formed therein.

The resistor coils 210 are located in the grooves of the troughs 218, and the upper half portions of the turns of the coils 210 are secured in the grooves of the troughs 218 and to the sheath plate 214 by insulating material 220 which may be aluminum oxide.

The reflector means 221 of the element 210 as shown is the same as the reflector means 21 for the element 10.

The mode of operation of the improved electric resistance heating element 10 comprising one embodiment of the present improvements, and of the electric resistance heating element 210 comprising another embodiment of the present improvements, is the same, and will be described for convenience by reference to the element 10.

Locating the resistor coils 19 between the apertures 14 on the underside of the sheath plate 11 is such that the flat top 12 of the sheath plate 11 constituting the heating plane or area of the element 10, presents upwardly only a supporting surface for a pan or kettle, and from the standpoint of preventing any accidental striking of the coils of the resistor 19 with a utensil, such as a fork, or any pouring of food or liquids thereon, the sheath plate 11 with only its upper metallic surface exposed, operates in substantially the same manner as if the coils 19 were entirely sheathed.

The exposure of the lower half portions of the turns of the coils of the conductors 18 serves to permit free escape of any gases or vapors which may be given off by the wire at certain temperatures, and thus does not result in any destruction thereby of the insulating material 28, resistor coil, or both, by chemical action or by physical strains.

From the standpoint of heat transmission in the improved electric resistance heating element 10, heat is transmitted to the heating plane 12 at the outer upper side or face of the sheath plate 11 by the four methods of heat transmission: namely, conduction, radiation, reflection, and convection.

Conduction is effected through the plate 11. Radiation is effected from the coils 19 which become luminous and give off visible light and also which give off invisible radiant heat rays extending in all directions from the coils 19.

The invisible radiant rays directed downwardly from the coils 19 are reflected by the reflector means 21 up through the apertures 14, and the reflector means 21 also reflect the light rays from the radiating coils 19 quickly through the apertures 14, thus giving quick evidence that the element is in operation.

The adjacent the coils 19 becomes hot, and convection through the reflector means aperture 24 and the apertures 14 and 16 of the plate 11 serves also to transmit heat from the coils 19 to the heating plane or area 12.

The improved electric resistance heating elements of the invention, several embodiments of which have been set forth in detail above by way of example, attain the objects of the invention as above set forth, whereby the heat from the resistors is transmitted to the heating plane or area at the outer surface of the sheath plates with a maximum efficiency, thereby resulting in a reduced cost of operation as compared with usual electric resistance heating elements.

We claim:

1. In electric resistance heating apparatus, a sheath plate having spaced apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection.

2. In electric resistance heating apparatus, a sheath plate having spaced elongated apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection.

3. In electric resistance heating apparatus, a metal sheath plate having spaced apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the metal sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the metal sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the metal sheath plate by conduction, convection, radiation, and reflection.

4. In electric resistance heating apparatus, a metal sheath plate having spaced elongated apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the metal sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the metal sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the metal sheath plate by conduction, convection, radiation, and reflection.

5. In electric resistance heating apparatus, a sheath plate having spaced apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the turns of the resistor coil to one side of the sheath plate, the resistor coil being located as between the apertures and having portions of its...
4 turns exposed, and reflector means spaced from the sheath plate and the resistor coil at the resistor coil side of the sheath plate, whereby heat from the resistor coil is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection.

6. In electric resistance heating apparatus, a sheath plate having spaced apertures formed therein, means forming elongated grooves between the apertures at one side of the sheath plate, an elongated electrical resistor adapted for having an electric current passed therethrough, the resistor being located in the groove, insulating means securing portions of the resistor to the groove, other portions of the resistor being exposed, and reflector means spaced from the sheath plate and the resistor at the grooved side of the sheath plate, whereby heat from the resistor is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection.

7. In electric resistance heating apparatus, a sheath plate having spaced apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection, the reflector means including a member having a conical reflector surface formed therein opposite the resistor.

9. In electric resistance heating apparatus, a sheath plate having spaced apertures formed therein, an elongated electrical resistor adapted for having an electric current passed therethrough, insulating means securing portions of the resistor to one side of the sheath plate, the resistor being located between the apertures and having elongated exposed portions, and reflector means spaced from the sheath plate and the resistor at the resistor side thereof, whereby heat from the resistor is transmitted to the plane of the other side of the sheath plate by conduction, convection, radiation, and reflection, the reflector means including a member having a reflection surface formed therein opposite the resistor, and the reflector member having an aperture formed therein.

10. In unitary electric resistance heating apparatus, a sheath plate having an aperture formed therein, an electrical resistor arranged about the aperture at one side of the sheath plate, insulating means embedding and securing portions of the resistor adjacent the sheath plate to the one side of the sheath plate, and reflector means spaced from the sheath plate at the side thereof having secured thereon the partially embedded resistor, whereby heat from the resistor is transmitted to a heating plane at the other side of the sheath plate by conduction, convection, radiation, and reflection.

ARLINGTON BENGEL
WILLIAM A. BRAUN.