

- [54] **METHOD OF MAKING ELECTRIC HEATING UNIT**
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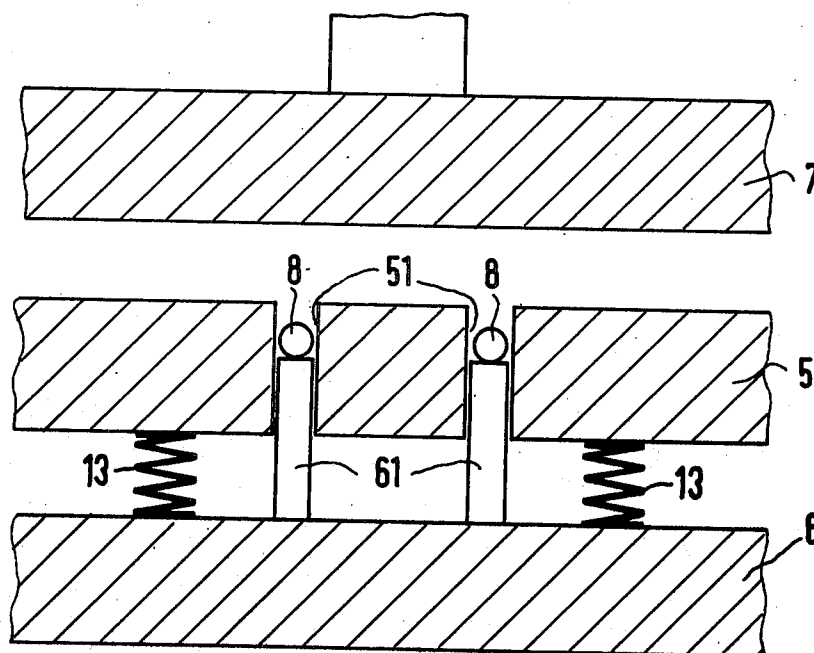
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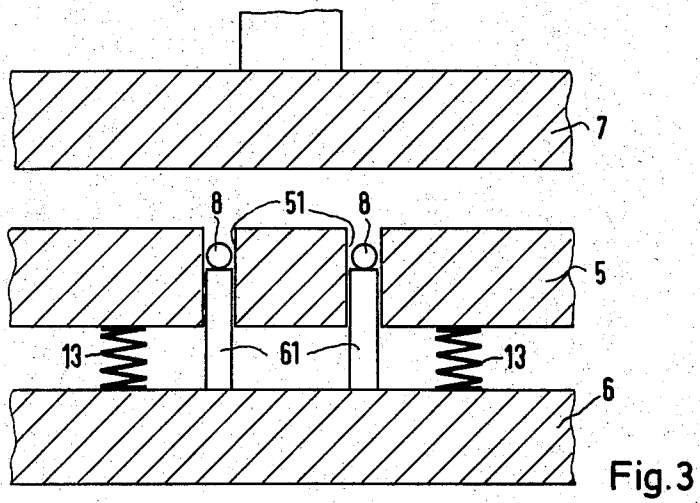
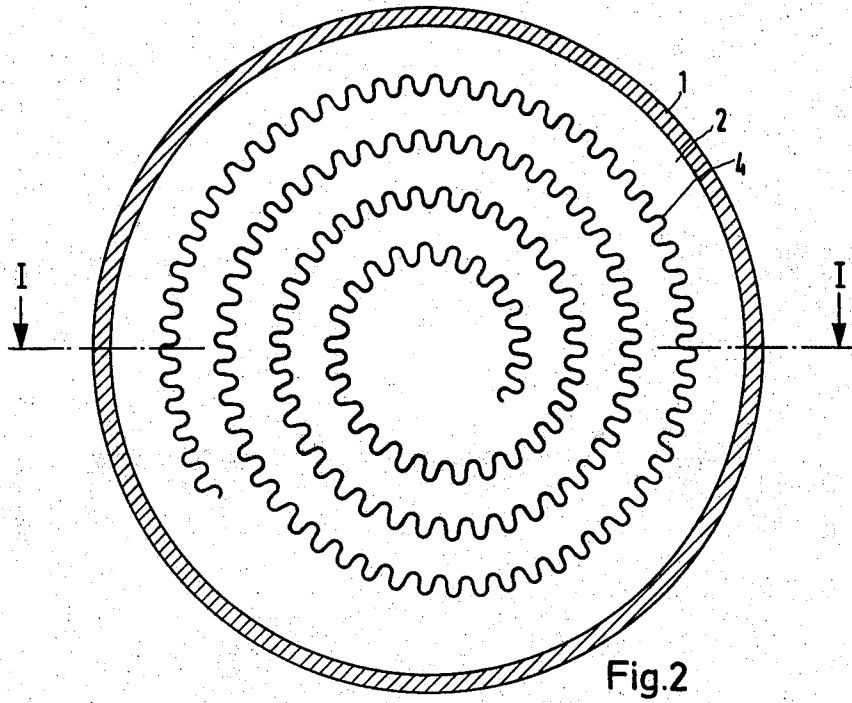
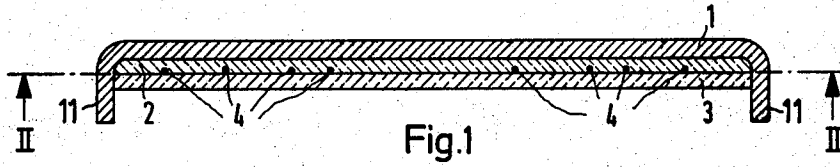
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[57] ABSTRACT

A heating unit for use in heating plates used for cooking, irons, and the like in which a conventional helical heater coil wire is pressed flat to provide a zig-zag, S shaped conductor and then embedded in an embedding compound in the heating unit. Pressing of the helical coils to provide the flat zig-zagging coil permits a more efficient heat transfer, since all of the heating coil will be in a plane parallel to and close to the surface being heated.

4 Claims, 3 Drawing Figures





METHOD OF MAKING ELECTRIC HEATING UNIT

BACKGROUND OF THE INVENTION

This invention relates to heating units such as those used in electric hot plates, electric irons and the like in general and, more particularly, to an improved heating unit and a method of making the same in which conventional helical coils are pressed flat to provide a heater which has better heat transfer characteristics.

The most conventional manner of forming heating units is to use a heater wire in the form of a wire helix, with the coils of the helix located in a plane essentially perpendicular to the plane of the heating surface of the heating unit. This type of construction lends itself to ease of manufacture but results in an unsatisfactory heat transfer. Since not all of the heater wire is equidistant from the surface to be heated most efficient heating is not obtained. This problem has been solved, at least to a small degree, in some prior art devices by installing heat conduction ribs and using a relatively thick embedding compound layer surrounding the heating coils. This solution is somewhat costly requiring excessive amounts of embedding compound which make warmup take longer and limit the response of the unit to control changes.

A much better heat transfer is obtained where the heating wire within the heating plate lies in a plane which is parallel to the heating surface of the unit. In such a case, the heating wire should meander or zig-zag through the embedding compound in which it is installed to obtain the maximum effective heating wire area. With the wire flat in the plane parallel to the heating plane, a maximum heat transfer will take place. Because the wire is flat the embedding compound may be thin and the above noted problems will not be present. However, prior art methods of constructing this type of heating unit have not been particularly efficient. In general, the heating conductors have been stamped out in the desired form from sheet stock consisting of appropriate resistance material. The processes used have considerable waste and are expensive to employ, thus resulting in a costly final product.

Thus, it can be seen that there is a need for providing a heating unit which has the low cost advantages of the conventional helical coil type unit, and also the good heat transfer characteristics of the type of unit which has the heating wires in a plane parallel to the heating surface. In some prior art devices, flat zig-zag or meandering wires have been placed into curved tracks. However, these particular installations did not completely achieve the desired result, since because of the heavy gauge of the heating wire used, the heater would bend out of the parallel plane, particularly in the regions of greatest path curvature.

SUMMARY OF THE INVENTION

The apparatus and method of the present invention, provide a solution to this problem allowing a heating unit to be constructed at a low cost, which unit has its heating wires lying in a plane parallel to the heating surface. The heating unit will comprise a support plate, e.g., the top of a heating plate or the bottom of an iron, in which a heating coil or conductor follows a zig-zag or S type path in an embedding compound, in which it is embedded. The embedding compound is placed on the side of the support plate opposite the heating sur-

face, the flat coil installed, and then covered with further embedding material. The coil which follows a zig-zag or S shaped path and lies in a plane parallel to the heating surface is formed by stretching a conventional circular helix coil to the desired length, placing it in a die which has the desired shape of the final heating element, and pressing it in that die, so that the helical curved portions are flattened out to form a flat zig-zag or S shaped coil path. Also described, is a method by which the flattened coil may be removed from the die by pressing it against an adhesive foil backing, and then transferred with the adhesive foil to a partially set embedding compound which has been placed on one side of the support plate and allowed to dry therein, after which the adhesive backing can be removed and a further layer of embedding compound placed over the coil to provide heat insulation.

Through this method, for the first time it is possible to manufacture a heating unit which has meandering heating wires which lie flat in a plane parallel to the heating surface of the heating plate.

The heating unit made according to the present invention will have a low heat capacity which will result in a very short heating up time and improved control properties. As compared to conventional cast plates with internally arranged ribs, the amount of reduction in material is substantial, thus allowing a significant reduction in cost.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional elevation view of a heating unit constructed according to the present invention.

FIG. 2 is a cross-sectional plan view of the same heating unit as shown on FIG. 1.

FIG. 3 is a cross-sectional view of a press apparatus which may be used to flatten the heating conductor used in the embodiment of FIGS. 1 and 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The heating unit constructed according to the present invention is illustrated by FIGS. 1 and 2. The unit comprises a support plate 1 with sloping sides 11, a first layer of embedding compound 2 in which are embedded the conductors 4, and an additional layer of heat insulating embedding compound 3. The support plate 1 may be stamped out of sheet steel or alternately may comprise another metal, ceramic glass material or the like. The layers of embedding compound, the composition of which will be described below, will have thicknesses in the range of 1 to 3 millimeters. The coils 4 are placed into the embedding compound layer 2 so as to be just completely immersed therein in a manner to be described below. As shown on FIG. 2, the conductor 4 is arranged in a spiral path while at the same time zig-zagging to cover more area. It should be noted that this is only used as an example and other arrangements are possible. This arrangement would be particularly suited when the unit forms a cook hot plate. If the unit were to be used in an iron, the path might be more oval shaped.

FIG. 3 is a cross-sectional view of a press apparatus which may be used for forming the conductor 4 into the flat spiral shape shown on FIGS. 1 and 2. The press apparatus comprises a base 6, a die mold 5, which is resiliently supported on base 6 by springs 13, and a press 7 which may be moved down upon the die plate 5 to

compress it against the force of the springs 13. The die plate 5 will have grooves or channels 51 formed therein corresponding to the shape of the heating conductor to be formed, e.g., the spiral shape shown on FIG. 2. The base plate 6 will contain corresponding projections 61 which fit into the grooves 51 and are capable of moving therein. A conventional helical heating conductor 8 is stretched and placed within the grooves 51, whereupon the press 7 is lowered compressing and flattening the conductor against the projections 61.

The heating coil of resistance wire in helical form is chosen with a coil diameter and pitch for the turns such that the coils will not flip over when pressed flat by the plate 7. Good results may be obtained where the pitch and the coil diameter are each five times the wire diameter. In operating the apparatus of FIG. 2, the coils of wire 8 are placed in the die 5, and the press 7 brought down flattening the coils into the shape shown on FIGS. 1 and 2. At this point, an adhesive foil backing which for the shape shown on FIG. 2 would be circular and large enough to cover all of the coils 4 shown on FIG. 2, may be placed on top of the die 5 and the base plate 6 brought up to push the flattened conductor against the adhesive foil causing the conductor to stick thereto.

The plate 1 is prepared by sand blasting or another means of roughening and then neutralized against acid by a method such as oxidizing or phosphatizing. The embedding compound will normally consist mainly of magnesium oxide and a phosphoric acid binder. A particularly good mixture is 2 parts of MgO and one part of SiO₂ and a solution of 1 part of Al [H₂P₀4]₃ and three parts of water. The compound is applied to the inside of the plate 1 with a thickness of about 1.5 millimeters. As soon as the compound has set to the point where it has become tacky, the heating conductor, which is now stuck to the adhesive backing, may be placed on top of the compound and pressed into it so that it is flush with the edge of the layer 2 as shown on FIG. 1. The unit may then be heated to between 40° and 80°C to cause the compound to completely solidify, after which the adhesive backing will be stripped off. The protective layer 3 of the embedding compound may then be applied and the finished unit fired at 600° C to accomplish final drying and setting. The layer 3 provides electrical and heat insulation to the conductors 4. The layer of embedding compound 3 can be composed of a mixture of 90 parts by weight of quartz sand and 10 parts by weight of talc mixed with a phosphoric-acid binder such as that described above. There can also be added to this mixture 10 to 30 parts by weight of magnesium oxide in order to make the setting of the compound occur more quickly at room temperature.

As an alternative, the layer 2, after the heating conductors are inserted therein, can have applied to it either by spraying, brushing or otherwise a protective sealing layer comprising a mixture of talc and alkali silicate or talc and colloidal silicon dioxide. Such a layer need only be 0.05 millimeters thick. This will form a protective coating which will prevent moisture from entering into the heating unit even at operating temperatures of 800°C. The sealing layer has extremely good mechanical stability at the high operating temperatures of the unit and will not affect the conducting properties of the embedding compound. Good results are obtained with a mixture of 1 part by weight of talc and 10 parts by weight of silicon dioxide. Even if the layer 3 is

used, it is preferable to coat it with the above described protective layer to obtain the moisture proofing described above.

Test results have shown that this method will result in excellent adhesion of the embedding compounds to the plate 1 where the embedding compound layers are 1 to 4 millimeters thick. Tests have indicated good results using base plates made of ceramic glass materials, sheet steel, cast iron, stainless steel or enamelled materials. With each of the materials, good adhesion was maintained throughout all temperature cycling tests.

If the heating plate 1 is constructed of an electrically conductive material, there arises the additional problem of preventing contact between the plate 1 and the conductor 4. To solve this problem and assure good electrical insulation, the layer of embedding material can be made thick enough to maintain a spacing which will avoid any breakdown problems. Another solution is to apply the embedding compound to a very thin axillary plate, e.g., a few tenths of a millimeter thick, made of an electrical insulating, heat resistant material, for example, mica. In this case, the embedding compound need only be applied to the axillary plate with a thickness which corresponds to the diameter of the wire, thus making it a very thin layer. After being pressed into the layer of embedding compound, it will then rest almost directly against the axillary plate of insulating material. Thus, an improved heating unit useful in hot plates for cooking, irons, and the like which provides better performance at a lower cost, has been shown. Although a specific embodiment has been illustrated and described, it will be obvious to those skilled in the art, that various modifications may be made without departing from the spirit of the invention which is intended to be limited solely by the appended claims.

What is claimed is:

1. A method for manufacturing a heating conductor for use in a heating unit of the type wherein the conductor lies parallel to the heating surface immersed in an embedding compound applied to the other side of the plate which forms the heating surface comprising:

- a. placing a length of helical conductor wire into a die shaped to provide the final path shape desired in the heating conductor;
- b. pressing said helical wire in said die to flatten it thereby forming a zig-zag, S shaped heating conductor, the pitch and diameter of the coils of said helical conductor wire being selected so that the turns do not flip over when pressed flat.

2. The invention according to claim 1, and further including the step of removing the pressed conductor from the die by pressing it against an adhesive foil strip and then removing the strip to which the conductor is attached.

3. The invention according to claim 2 and further including the step of pressing said heating conductor along with the adhesive strip to which it is attached into a first layer of embedding compound, which has been applied to the other side of the heating plate of the heating unit, in such a manner as to cause the heating wire to be just completely immersed in the embedding compound, and, after said embedding compound has set, stripping off said adhesive backing.

4. The invention according to claim 3 and further including the step of applying a further insulating layer of embedding compound over said first layer and said heating conductors therein after said adhesive strip is removed.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,798,759 Dated March 26, 1974

Inventor(s) Hermann Gerds

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Foreign Application Priority Data change the file number of the German application upon which the claim for priority is based from "2207343" to --P 22 07 343.4--

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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