

A SANDWICH STRUCTURE HEATING UNIT AND AN ELECTRICAL
HOUSEHOLD APPLIANCE OF THE STEAM IRON TYPE INCLUDING SUCH
A UNIT

The present invention relates to the general
5 technical field of flat heating structures of the
sandwich type, intended to perform at least two different
thermal functions.

The present invention relates to a sandwich-type
heating structure, bounded externally by two parts of a
10 certain stiffness, at least one of which is a heating
plate intended for diffusing the heat produced by a
resistive element which extends between the two parts.
Such a structure is therefore capable of providing a
different amount of heat from each element in the case
15 where two heating plates are used, so as to provide
distinct thermal functions such as heating, vaporization
or simply heat dissipation.

The present invention is particularly, but not
exclusively, applicable to electrical household
20 appliances, and preferably to such appliances which are
likely to be used in moist surroundings or which may be
in contact with moisture, such as irons in general,
whether of the steam or of the dry type (used with a
damping cloth), or deep fryers or any kind of grilling
25 appliance.

In the above-mentioned preferred applications, the
heating structure is advantageously integrated into an
iron of the steam or of the dry type, and the present
invention also directly relates to an iron provided with
30 such a heating structure.

In the specific technical field of irons, it is
already known, as described in Patent No: GB-A-1085784,
to make a soleplate for an iron, the soleplate comprising
a metal sheet which diffuses the heat produced by a
35 resistive element and which makes contact with the
textile article to be ironed. The resistive element is
electrically insulated using a polymerized plastics

material of the silicon-containing resin, epoxy resin or polyamide type, consisting of a bottom insulating covering layer and a top insulating covering layer. The assembly of the resistive element and these two layers of electrical insulation is glued to the metal sheet via an adhesive layer. In the case where the iron has a high working temperature which may adversely affect the strength of the initial layers of electrical insulation, there is also provision to employ two additional protective layers which may for example consist of mica or micanite sheets. Such a design of soleplate may be regarded as conventional in the prior art and suffers from a series of drawbacks.

Firstly, it has already been noted that the strength of the adhesive layer is insufficient at temperature and that the resistive element may become partially or totally unglued after a period of use which is relatively short in relation to the overall expected lifetime of the other parts of the iron.

It should also be noted that such a technique has been shown to be completely unsuitable for making soleplates for irons, particularly steam irons, in which the operating stresses, and particularly the thermal stresses suffered by the soleplate, are very demanding and non-uniform.

The soleplate must therefore perform two thermal functions, since it must evaporate water from the top surface of the soleplate and it must also perform the actual ironing function via the bottom surface of said soleplate.

Proposals have already been made to make soleplates for steam irons, in which the soleplates have a so-called "sandwich" structure, being bounded externally by two heat diffusing parts such as metal plates between which a plurality of intermediate layers are disposed which are superposed on one another starting from a central part constituted by the resistive element. Such a sandwich

structure may be illustrated, for example, by the soleplate described in French Patent Application FR-A-2641291, in which the intermediate layers between the central resistive element and the two external metal sheets are constituted by co-laminated layers of a brazing alloy, the resistive element being separated from these layers by electrically insulating layers constituted by sheets of micanite. The utilization of a sandwich structure of this type may be considered to give overall satisfaction as regards the thermal behavior of the soleplate. However, it should be noted that the making of such a sandwich structure requires a series of heavy and burdensome industrial investments due to the necessity of using a brazing oven. Such a technique may therefore be regarded as giving rise to the incorporation of a high-cost part in an electrical household appliance.

Consequently, the present invention seeks to remedy the various disadvantages enumerated above, and to provide a high temperature heating structure with a sandwich structure which is suitable for performing at least one and preferably two different thermal functions and which is capable of improving heat dissipation from the resistive element without adversely affecting the long term behavior of the actual internal construction of the heating structure, whatever the thermal stresses suffered, and with all this being at low manufacturing cost.

The invention also seeks to provide a heating structure that is made in a particularly simple manner and that has improved properties as regards sealing against air and steam.

The invention also seeks to provide a heating structure which gives an improvement in the long term cohesion of its various constituent layers, despite severe thermal stresses.

The invention also relates to an electrical household appliance including such a heating structure,

and in particular it relates to a steam iron which can be made at low cost whilst still having good heat dissipation properties, good internal cohesion of the soleplate parts over time, and good sealing of the soleplate.

The objects of the invention are achieved by means of a heating structure, in particular for an electrical household appliance of the iron or cooking receptacle type such as a deep fryer for example, the structure being made as a sandwich structure bounded externally by two rigid parts, at least one of which forms a heating plate, said parts being intended to diffuse the heat produced by a heating unit comprising a resistive element covered with an electrical insulator, said unit being secured to said parts by bonding means, the heating structure being characterized in that:

- the heating unit is defined by the electrical insulator which comprises two sheets of an electrically insulating covering between which there extends a first thermoplastic resin layer in which the resistive element is inserted, said thermoplastic resin layer adhering to the sheets of electrically insulating covering, and

- the bonding means are constituted by at least one second thermoplastic resin layer which extends between the heating plate and the associated sheet of electrically insulating covering and which adheres to said plate and to said sheet.

Other features and advantages of the invention will become apparent and emerge in greater detail from the following description, given by way of non-limiting example and with reference to the accompanying drawings, in which:

- Figure 1 is a cross section through a heating structure of the invention, before the pressing and heating operation by which it is obtained;

- Figure 2 is a cross section through a heating structure of the invention identical to that shown in

Figure 1, in its final state after the pressing and heating operation;

- Figure 2a shows a simplified variant on the heating structure shown in Figure 2;

- Figure 3 is a fragmentary cross section through a heating structure of the invention provided with a peripheral sealing means;

- Figure 4 is a cross section showing how a heating structure of the invention is integrated in a steam iron;

- Figure 5 shows a detail of the sealing of a steam pocket in the case where a heating structure of the invention is integrated in a steam iron;

- Figure 6 is an elevation showing a detail of the construction of the resistive element of the heating structure; and

- Figure 7 shows another variant of the heating structure of the invention.

The heating structure 1 of the invention and shown in Figure 2 is of the high temperature type and is made as a sandwich structure constituted by stacking a plurality of layers bounded externally by two heat diffusing parts respectively forming a bottom plate 2 and a top plate 3. Such a structure generally reaches temperatures which exceed 180°C and which are preferably even close to 300°C. The plates 2, 3 may be made of any rigid or flexible material as generally used to perform a heat diffusion function, such as stainless steel, mild steel, ceramic, vitro-crystalline materials or glass, for example, or aluminum, this latter material being particularly advantageous where the heating structure is to be used in an iron. The plates 2, 3 may be made of the same material or of two different materials depending on the intended application, and may be of equal or of unequal thicknesses.

The heating structure includes a heating unit made in the form of a resistive element 4 constituted by one or more tracks extending along a clearly defined path

forming a series of loops or zig-zags (Figure 6) between the two plates 2, 3. Preferably, the resistive element 4 and its constituent loops extend in the longitudinal plane of symmetry P of the heating structure 1. The
5 resistive element 4 may be made of any material which is generally used as a heating track, such as nickel-chromium alloys or preferably alloys based on constantan. The cross-section and the length of the resistive element 4 varies as a function of the desired electrical power.
10 Advantageously, its thickness is of the order of 50 μm and may vary between 20 μm and 100 μm for example.

The resistive element 4 is inserted into a first thermoplastic resin layer 5 which covers at least the top and bottom portions of the resistive element 4. The
15 resistive element 4 is provided in conventional manner with an electrically insulating covering constituted by a top sheet 6a and a bottom sheet 6b which adhere respective faces of the first thermoplastic resin layer 5 and which consequently delimit the heating unit. The
20 material used as the electrically insulating layer may be chosen from amongst any of the conventional components presently used by the person skilled in the art, as a function of the thermal stresses of the heating structure. In the case where the heating structure is to
25 be utilized in an electrical household appliance, of the steam iron type, it is particularly advantageous to employ a material of the polyamide type.

The bonding means which provides adhesion between each of the opposed faces 2b, 3a respectively of the
30 bottom and top plates 2, 3 and the top and bottom faces of the insulating sheets 6a, 6b, comprises at least one thermoplastic resin layer which therefore forms a "top" layer 7a and a "bottom" layer 7b.

In preferred applications of the invention, the
35 respective bonds between the plates 2, 3 and the sheets of insulating covering 6a, 6b are each constituted by a single thermoplastic resin layer.

To ensure constant heat dissipation across the thickness of the sandwich structure, the same composition of thermoplastic material is preferably used for each of the three thermoplastic resin layers 7a, 7b, and 5. It is however possible to make all three layers of different thermoplastic materials, depending on the type of thermal stress to which the heating structure 1 is to be subjected, or even to make only the first thermoplastic resin layer in a different material from that of the top and bottom layers 7a, 7b. Advantageously, at least the top and bottom layers 7a and 7b are made from the same material and also preferably the first resin layer 5.

The choice of thermoplastic resin clearly depends on the thermal stresses suffered by the heating structure, and in the case of a specific application to electrical household appliances and in particular to steam irons, the choice will advantageously be either PFA (perfluoroalkoxy) or PEEK (polyetheretherketone) for making each of the three resin layers. Depending on the thermal stresses the heating structure is expected to suffer as a function of its predicted use, other thermoplastic materials may be considered, such as PTFE (polyfluorochloroethylene) or FEP (tetrafluoroethylene hexafluoropropylene - nomenclature taken from Editions WEKA Volume 1) for example.

It is also possible to simplify the heating structure 1 of the invention, by omitting a thermoplastic resin layer, for example the top layer 7a, as shown in Figure 2a. In such a variant, only the bottom plate 2 specifically performs a heat diffusing function, the rigid part 3 defining the top of the heating structure 1 then mainly performing a mechanical function of providing stiffness, heat diffusing being a secondary function. The rigid part 3 rests directly on the top sheet 6a of electrically insulating covering and may be constituted by a series of blades or strips 3d which are spaced from one another.

In another variant, such as that shown in Figure 7, the electrically insulating covering comprises a top fabric sheet 6'a and a bottom fabric sheet 6'b, the weft of these sheets being impregnated in part by the thermoplastic resin layers 5, 7a and 7b. The partial impregnation advantageously leaves the core of the weft free, and the electrical insulation is obtained by the conjunction of the thermoplastic resin and the fabric. In the example shown in Figure 7, the thermoplastic resin is advantageously constituted by three layers of PEEK and by two partially-filled sheets of glass fabric. The fabric sheets 6'a and 6'b also provide the function of mechanically bracing the heating structure, and in conjunction with the thermoplastic resin, guarantees good electrical insulation in the event that the tracks of the resistive element 4 overheat. The presence of glass fabric sheets also facilitates the making of the sandwich structure by avoiding shrinking effects in the thermoplastic resin layers thereby improving the inherent flatness of the final product. The thickness of the resin layers 7a, 7b forming the bonding means with the plates 2, 3 is preferably less than that of each fabric sheet 6'a, 6'b. Advantageously, the sum of the thicknesses of the resin layers 5, 7a, 7b is greater than or equal to twice the thickness of each fabric sheet 6'a, 6'b. Preferably, the sum of the thicknesses of the resin layers 5, 7a, 7b is close to 1/10 mm.

The heating structure of the invention may be made by a production process in which the resistive element 4 is constituted by a metal foil from which the actual resistive element 4 may be obtained by any means known to the person skilled in the art, and in particular by chemical cutting. The resistive element 4 may equally well be obtained by mechanical cutting or by silk screen printing of a resistive paste. Concurrently with the making of the resistive element 4, the method of making the heating structure 1 includes a step of coating each

of the electrically insulating sheets 6a, 6b, which are pre-coated on both faces by a thermoplastic resin layer, as shown in Figure 1. In that figure, the top covering sheet 6a is pre-coated on its top face with a thermoplastic resin layer 7a, and on its bottom face with another thermoplastic resin layer 5₁. The bottom covering sheet 6b is likewise coated on its bottom face with a thermoplastic layer 7b and on its top face with another thermoplastic resin layer 5₂. Coating of the thermoplastic layers may be carried out using any known means, for example by spraying or by powder coating. The resin layers 5₁ and 5₂ are intended to adhere to the resistive element 4 and to this end, their overall individual thicknesses may be less than that of the top and bottom thermoplastic resin layers 7a and 7b which are intended to adhere to the faces 2b and 3a of the heat diffusing parts 2, 3. Advantageously, before the chemical cutting, the foil is co-laminated onto one of the thermoplastic resin layers 5₁, 5₂ or onto one of the electrically insulating sheets. The following step consists in arranging at least one resistive element 4 between the two sheets of electrically insulating covering 6a, 6b, each of which have previously been pre-coated on both faces with thermoplastic resin layers.

Positioning of the various layers is completed by superposing a heat diffusing part 2, 3 on each of the free faces of the thermoplastic resin layers 7a and 7b, as shown in Figure 1. These heat diffusing parts may consist of different materials well known to the person skilled in the art, such as rolled aluminum, stainless steel, steel coated with another metal by co-lamination (mild steel + stainless steel) or by deposition, for example galvanized steel. It is also possible to use synthetic resin moulded materials or even sheets of lacquered steel. After the various layers have been superposed with the sheets and diffusing parts in the order and in the configuration shown in Figure 1, the

entire stack is taken to a press (not shown in the figures) where the external faces 11 and 12 respectively of the bottom and top plates 2, 3 are acted on by pressing means which, by means of opposite forces F_1 , F_2 , compress the stack constituted by the plates 2, 3, the resin layers 7a, 7b, 5₁, 5₂, and the resistive element 4 with its sheets of insulating covering 6a, 6b.

At the same time as the pressing operation is being performed, the entire sandwich structure is also heated to a temperature which is not less than the melting temperature of the thermoplastic resin being used, so as to cause the resin to pass from its initial solid state into its liquid state. The heating means used may be conventional or of the vibration or ultrasonic heating types, for example, to avoid generalized heating of the heating structure. In the case where a thermoplastic resin such as PFA is used, the heating temperature should be such that the resin reaches a temperature lying in the range 300°C to 310°C. As the different thermoplastic resin layers 7a, 7b, 5₁, 5₂, undergo the combined pressing and melting operation, the various constituents of the sandwich structure adhere and seal together. In particular, the combined action of the pressing and the rise in temperature allows the top and bottom thermoplastic resin layers 7a, 7b respectively to be securely bonded to the plates 2, 3 and the sheets 6a, 6b, whilst a diffusion and subsequent amalgamation of the two resin layers 5₁, 5₂ around the various constituent tracks of the resistive element 4 constitutes the first thermoplastic resin layer 5 shown in Figure 2. Depending on the relative thicknesses of the resistive elements and the initial resin layers 5₁, 5₂, the resistive element 4 is immersed to a greater or lesser extent in the first thermoplastic resin layer 5. The interstitial spaces 13 which exist between the various tracks of the circuit formed by the resistive elements 4 before the step of applying pressure and raising temperature, may be filled

to a greater or lesser extent by the thermoplastic resin 5. In all cases, it has been observed that filling of the interstitial spaces 13, even partially, has no effect on the dielectric properties of the heating structure, and that the first thermoplastic resin layer 5 adheres sufficiently to the resistive elements 4, even if they are only partially immersed. Thus, it is not necessary to control the quantity of thermoplastic material closely so as to immerse the track fragments of the resistive element 4 completely. In the preferred intended application, which is that of steam irons, the thickness of each of the thermoplastic resin layers 7a, 7b, 5₁, 5₂, is preferably of the order of about 12.5 μm , whereas the thickness of the resistive element 4 itself is of the order of 50 μm (0.05 mm), the thickness of the electrically insulating sheets being about 25 μm (0.025 mm). The resulting thickness ratio of PFA layers over the resistive element 4 having a value of the order of 3/10, may be considered as being the lower limit below which the properties of adhesion, heat dissipation and strength at temperature are compromised and indeed insufficient.

In the case where a heating structure of the invention is made having a first thermoplastic resin layer 5 obtained from two initial layers 5₁, 5₂, which are as thin as small as possible within the limits of the relationship mentioned above, it is preferable, in order to maintain a heating structure having good dielectric properties, to provide additional peripheral sealing means around the edge of the resistive element 4 so as to avoid any possibility of air, steam or liquid passing from the outside environment towards and into the resistive element 4 and onto the outside of the first resin layer 5. As shown in Figures 3 and 6, the peripheral sealing function may be obtained in a particularly simple and inexpensive manner by including a peripheral border 14 adjacent to the tracks constituting

the resistive element 4 and within the first resin layer 5, which peripheral border 14 is formed by a passive resistive track, unconnected to the supply voltage and surrounds all of the active resistive tracks. Such a border 14 is formed at the same time and by the same method as the active tracks of the resistive element 4, and prevents escape, in the radial direction, of the liquid thermoplastic resin which comes out from the layers 5₁, 5₂ while the sandwich structure is being compressed, the border 14 acting as a barrier against the outflow.

Advantageously, the bottom and top plates 2, 3 and the thermoplastic material are chosen so as to have substantially identical thermal expansion properties so as to maintain a substantially constant temperature gradient over the entire thickness of the sandwich structure.

Also advantageously, the bottom and top plates 2, 3 are constituted by metal plates of aluminum, the resistive element 4 is preferably made of constantan, whereas the two layers of electrically insulating covering 6a, 6b are constituted by two layers of polyamide.

Figure 4 shows the incorporation of a heating structure 1 of the invention into an electrical household appliance constituted by a steam iron, only the bottom portion of which is represented. In such an embodiment, the bottom metal plate 2 forms the actual ironing soleplate which is intended to make contact with a textile article to be ironed (not shown in the figure), whereas the top metal plate 3 forms at least part of the bottom wall of a steam-generating chamber 16 which is therefore arranged directly above the heating structure 1. In such an application, the function of sealing against steam and against external attack in general is assured as described previously by mounting a resistive track 14, unconnected to the supply voltage, to form a

peripheral seal around the edge of the first resin layer 5. In conventional manner, the sealing function may be improved by interposing a gasket 17 of the silicone type, arranged between a peripheral lateral wing 18 of the steam-generating chamber 16, and the top metal plate 3. The assembly may be held in place to form a good seal by folding the peripheral edge 19 of the bottom plate 2 over the wing 18 so that the peripheral edge 19 pinches the entire soleplate structure together and ensures peripheral sealing thereof.

As is well known in the prior art, the steam iron of the invention includes a series of through orifices 21 for steam, these orifices connecting the steam-generating chamber with the external face of the bottom plate 2. Preferably, the orifices 21 are formed by extruding the bottom plate 2 so as to make cylindrical through orifices 21, the walls of which sealingly cross the soleplate to emerge above the bottom face 11 of the plate 3 (see Figure 5). The various layers of the soleplate heating structure are then held in place at the orifice 21 by riveting down the extrusions, in such a manner that the top collar 23 of the orifice 21 which forms the rivet assumes the function not only of compressing the various layers of the heating structure between the plates 2, 3 so as to promote heat exchange and avoid deformation, but also a function of providing sealing against steam. The sealing at the through orifices 21 is also improved, as shown in Figures 5 and 6, by incorporating resistive element tracks 24 in the first resin layer 5, these tracks being in the form of rings surrounding the outside diameters of the walls 22 constituting the extruded orifices 21.

By virtue of the three layers of thermoplastic resin, the heating structure of the invention therefore presents good properties of heat transmission between the various layers, and also has good resistance to

mechanical and thermal shocks, whilst still conserving good bonding properties between the various layers.

The making of such a heating structure does not require the use of heavy and expensive industrial

5 equipment, and consequently, the cost of such a heating structure may be substantially reduced. Similarly, the dielectric properties of the heating structure may be obtained at lower cost, by limiting the amount of thermoplastic material used to form the first resin layer
10 5. It should also be noted that the heating structure of the invention, and in particular the iron which includes such a heating structure, has remarkable steam-sealing properties which are obtained at reduced cost. Sealing is assured not by fitting a conventional sealing element,
15 but by using certain tracks of the resistive element 4 as a sealing means.

Finally, by virtue of the good heat dissipation properties of the heating assembly, it may be noted that incorporating a heating structure of the invention into
20 the ironing soleplate of a steam iron allows the steam-generating chamber to be mounted directly above the top plate of the sandwich structure. As a result, the internal construction of the iron is greatly simplified which has a positive effect on cost and on ease of
25 manufacture. The heating structure of the invention is preferably incorporated in a steam iron, but it can clearly be fitted to any type of iron in general, and also to cooking receptacles of the deep fryer type, to appliances which perform a grilling function, or to
30 appliances which raise steam such as coffee-pots or kettles, for example.

CLAIMS

1/ A heating structure (1), in particular for an electrical household appliance of the iron or cooking receptacle type such as a deep fryer for example, the structure being made as a sandwich structure bounded externally by two rigid parts (2, 3), at least one of which forms a heating plate (2), said parts being intended to diffuse the heat produced by a heating unit comprising a resistive element (4) covered with an electrical insulator (6a, 6b, 6'a, 6'b), said unit being secured to said parts (2, 3) by bonding means, the heating structure being characterized in that:

- the heating unit is defined by the electrical insulator which comprises two sheets of an electrically insulating covering (6a, 6b, 6'a, 6'b), between which there extends a first thermoplastic resin layer (5) in which the resistive element (4) is inserted, said thermoplastic resin layer adhering to the sheets of electrically insulating covering (6a, 6b, 6'a, 6'b), and
- the bonding means are constituted by at least one second thermoplastic resin layer (7b) which extends between the heating plate (2) and the associated sheet of electrically insulating covering (6b, 6'b) and which adheres to said plate (2) and to said sheet (6b, 6'b).

2/ A heating structure according to claim 1, characterized in that the second rigid part forms a second heating plate (3) and in that the bonding means comprise a third thermoplastic resin layer (7a) which extends between the second heating plate (3) and the associated other sheet of electrically insulating covering (6a), and which adheres both to said second plate (3) and to said sheet of electrically insulating covering (6a).



- 3/ A heating structure according to claim 1 or claim 2, characterized in that the thermoplastic resin layers (5, 7a, 7b) are made of a material of the same composition.
- 5 4/ A heating structure according to claim 3, characterized in that the resin layers (5, 7a, 7b) are constituted of PTFE, FEP or preferably of PFA or PEEK.
- 10 5/ A heating structure according to any preceding claims, characterized in that it includes, adjacent the first resin layer (5), at least one peripheral sealing border (14) formed by an inert resistive track.
- 15 6/ A heating structure according to any preceding claims, characterized in that the heating plate or plates (2, 3) and the thermoplastic resin layers (7a, 7b, 5) have substantially identical thermal expansion properties.
- 20 7/ A heating structure according to any preceding claims, characterized in that the plates (2, 3) are of aluminum and the resistive element (4) is of constantan.
- 25 8/ A heating structure according to any one of claims 1 to 7, characterized in that the sheets (6a, 6b) of electrically insulating covering are constituted by two polyamide sheets.
- 30 9/ A heating structure according to any one of claims 1 to 7, characterized in that the sheets (6a, 6b) of electrically insulating covering are each constituted by one sheet of fabric (6'a, 6'b), preferably glass fabric, impregnated by the thermoplastic resin layers (5, 7a, 7b).



10/ An electrical household appliance including at least one heating structure in accordance with any one of claims 1 to 9.

5 11/ An electrical household appliance according to claim 10, characterized in that said appliance is a steam iron in which the bottom plate (2) forms the ironing soleplate and the top plate (3) forms at least partially the bottom wall of a steam-generating chamber (16).

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12/ An electrical household appliance according to claim 11, characterized in that it includes through orifices (21) for steam, these orifices connecting the steam-generating chamber (16) to the ironing soleplate (2),
15 said orifices being formed by extruding the bottom plate and by riveting these extrusions onto the top plate (3) so that the steam orifices (21) form additional means for bonding the heating structure.

20 13/ An electrical household appliance according to claim 12, characterized in that it includes, in the first thermoplastic resin layer (5), inert resistive tracks (24) which surround the extrusions of the steam-passage orifices (21) to form seals.

25

14/ A method of making a heating element according to any one of claims 2 to 9, characterized in that it consists in:

• arranging at least one resistive element between
30 two sheets of electrically insulating covering, pre-coated on both faces with layers of thermoplastic resin,
• arranging at least two heat diffusing elements forming plates on each layer of thermoplastic resin remote from the layer of thermoplastic resin which faces
35 the resistive element,

• using pressing means acting on the external surfaces of the diffusing elements, to compress the



- assembly of the plates, the resin layers and the sheets of electrically insulating covering, whilst simultaneously heating the assembly to a temperature at least equal to the melting temperature of the thermoplastic material used, and
- 5 • halting compression of the assembly, allowing it to cool, and removing the resulting sandwich structure heating structure.

