



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.02.2009 Bulletin 2009/07

(51) Int Cl.:
D06F 58/26 (2006.01)

(21) Application number: **07014979.4**

(22) Date of filing: **31.07.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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(54) **Clothes dryer having an air passage volume with an insulated section, and heating unit and outer cover thereof**

(57) The invention relates to a preassembled heater unit (7) for a clothes dryer (25), to a preassembled outer cover (1) of a clothes dryer, and to a clothes dryer, which are provided with an electric heating element (4), preferably of the coiled resistance wire type, and form an insulating section (S), into which the heater element extends. In order to avoid current leakages from the heater elements to parts of the heater unit, the outer cover and/or

the clothes dryer, respectively, the insulating section is separated from those parts that are electrically conductive and are electrically insulated from the heater elements by a layer of insulating material (5). Thus, there are no grounded parts in the vicinity of the heater elements that protrude into the air passage volume and may be conductively connected to the heater elements in operation due to the saline fog or splashing.

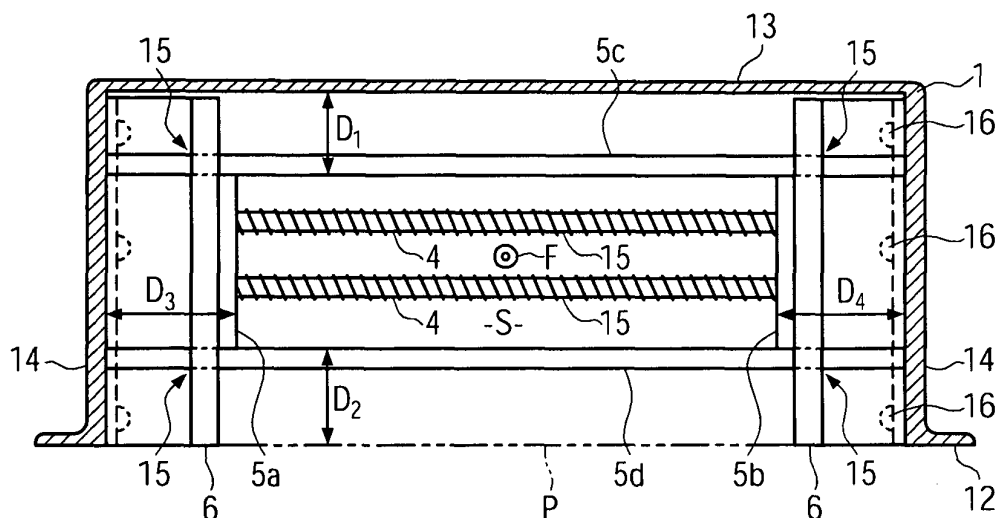


FIG. 2

Description

[0001] Preassembled heater unit, which is adapted to be mounted in a clothes dryer, comprising at least one laterally confined air passage volume extending in an air flow direction from an inflow opening at its upstream end to an outflow opening at its downstream end, said air passage volume comprising an insulating section that is at least partly enclosed by electrically insulating material, at least one open heater element extending into said air passage volume, and heater unit parts that are arranged adjacent to said air passage volume made from electrically conductive material and electrically insulated from said heater unit.

[0002] The invention relates further to a pre-assembled outer cover for a clothes dryer, said cover comprising an outer wall of electrically conductive material, said outer wall being adapted to form an outer wall of said clothes dryer, an air passage volume extending in an airflow direction, said air passage volume comprising an insulating section that is at least partly enclosed by electrically insulating material, at least one open electric heating element that extends into said insulating section, and cover parts made of electrically conductive material that are arranged adjacent to said air passage volume and that are electrically insulated from said heater element and/or electrically connected to said outer wall.

[0003] The invention finally relates to a clothes dryer, said clothes dryer comprising at least one outer wall made from electrically conductive material, an air passage volume extending in an airflow direction, said air passage volume comprising an insulating section that is at least partly enclosed electrically insulating material, an open electric heating element that extends into said insulating section, said electrical heating element connected via electric elements to an electric source having a first electric potential, and dryer parts that are arranged adjacent to said air passage volume, are made from electrically conductive material and are electrically insulated from said heater element and/or connected to a ground potential source, said ground potential source having a different electric potential from said electric source.

[0004] Heating units, pre-assembled covers and clothes dryer having the above features are known from e.g. EP-B-1,538,255, which is concerned with a heating unit that is integrated into a cover for a clothes dryer to reduce manufacturing costs and ease maintenance work.

[0005] A conduit having a PTC-element as an electric heating element and a clothes drying machine provided with such a conduit is known from WO-A-2004/042132. According to this prior art reference, the flow of air must be guided in such a manner as to flow over, i.e. touch just a single side of the planar heating element. The advantage of such an arrangement lies in the reduced flow resistance and in the distribution of the heat flow across a large surface, which in turn, means that a large section of the airflow is heated.

[0006] In US-A-5,134,270, a heater assembly for installation in a clothes dryer between an inner and an outer support is shown. The heater assembly comprises an open-coil heating element that is arranged within a pan-structure.

[0007] CH-A-240,775 shows a clothes drying machine having a top, in which an electric resistance heater and an air channel is enclosed. A support bracket, and a method for mounting a heating coil in a dryer or the like by means of such a bracket, is disclosed in US-A-4,994,654. The support bracket is a plate of unitary construction having one or more openings for receiving and supporting an insulating bushing and a pair of support legs adapted for engagement with slots in a support wall. At least one portion of the plate is folded upon itself to form a retaining rim for the bushing and reinforcing the support legs.

[0008] US-A-3,816,706 is concerned with a heating member for a hairdryer or other blower-operated heating appliance, whose wire heating element is disposed in a flow duct formed by a box-shaped frame of insulating panels. The heating member comprises a heating wire helically wound on a self-supporting core which is coiled to a diameter corresponding to the distance between opposite panels and is disposed with its transverse axis transverse to the flow direction. The element is attached to the frame only by its terminals which are secured to one of the panels. A tapping resistor for the blower-motor, and a thermal cut-out, are provided on the panels. The heating wires themselves are surrounded by an insulating stratum, such as glass fiber silk or the like.

[0009] JP-A-62-186899 relates to a dryer that comprises a fan case and an air passage that are made of expandable resin for air foams, which prevents heat radiation from the air.

[0010] An improved lint handling system for a household laundry dryer is shown in US-A-5,560,120. The lint handling system of this prior art reference is capable of more efficient operation and greater convenience to a user. This is in part achieved by providing a blower housing having a Helmholtz resonator to reduce the acoustic emissions at a blade passage frequency. Furthermore, a lint container and a foreign objects trap are provided.

[0011] DE-A-19842644 relates to the monitoring of the drying air stream in a household clothes dryer. The drying air stream is heated and thus undergoes a temperature change. The temperature change is monitored by temperature sensors that are arranged downstream of the heater. By measuring the time needed for the temperature change to arrive from the heater at the temperature sensors, the airflow velocity may be determined.

[0012] DE-C-3419743 relates to a clothes dryer of modular design which allows an easy adaptation of the clothes dryer to different operation modes.

[0013] To arrive at a more manufacturing-friendly and service-friendly household device, DE-A-4139588 provides that the household device is mounted from pre-assembled modular groups.

[0014] This principle is further improved in DE-A-4327916. Here, a clothes treating machine is assembled into a fully operable state, wherein this state does not comprise any outer panels that define its appearance.

[0015] Furthermore, the prior art comprises a variety of clothes dryers that are available on the market, such as the Hotpoint 6kg Condenser Tumble Dryer, the Hotpoint 5kg Tumble Dryers, all of General Domestic Appliances Ltd., and the Creda Condenser Tumble Dryer 37550 and the Hotpoint Reversomatic Condenser Dryer plus, both of Creda Ltd.

[0016] EP-A-0576825 is concerned with a clothes dryer that uses the waste heat from the blower driving motor to preheat the drying air.

[0017] US-A-3,293,769 relates to an adjustable cool-down control for dryer cycles.

[0018] Further clothes dryers are known from JP-A-55-070420, JP-A-56-130192, and JP-A-2000-317200.

[0019] As can be seen from the above listing of prior art references, clothes dryers are subject to a host of innovations that are very often close to each other. The development work in clothes dryers is mainly driven by the costs of energy and the costs of manufacturing. Additionally, security standards have to be obeyed, so that users of the appliances are not endangered even in situations where the clothes dryer fails.

[0020] Despite the current host of innovations in clothes dryers, it is still a problem with such dryers that while open, i.e. non-insulated, electric heater elements are very efficient for heating air flowing past the coils, they are electrically live at all times when the clothes dryer is in use. The open electric heater elements are therefore susceptible to earth leakage. This problem is exacerbated as a result of water from the clothing including dissolved salts from washing detergents, thereby making such water more electrically conductive. Because of this, even a well-insulated electric heater may still be susceptible to earth leakage problems due to splashing. Moreover, the air passage volume in which the heater is situated fills up in operation of the clothes dryer with a dense fog containing droplets of high salinity that are suspended in highly saturated damp air. This increases considerably the likelihood of earth leakage.

[0021] When such earth leakage occurs, one or several circuit breaker switches in the electrical supply, such as a domestic consumer unit, may trip, leading to a loss in power to other items connected on the same circuit. In many circumstances, this may be a loss of electrical supply to the whole house. On the other hand, if no such security devices are present, or if they fail to operate, the health or even life of the consumers is in danger as they might be exposed to dangerous currents if they touch parts of the dryer. None of the above-listed prior art references adequately solves this problem.

[0022] The present invention strives to solve this problem by significantly reducing if not eliminating leakage problems in a clothes dryer.

[0023] This problem is solved according to the inven-

tion for a pre-assembled heater unit, outer cover or clothes dryer mentioned in the beginning in that the air passage volume is separated from said heater unit parts by at least one layer of electrically insulating material.

[0024] This solution is simple and reliably avoids leakage problems. The present solution is derived from the realization that the problem of earth leakage causing tripping in clothes dryers, especially condenser clothes dryers, is primarily caused by the mechanical configuration of the insulation techniques which generally provide only a relatively short conduction paths between the coils and earthed metal components thereby defining a relatively large area of vulnerability compared to the size of e.g. a droplet of water from a splash. This makes it possible or even probable that when splashing occurs on or across the insulation, the size of the droplet is sufficient to bridge the gap between the coil and earth metal components, thereby leading to tripping of the earth leakage trip switch. Further, droplets flowing on the wall of the air passage volume leave a trace of increased humidity in their wake. This trace forms a path for leakage currents. If a droplet hits a conductive part that protrudes into the air passage volume and continues to flow into the vicinity of the open heater elements, a current is likely to flow. As, according to the invention, all parts adjacent to the air passage volume are separated by a layer of solid insulation material, they cannot connect to the heater elements.

[0025] The inventive principle can be further improved by the following features, which can be combined independent from one another, according to the specific requirements for the operation at hand.

[0026] First of all, it is of advantage to use an open coiled heater element of the resistance type, preferably having coils made of flat wire of which the long side is preferably aligned in the flow direction. Such a heating element combines low manufacturing costs with high efficiency in the heat transfer from the wire to the airflow.

[0027] In a further advantageous embodiment, the electrically insulating material may form a support structure which holds together said heater unit. In this embodiment, an additional structure, which is usually formed of conductive material such as sheet metal, can be dispensed with. The heater unit becomes more lightweight and more importantly, the risk of leakage occurrence is greatly reduced due to the increased absence of conductive material in the vicinity of the heater elements.

[0028] The support structure may especially be self-supporting, so that no additional elements are needed to secure the integrity shape of the pre-assembled heater unit.

[0029] The heating element may be supported by the insulating material so that no additional supports are needed, again giving the advantage of doing away with conductive material in the vicinity of the heater element, that may be easily bridged by droplets, that accumulates during operation in the air passage volume.

[0030] The air passage volume may be of substantially rectangular flow cross-section, so that existing clothes

dryer may be retrofitted with the heater unit according to the invention.

[0031] The heater unit may further have a substantially box-like outer contour, where two opposing side faces of the box are open to form the inflow and the outflow opening, respectively.

[0032] The insulating material may comprise sheet material, the sheet material forming walls of the air passage volume or, in the case of the outer cover in order to facilitate manufacturing.

[0033] Furthermore, the insulating material may comprise a sheet material that forms the wall of said air passage volume. In this configuration, assembly of the insulating section is greatly facilitated.

[0034] According to one further embodiment, the walls may comprise at least two substantially plane support walls that face each other, said heating element extending between said two support walls. This design provides that of the heater element itself or a base, on which the heater element is wound, is used also as part of the support structure. This rigidifies the heater unit. The base may in particular, be another plate of insulating sheet material.

[0035] The manufacturing of the heater unit may also be facilitated by channel walls made of insulating material that are engagingly locked with one another. The engagement may in particular be adapted so that gaps are avoided, as in such gaps, water may collect that may leak out from time to time and increase the probability of leakage currents.

[0036] For increasing heating power and more beneficially, to be able to have all the terminals for supplying energy to the heater elements located on one side of the heater unit, a plurality of resistance heater elements, in particular, an even number of heater elements, may be arranged substantially parallel to one another.

[0037] To increase the heat transfer from the heater elements to the airflow, it is often desired to have the flow velocity decreased. Towards this end, the flow cross-section of said Inflow opening is of different size than the flow cross-section of said outflow opening. If, on the other hand, it is desired to avoid lint to reach or accumulate on the resistance elements, it may be desired to increase the flow velocity. This is in particular the case, if there is no lint filter upstream of the heater element. To achieve a change in the flow velocity during the passage of the airflow through the air passage volume, the insulating walls may be at least partly inclined with respect to one another, so that the insulating section tapers in one direction.

[0038] The insulating sheet material may, in another embodiment, form closed surfaces around said air passage volume, thus avoiding any openings in the channel walls, through which in operation of the clothes dryer, may diffuse to other areas of the clothes dryer.

[0039] Alternatively, the insulating sheet material may have openings, that are arranged between the terminals of the heater elements. In particular, the openings may

be arranged in the airflow direction and/or the gravity direction between the terminals, or on the straight line connecting the terminals. Thus, the openings prevent that droplets can flow along the wall from one terminal to the other and form a leakage bridge between them. The openings themselves are preferably separated from any grounded parts.

[0040] As insulating material, mica, especially sheet mica may be used. Sheet mica has sufficient rigidity to act as a support for the heater coils whilst also performing its function of providing electrical and thermal insulation.

[0041] The heater parts may in particular comprise fastening means for mounting said heater unit onto at least part of a clothes dryer and/or effecting structural integrity of said heater unit. In the past, such fastening means often protruded into the air passage volume, as already stated above. Moreover, these fastening means constituted pointy structures, where a high electric potential is likely to accumulate.

[0042] The heater parts may furthermore be conductively connected to one another, so that they may be easily grounded by using e.g. a single terminal.

[0043] The pre-assembled outer cover may comprise at least one fluid guidance wall that at least partly encloses said air passage volume and is extending in said airflow direction to said insulating section. The fluid guidance wall serves to minimize flow losses during operation of the clothes dryer and to keep away the airflow of drying air from other areas of the outer cover, so that they do not fill up with high humidity.

[0044] The outer cover may furthermore comprise a support structure for the at least one heating element that is similar to one of the above-described configurations of the heater unit. Alternatively, the heater unit may be inserted in the pre-assembled state into the outer cover.

[0045] More specifically, the heater unit may be inserted into said flow guidance wall so that the flow guidance wall serves both as a support means for the heater unit and guides the airflow to the heater elements.

[0046] In another embodiment, a side wall of said heating unit may be received within an opening, the opening being at least in one direction, preferably the airflow direction, larger than the side wall. This configuration leads to an air gap between the side wall and the member of the outer cover, in which the opening is formed. The air gap has an additional insulating effect in that it interrupts the flow of droplets and the walls of increasing humidity.

[0047] In another advantageous embodiment, the insulating material may be arranged between the heater element and the outer wall of the outer cover, to form not only an electric but also a heat insulating layer at the same time.

[0048] To increase the insulation efficiency, the insulating material of the outer cover and/or the heater unit may be spaced apart from the outer wall by an air volume.

[0049] The same effect may be additionally or alternatively reached on the internal side of the outer cover facing the clothes dryer in that the insulating material is re-

ceded from an attachment plane of the outer cover. The attachment plane may be formed by a sealing flange of the cover, that is, adapted to sealingly engage with a corresponding surface of the clothes dryer, such as a back panel.

[0050] The clothes dryer may have a heater assembly, a heater unit and/or an outer cover that is configured similar to the pre-assembled outer cover and/or the pre-assembled heater unit in one of the above-described configurations.

[0051] In the following, the invention is described by an example only with reference to the drawings that show specific embodiments of the invention. In light of the above description, the combination of features shown in the embodiments only may be altered, if the advantageous effect of a specific feature is not needed for a specific application.

Fig. 1 is a perspective view of an outer cover for a clothes dryer,

Fig. 2 is a front view of another embodiment of a heater unit;

Fig. 3 is a side view of Fig. 2;

Fig. 4 is a side view of a second embodiment of the invention; and

Fig. 5 is a schematic sectional view of a part of a clothes dryer.

[0052] In Fig. 1 there is shown an outer cover 1 according to the invention. The outer cover 1 is designed to be mounted onto the back panel (not shown) of a clothes dryer, in particular of a clothes dryer of the condenser type. In such a clothes dryer moisture is extracted from the air being circulated by condensing and collecting it before re-circulating the air within the dryer.

[0053] The outer cover 1 may have, as shown, a generally circular lower region 2, intended to fit over an impeller or fan and an upper region 3 into which is fixed at least one heater element 4, preferably of the coiled resistance wire type having a wire with an elongated rectangular cross section of which the longer side is aligned in a flow-direction F. In Fig. 1, two heater elements are shown by way of example only.

[0054] The heater element 4 extends into a laterally confined air passage volume V that has, at its upstream end an inflow opening I in respect to the flow direction F and an outflow opening O at its downstream end.

[0055] In at least one section, the air passage volume is bounded by solid walls 5a, b, c, d of insulating material 5, such as sheet mica. The insulating material may form plate-like walls so that the air passage volume V has a substantially rectangular flow-cross section. This section forms an insulating section. One wall 5d is shown transparent in Fig. 1.

[0056] The outer cover 1 further comprises fluid guidance walls 6 that direct the flow onto the heater elements and serve as a support for mounting the heater unit 7. The heater unit 7 may be pre-assembled as a heater unit as a self-supporting integral structure. If the heater elements 4 are wound about a preferably plate-like stratum of insulating material such as mica, they may also contribute to the integrity of the structure, e.g. if this stratum is held by the side walls 5a, b which then serve as support walls.

[0057] As can be seen in Fig. 1, the at least one heater element extends from one insulating side wall 5a to the opposite side wall 5b. If an even number of heater elements is used, they may be series-connected by an electric conduit 9 on the one side of side wall 5a outside of the insulated section volume, and be connected to a power source by a connector 10 on the other side, also outside the insulated section, the fluid guidance wall 6.

[0058] The heater unit is of essentially box-like, i.e. cuboid shape made up by the insulating material 5 and the inflow and outflow opening respectively.

[0059] The insulating material 5 forms a solid layer that separates the insulated section 5 of the air passage volume V from heater unit parts and for cover parts that are arranged adjacent to said air passage volume and that are electrically insulated from the heater element, such as the fluid guidance wall section 11 that is in contact with the side walls 5a, 5b or fastening elements such as brackets, rivets or screws with which the heater unit and/or the heater elements 4 are attached to the outer cover 1. The layer of insulating material may also be applied as e.g. an insulating paint-like or paste-like material that hardens in the course of the manufacturing process.

[0060] For easy manufacturing, however, it is preferred that the insulating material 5 is made from mica plates that are engagingly connected to each other and form a closed bounding surface around said insulated section S. If there are holes in the insulation material bounding the insulated section S, these holes should preferably not be adjacent to conductive material that is insulated from the electrical supply lines to the heater element.

[0061] The outer cover 1 further may comprise a sealing flange 12, which is adapted to sealingly engage with a corresponding surface of the clothes dryer, in particular of a back panel of the clothes dryer, and defines an attachment plane P. The sheet of insulating material 5 that faces the clothes dryer may be receded from the attachment plane P into the volume of the outer cover 1. Likewise, the sheet of insulating material 5 that faces away from the clothes dryer and towards the outer wall of the outer cover may also be spaced apart from the outer wall of the outer cover 1. In both cases, an air volume is added as a further insulation layer between the insulating material 5 and cover parts that are conductive and may be grounded in the complete clothes dryer.

[0062] Another embodiment of an outer cover according to the invention is shown in Figs. 2 and 3. The outer

cover 1 is shown to have an outer wall 13 and side walls 14 which together with attachment plane P define an inner volume of the outer cover 1. Within this inner volume of the outer cover 1, there is arranged the insulated section S. The insulated section S is shown to be separated from the walls 13, 14 and the attachment plane P by distances D_1 , D_2 , D_3 and D_4 respectively. The insulated section S is further shown by the layers of insulation material 5, that are also spaced apart from walls 13, 14 and attachment plane P.

[0063] The side walls 5a,b of the insulated section S hold the heater elements 4 and thus serve as heater coil mounting plates 15'. The mounting plates 15' are secured by means of protruding tabs (not shown) which fit into correspondingly shaped cut out portions (also not shown) are attached onto the facing sides of the fluid guidance walls 6. Thus, the respective ends of the heater elements 4 are not secured to metal frame members as in the prior art with insulating material in between to act as an insulator. Rather, in the embodiment according to the invention, the insulating material 5 itself forms the support for the at least one heater element 4.

[0064] As can be seen best in the cross-sectional view of Fig. 2, there are no heater parts or cover parts that are electrically conductive and insulated from the heater element and protruding into the insulated section S. Thus, leakage currents cannot occur.

[0065] In particular, all parts that in operation of the clothes dryer are grounded, or have a different electric potential than the heater elements 4, are separated from the insulated section S by a layer of insulating material 5.

[0066] The upper and lower sheets of insulating material, i.e. walls 5c and 5d that face the clothes dryer and the outer wall 13 respectively, may be extended on both sides into a direction transverse to the air flow direction F beyond the length of the heater element 4 and in particular extend through a respective opening 15, in particular of the fluid guidance walls 6. In such a configuration, the insulation material 5 also serves as a spacer to define the lateral position of the heater elements and the fluid guidance walls 6. The upper and lower walls 5c, 5d of insulating material 5 may be in particular abut on the side walls 14 and thus serve as additional support for the fluid guidance walls 6.

[0067] The fluid guidance walls 6 and the insulating material 5 may be preassembled as a heater unit 7 and then mounted to the outer cover 1 by fastening means 16 such as rivets, screws, bolts or welding points.

[0068] According to Fig. 3 there is provided only a single opening 15 which receives the side walls 5a, 5b of the insulated section S and the upper and lower walls 5.

[0069] The opening 15 is, in the flow direction F, larger than the insulating section S, so that a gap A results on both the upstream and the downstream end of each side wall 5a, 5b, further increasing the protection against leakage currents, as the air gap A cannot be easily overcome by droplets and no bridge is formed between the heater elements 4 and the fluid guidance wall 6.

[0070] Fig. 3 further shows, that the side walls 5 of insulating material are engaged into the upper and lower walls of insulating material by protruding tabs 17 which may engage into respective openings. The height of the protruding tabs 17 most preferably corresponds to the thickness of the upper and lower insulating walls, so that the thickness of insulating material surrounding the insulated section S is not reduced by the positive lock.

[0071] Using this configuration, the assembly shown in Fig. 3 may be easily mounted by first inserting the tabs 17 into the upper and lower walls 5c, 5d respectively to form a cuboid, box-like shape of insulating material 5, which encloses both the heater elements 4 and the insulated section S. This box is then inserted into opening 15. The correct position within the opening 15 may be assured by elongating the upper and lower walls 5 in the upstream and downstream direction so that the abut on the upstream and downstream ends of the opening 15 respectively and fix the position of the box made of insulating material 5. The lateral position of the insulated section S may be fixed by elongating walls 5c, 5d in the transverse direction, as shown in Fig. 2.

[0072] As is especially clear from the embodiment of Fig. 3, there is needed no additional support structure besides the sheets of insulating material 5 to both hold the heater elements and assure structural integrity of the insulator box formed by the insulating material 5.

[0073] Thus, assembly of the box without complicated tools and involving only easy manufacturing steps is possible.

[0074] Another embodiment is shown in Fig. 4, where like parts are numbered the same as in the preceding Figs.

[0075] The opening 15, having any suitable geometry that fits to the outer contour of the side wall made from insulating material 5, again receives the insulating box surrounding the insulating section S.

[0076] However, in this embodiment, one, or both, of the upper and lower walls 5c, 5d of insulating material 5 are inclined to form an insulating section, of which the cross sectional area of the inflow opening differs from the cross sectional area of the outflow opening. The inclined wall of insulating material is preferably spaced apart from the outer wall 13 of outer cover 1 to allow air flowing parallel to the insulated section S along the outer wall and the corresponding insulating material. This bypass air may be directed towards a thermal cut-out switch 18, which is arranged in the flow of substantially bypass air and therefore receives cooler air than would otherwise be the case. The position of thermal cut-out switch 18 is shown for illustrative purpose only and may be located in other convenient positions within the heater assembly. Alternatively or additionally, the side walls 5a, 5b may be inclined.

[0077] Furthermore, the embodiment of Fig. 4 differs from the embodiments in the preceding figures in having sidewalls of insulating material with at least one opening 19, that is arranged between terminals that are adapted

to be connected to different electric potentials, e.g. a neutral terminal 20 and a live terminal 21.

[0078] Furthermore, the terminals 20, 21 are preferably arranged in a way that they do not overlap in the flow direction. Only terminals 20, 21 that are connected to the same potential may overlap, in order to avoid the building of bridges by droplets that are carried by the air flow and/or plurality from an upstream terminal to a downstream terminal.

[0079] The openings 19 in the insulating material may be of rectilinear or any other shape. They are preferably arranged within a direct path leading from one terminal 20, 21 to any of the adjacent terminals, 20, 21, at least to those terminals, 20, 21 that are of different electric potential.

[0080] Another embodiment is shown in Fig. 5, where again like parts are designated with the same reference signs. Fig. 5 shows schematically a clothes dryer 25 of the condenser type. Attached to a back panel 26 of the clothes dryer 25 is the outer cover 1. Between the sealing flange 12 and the back panel 26 there is a preferably continuous layer 27 of sealing material such as foam tape.

[0081] The outer cover 1 is part of a channel system C of the clothes dryer for heating air that is used to dry clothes. Within the heating channel, air is flowing in an air flow direction F.

[0082] As can be seen in Fig. 5, the outer wall 13 of the outer cover 1 forms part of the outer wall of the clothes dryer 25. This arrangement leads to the consequence, that the outer wall 13 must not only be electrically but also thermally insulated from the heating elements 4 so that in operation, temperatures at the outer wall 13 may not exceed 85°C irrespective of the temperature within.

[0083] Both the electric and the thermal insulation is created by the insulated section S within the air passage volume V. Within the insulating section S, the air passage volume V is separated from parts that are connected to a different electric potential than the heater elements, especially from parts that are grounded. These parts include any fastening elements, with which the outer cover 1, the fluid guidance wall 6 or the insulating material 5 are fixed to their respective supports.

[0084] Furthermore, to enhance protection against current leakage, terminals 20, 21 are separated by openings 19, that partly encircle the terminals and are situated between them.

[0085] As can be seen in Fig. 5, the outer wall 13 of the outer cover 1 is connected via line 28 and connector 10 to a ground line 29 of the connector plug 30. Terminals 20 and 21 which are the live terminals for the heater elements 4 are connected via respected lines 28, 31, 32, and via connector 10 to live and neutral terminals 33, 34 of the plug 26.

[0086] Further, in order to avoid elements that are grounded and made of conductive material to protrude into the air passage volume V and in particular into the insulating section S, the insulating section S including

the fluid guidance walls 6 may be spaced apart from the outer wall 13 by beads 35, that have been pressed into the sheet metal of outer cover 1.

[0087] Within clothes dryer 25, either a preassembled heating unit or both a preassembled heater unit and a preassembled outer cover 1 may be installed.

Claims

1. Preassembled heater unit, which is adapted to be mounted in a clothes dryer, comprising:

- at least one laterally confined air passage volume extending in an air flow direction from an inflow opening at its upstream end to an outflow opening at its downstream end, said air passage volume comprising an insulating section that is at least partly enclosed by electrically insulating material,
- at least one open heater element extending into said air passage volume, and
- heater unit parts that are arranged adjacent to said air passage volume made from electrically conductive material and electrically insulated from said heater unit,

characterized in that at least within said insulated section, said air passage volume is separated from said heater unit parts by at least one layer of electrically insulating material.

2. Heater unit according to claim 1, **characterized in that** said electrically insulating material forms a support structure which holds together said heater unit.

3. Heater unit according to claim 2, **characterized in that** said support structure is self supporting.

4. Heater unit according to any one of claims 1 to 3, **characterized in that** said heating element is supported by said insulating material.

5. Heater unit according to any one of claims 1 to 4, **characterized in that** said air passage volume is of substantially rectangular flow cross-section.

6. Heater unit according to any one of claims 1 to 5, **characterized in that** said insulating material comprises sheet material, said sheet material forming walls of said air passage volume.

7. Heater unit according to any one of claims 6, **characterized in that** said walls comprise at least two substantially plane support walls that face each other, said heating element extending between said two support walls.

8. Heater unit according to any one of claims 1 to 7, **characterized in that** said channel walls are engagingly locked with one other.
9. Heater unit according to any one of claims 1 to 9, **characterized in that** said heater unit has a substantially box-like outer contour.
10. Heater unit according to any one of claims 1 to 9, **characterized in that** said heater unit comprises a plurality of resistance heater elements that are arranged substantially parallel to each other.
11. Heater unit according to any one of claims 1 to 10, **characterized in that** the flow cross-section of said inflow opening is of different size than the flow cross-section of said outflow opening.
12. Heater unit according to any one of claims 1 to 11, **characterized in that** said channel walls are at least partly inclined.
13. Heater unit according to any one of claims 1 to 12, **characterized in that** said insulating material comprises mica.
14. Heater unit according to any one of claims 1 to 13, **characterized in that** said insulation sheet material forms closed surfaces around said air passage volume.
15. Heater unit according to any one of claims 1 to 14, **characterized in that** said further elements comprise fastening means for mounting said heater unit onto at least one part of a clothes dryer and/or for effecting structural integrity of said heater unit.
16. Heater unit according to any one of claims 1 to 15, **characterized in that** said heater unit parts are conductively connected to one another.
17. Preamsembled outer cover for a clothes dryer, said outer cover comprising:
- an outer wall of electrically conductive material, said outer wall being adapted to form an outer wall of said clothes dryer,
 - an air passage volume extending in an air flow direction, said air passage volume comprising an insulating section that is at least partly enclosed by electrically insulating material,
 - at least one open electrical heating element that extends into said section, and
 - cover parts made of electrically conductive material that are arranged adjacent to said air passage volume and that are electrically insulated from said heater element and/or electrically connected to said outer wall,
- characterized in that** at least within said insulated section, said air passage volume is electrically insulated from said cover parts by at least one layer of insulating material.
18. Outer cover according to 17, **characterized in that** said outer cover comprises at least one fluid guidance wall that at least partly encloses said air passage volume and is extending in said air flow direction to said insulating section.
19. Outer cover according to any one of claims 17 to 18, **characterized in that** said insulating material includes mica sheets.
20. Outer cover according to claim 18 and 19, **characterized in that** at least one mica sheet forms said flow guidance wall.
21. Outer cover according to any one of claims 17 to 20, **characterized in that** said insulating material forms a support structure on which said heater element is mounted.
22. Outer cover according to any one of claims 17 to 21, **characterized in that** said insulation material is arranged between said heater element and said outer wall as a heat insulating layer.
23. Outer cover according to any one of claims 17 to 22, **characterized in that** said heater element and said insulating material is part of a heater unit according to any one of claims 1 to 16.
24. Outer cover according to claim 19 and 23, **characterized in that** said heater unit is inserted into said flow guidance wall.
25. Outer cover according to claim 23, **characterized in that** a side wall of said heating unit is received within an opening, said opening being at least in one direction, preferably said air flow direction, larger than said side wall.
26. Outer cover according to any one of claims 17 to 25, **characterized in that** said air passage volume tapers in said flow direction.
27. Outer cover according to any one of claims 17 to 26, **characterized in that** said insulating material is spaced apart from said outer wall by an air volume.
28. Outer cover according to any one of claims 17 to 27, **characterized in that** said insulating material is recessed from an attachment plane of said outer cover, said attachment plane formed by a sealing flange of said cover, said sealing flange adapted to sealingly engage with a corresponding surface of said clothes

dryer.

29. Clothes dryer, said clothes dryer comprising:

- at least one outer wall made from electrically conductive material, 5
- an air passage volume extending in an air flow direction, said air passage volume comprising an insulating section that is at least partly enclosed by electrically insulating material, 10
- an electrical heating element that extends into said insulating section, said electrical heating element connected via electric elements to an electric source having first electric potential, and 15
- dryer parts that are arranged adjacent to said air passage volume, that are made of electrically conductive material and that are connected to a ground potential source, said ground potential source having a different electric potential from said electric source, **characterized in that** at least within said insulating section, said air passage volume is separated from said dryer parts by at least one layer of insulation material. 20

30. Clothes dryer according to claim 29, characterized in that a cover according to any one of claims 17 to 29 is mounted on a back panel of said tumble dryer, said cover channel being installed as part of said channel system. 25

31. Clothes dryer according to any one of claims 29 to 31, characterized in that a heating unit according to any one of claims 1 to 16 is mounted within said clothes dryer. 30

32. Heating unit or Cover or Clothes dryer according to any one of claims 1 to 31 characterized in that said electric heating element is a non-insulated resistance heater made from a coiled wire or sheet material. 35 40

33. Heating unit Cover or Clothes dryer according to any one of claims 1 to 34, characterized in that a plurality of heating elements are arranged parallel to each other within said air passage volume. 45

Amended claims in accordance with Rule 137(2) EPC.

1. Preassembled heater unit, which is adapted to be mounted in a clothes dryer, comprising: 50

- at least one laterally confined air passage volume extending in an air flow direction from an inflow opening at its upstream end to an outflow opening at its downstream end, said air passage volume comprising an insulating section that is 55

at least partly enclosed by electrically insulating material,

- at least one open heater element extending into said air passage volume, and
- heater unit parts that are arranged adjacent to said air passage volume made from electrically conductive material and electrically insulated from said heater element,

characterized in that at least within said insulated section, said air passage volume is separated from said heater unit parts by at least one layer of electrically insulating material.

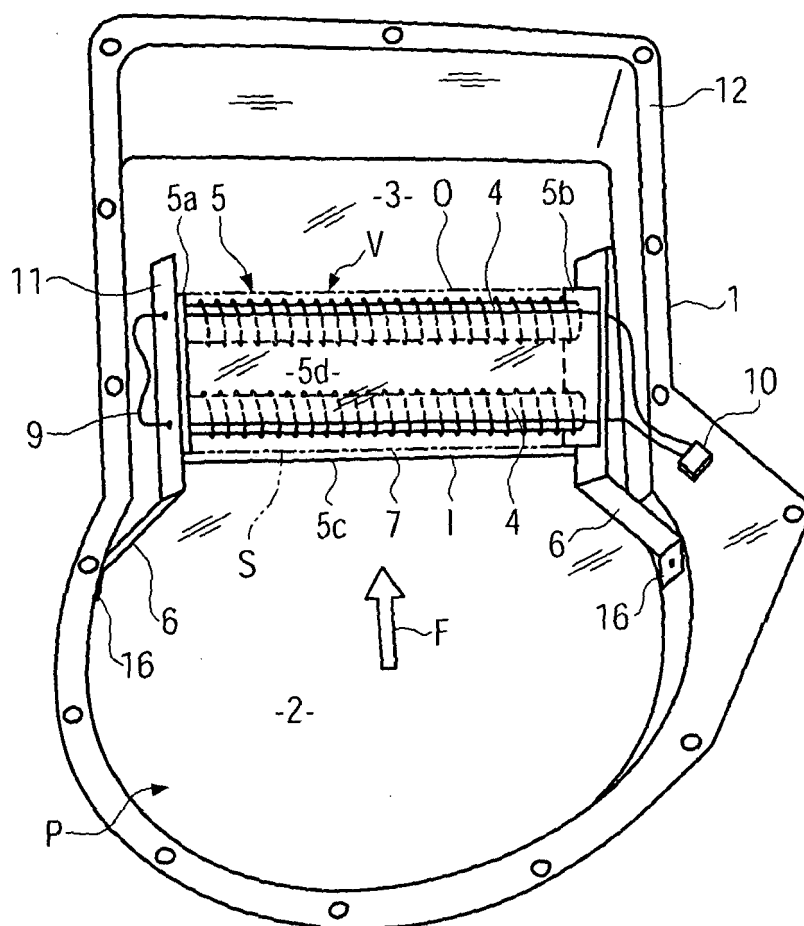


FIG. 1

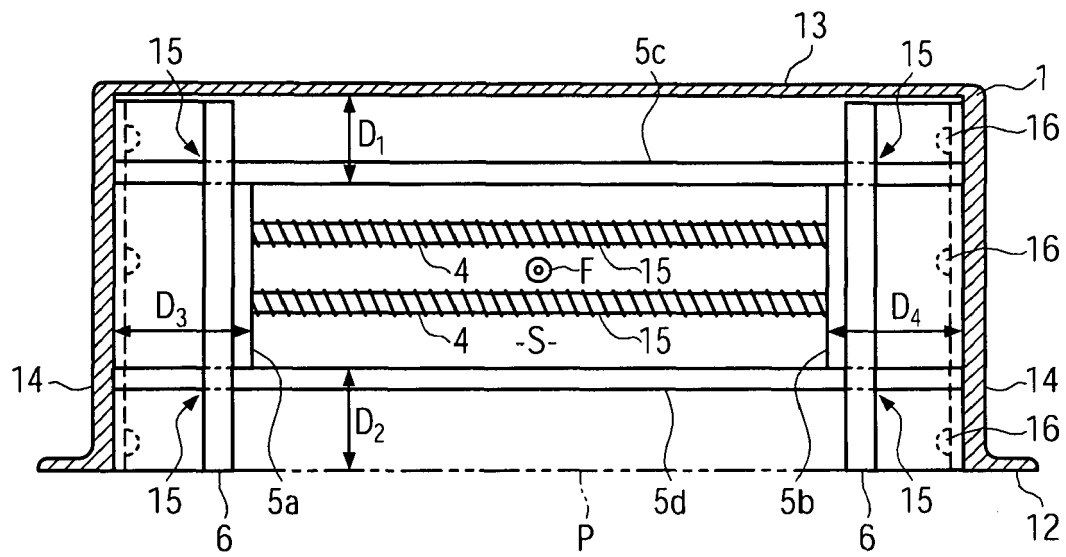


FIG. 2

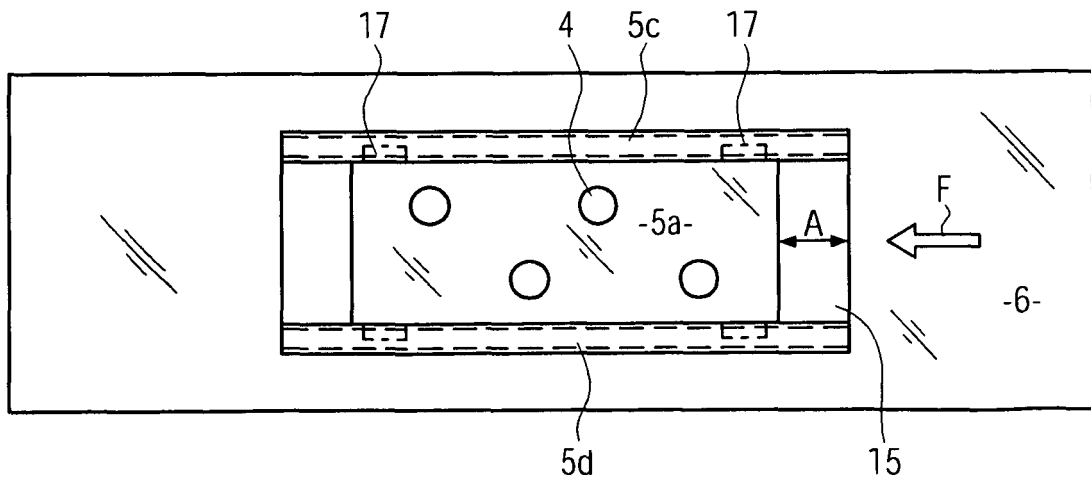


FIG. 3

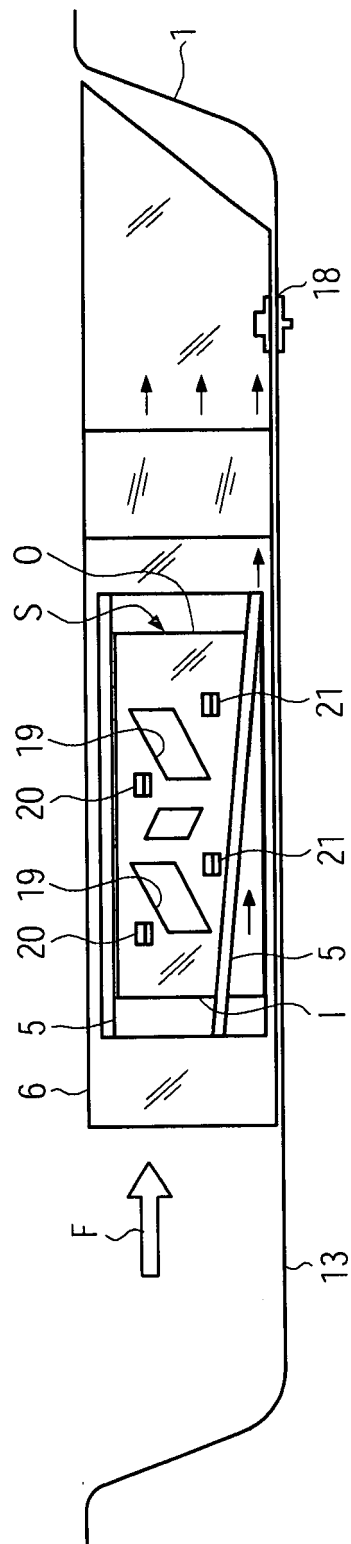


FIG. 4

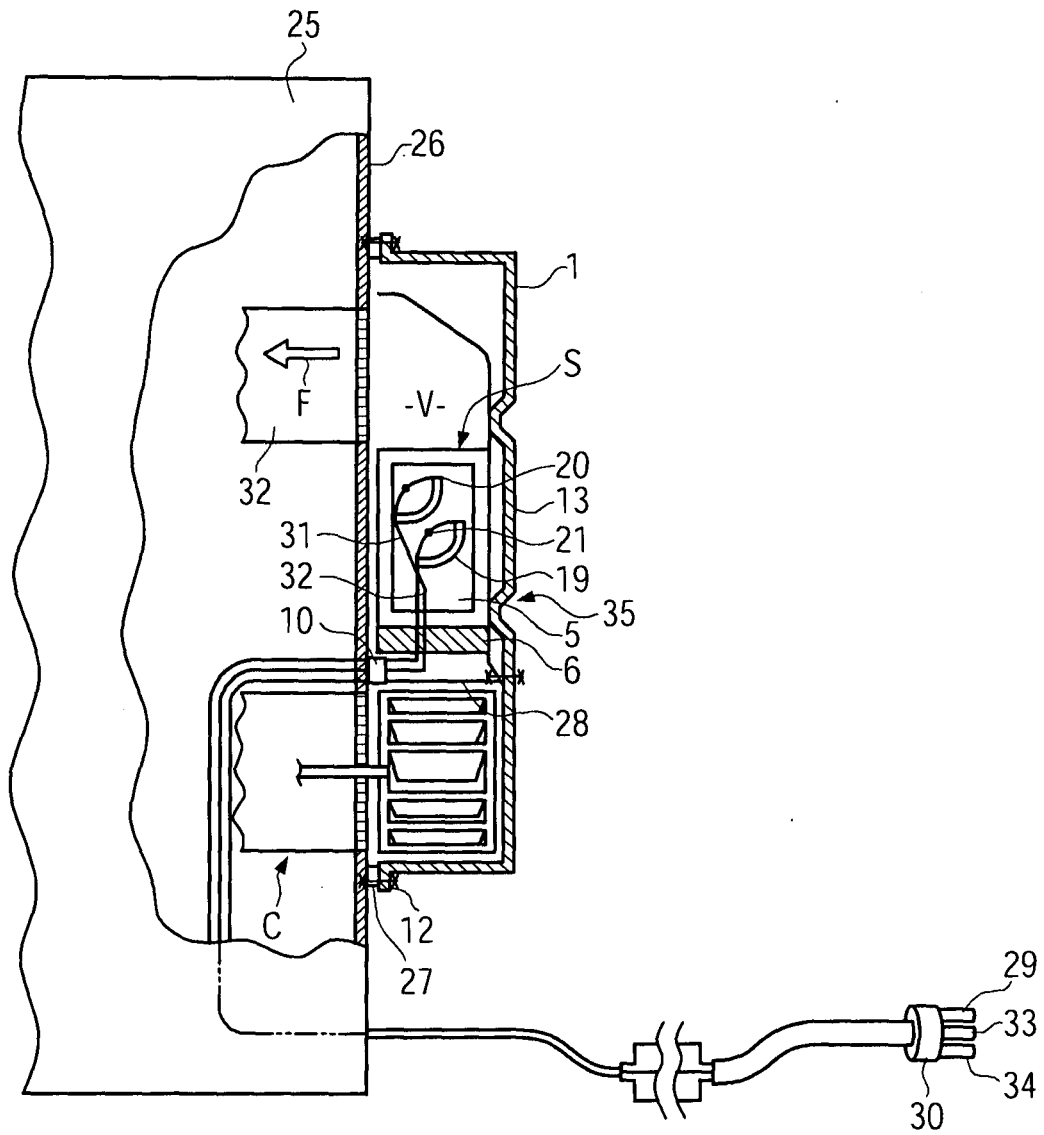


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 07 01 4979

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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 November 2007	Examiner DIAZ, M
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28-11-2007

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