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(54) Heat Exchanger Constructional Components for Building and/or Installation Purposes

(57) Heat-exchanger components are formed as block-shaped or panel-shaped units 1, Fig. 2 of ceramic foam material, having channels 4,5 for a heat-transfer medium going through them and joined into the desired circulation system by cross channels at the respective ends of the units (Fig. 1, not shown). The outer wall regions 2,3 of the units have the ceramic material in a denser form which thus has a higher heat conductivity. In a modification, Fig. 4, an outer region is formed by a cover part 12 which has channels 11 therein. In a further modification (Fig. 3, not shown) the channels, instead of being in a cover part, are in the surface contacted by the cover part. The cover parts may be of ceramic or metallic materials. The components may be constituents of floors, walls or ceilings or may form separate heating and/or cooling bodies. The cover parts may be suitably coated to form solar collectors.

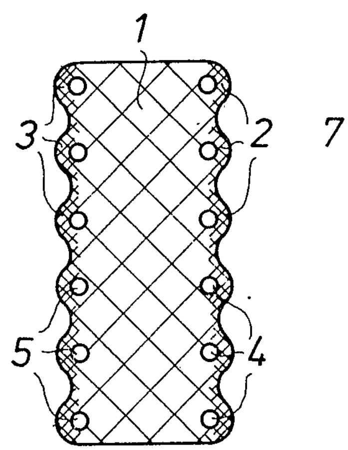

Fig. 2

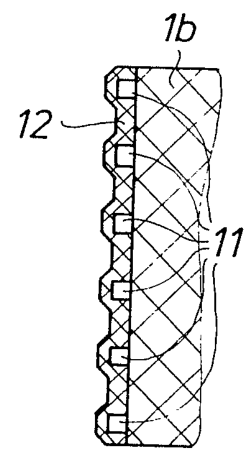

Fig. 4

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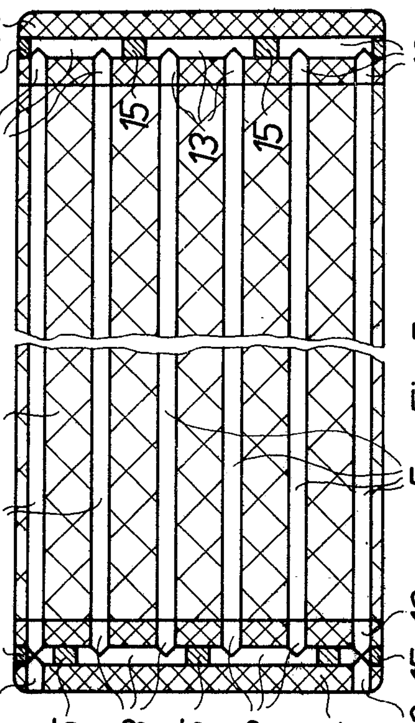

Fig. 5

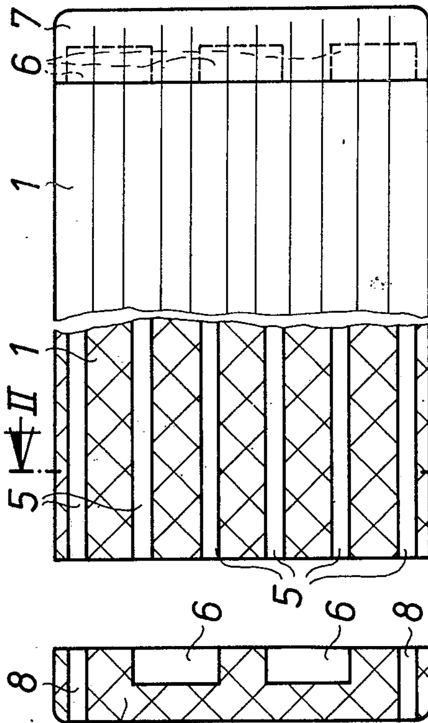

Fig. 1

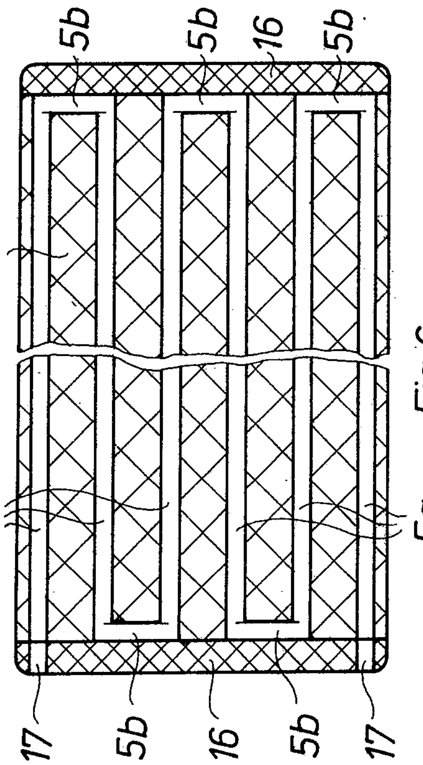

Fig. 6

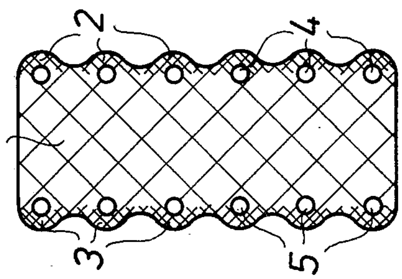

Fig. 2

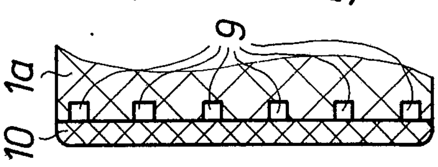

Fig. 3

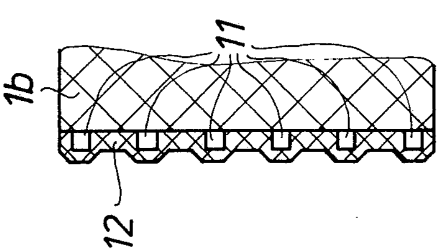

Fig. 4

SPECIFICATION

Heat Exchanger Constructional Components for Building and/or Installation Purposes

The invention relates to block-shaped or plate-shaped heat-exchanger constructional components for building and/or installation purposes, particularly to heating or cooling units, with ducts for conveying a heat-transfer medium.

It is known to use metal heater units as heat-exchanger components for building purposes, which are constructed in varied forms, wherein a heat-transfer medium, in partiular heating or cooling water, is conducted inside the heater unit. Such metal heater units are made as a rule in various sizes and forms as radiators or heater panels and are selected in size and installed in accordance with the requirements of the room to be heated. Adaptation of such metal heater units to specific heating requirements and also to existing building constructions is coupled with considerable difficulties and, especially, with considerable expense, since these metal heater units, if they can be taken to pieces at all, must be disconnected and then reassembled to the particular desired extent. The capacity for adjustment of such metal heater units is thus extremely limited, while industrial mass production is likewise possible only to a limited extent, since the most varied sizes and types have to be made and kept in stock. Furthermore, such metal heater units have the disadvantage of being considerably prone to corrosion and, particularly, of being sensitive to ions. A further disadvantage of such metal heater units resides in the virtually unattainable control of sound, flow noises and, particularly, cracking noises being unacceptably apparent with such metal heater units. It is also a disadvantage that such metal heater units always have to be installed as separate constructional components and cannot be incorporated as constituent parts of the actual building.

The invention is based upon the purpose of providing a heat-exchanger component for building purposes of the kind mentioned initially, which permits industrial prefabrication and has practically any desired adaptability to specific heat requirements and building constructions, is practically free from corrosion problems and servicing requirements, itself ensures a high level of sound-damping and finally can be installed as a component of the actual building during the construction process. This is achieved above all, in accordance with the invention, in that ducts for conveying heat-transfer medium are so formed as channels in the component, comprising a body unit of a ceramic foam material and outer wall regions adjacent the body unit and comprising a material of higher heat conductivity than the body unit, that at least the outwardly-facing channel wall is formed of the material of the outer wall regions. As the ceramic foam material for the body unit and, if required also for the outer wall regions, as described in more detail in the following, there is preferably used a ceramically-bonded expanded clay block, such as described essentially in DE-PS 1914372. The formation of channels in such a body unit with the outer wall regions enables the component to be manufactured by industrial prefabrication with large dimensions and then this component is cut into lengths or is divided into parts of the desired dimensions, according to heating or space requirements. In this way, substantially total adaptability to the existing building construction is achieved. The ceramic foam material and the ceramic material of the outer wall regions are to be regarded as completely heat- and corrosion-resistant. They are free from hydraulic binding agents and organic substances, so that no sensitivity to corrosion of ions arises. The ceramic foam material of the body unit is itself sound-damping and thus itself prevents flow and cracking noises when in use as a heating or cooling component. Such a component can be used in any duct system and, in particular, in heating systems, particularly in open systems with oxygen entry and frost protection requirements, without there being any likelihood of corrosion occurring. A further essential advantage of the component according to the invention is that the ceramic foam material or the ceramically-bonded swelled clay block or unit can have such a strength that it can be used directly as a self-supporting component in the building, namely as a constituent of floors, particularly as a direct floor component with under-floor heating or cooling, as a wall component in all rooms having heating and cooling requirements, and also as ceiling components, likewise for heating or cooling purposes. Moreover, formation from the body unit of ceramic foam material and from the outer wall regions of ceramic material enables advantageous application in the fitting out of buildings and, particularly the up-grading of old buildings, since the components themselves provide additional thermal insulation and also can be used directly as additional heating or cooling units. The heat-exchanger component according to the invention can thus not only form wall elements, but also building blocks for the construction of floors and flat and other roofs and can also be installed separately, in the same way as the usual heater units, for heating other rooms or also water tanks and, particularly, swimming pools or the like, since, owing to the ceramic outer wall regions, the outer surfaces are corrosion-resistant and non-rottable as well as being anti-corrosive. The manufacture of the components according to the invention can be carried out in simple ways, by making the body unit of ceramic foam material and the outer wall regions and then boring or drilling the desired ducts for the duct system required, the channels for the heattransfer medium bordering at least on one side the outer wall regions of higher heat conductivity, in order to ensure the necessary heat transfer with the outer surfaces.

From the production and particularly the industrial production in large quantities and also the desired function, a particular advantage is given, if in the further development of the invention the body unit and the outer wall regions consist of ceramic foam material in one piece, the channels are made in the foam material and the outer wall regions are formed by compressing the foam material to a higher heat conductivity in comparison with the body unit *per se*. Such a component can be made as a stock product in large lengths and dimensions and can then be cut to the desired dimensions according to the particular conditions of use. A compact component is thus given, which is particularly suitable for installation as a load-bearing and, in particular, as self-supporting component of building units, as explained above.

In the further development of the invention, channels are preferably made, in the body unit and in the outer wall regions, on two opposed sides of the component. In this way, it is possible to instal the component as a double heating or double cooling unit which, for example, then functions as a wall component with a heat concentrating zone and can be operated correspondingly from either side of the wall. It is thus also possible, with such a component, to use one wall region e.g. for the reception of external heat and the other, as a rule the inwardly-located region, for heat removal. The component is then most preferably connected to heat-circulation systems which operate with heat stores and heat pumps.

With the aforementioned provision of the component according to the invention with the compressed or denser outer wall regions of foam material, these denser outer wall regions are preferably produced in the pyroplastic state during the manufacturing process itself, namely during the actual heating process for manufacturing the whole component of ceramic foam material. Then, the required channels can be formed in the desired configuration, particularly being bored or drilled out.

According to another embodiment of the invention, at least part of the channels are formed as one-sided open longitudinally-extending cavities in the surface of the body unit, which are then completed and closed by panel-like cover portions forming an outer wall region, e.g. of ceramic material. The body unit can thus be provided in its open construction with the desired duct configuration to the particular desired dimensions by initial forming or by cutting out the ducts, after which the component is completed with the aid of the cover portion or portions and the desired duct configuration is then closed.

In another embodiment of the invention, it is also possible for at least a part of the channels to be constructed as one-sided open longitudinally-extending cavities in panel shaped cover portions, forming an outer wall region, which cavities are then closed, i.e. completed, by means of the surface of the associated body unit. In this case, the body unit can be made as a simple constructional block and then forms the actual inner walls of the channels for the heat-transfer medium, whilst the panel-like cover portions contain the duct configuration and the desired channels in the entire component are formed after the cover portions are combined with the body unit.

If the component is formed by first making a prefabricated part to the largest possible dimensions and then subdividing it to the desired sizes, the problem then arises of suitably interconnecting the separate channels. In accordance with a further feature of the invention, this can be done particularly suitably if a plurality of parallel channels are provided, running in the longitudinal direction of the components and having their open ends in the end faces of the component, and are connected together either by associated channel ends at the end faces formed by cavities in the body unit and closed by means of cover plates located against the end faces or formed in associated cover plates located against the end faces. A simpler first form of component can be made, only containing longitudinal channels, which is then cut off to the desired length and completed at the end faces by means of individual connecting elements. The cover plates at the end faces are suitably provided with apertures which are associated with predetermined open channel ends, for completing the supply duct system. In this way, a continuous duct system in the subsequent installation is ensured, even in the cover plates.

For the heat exchange function of the component, it is also preferable if, in accordance with a further feature of the invention, the outer surface of the outer wall region containing the channels is enlarged by profiling. This profiling can simply be produced when forming the more dense outer wall regions of the cover plates used as the outer wall regions can be provided during manufacture with such profiled shapes.

Suitably, in accordance with a further feature of the invention, at least the channel walls formed from the material of the body unit are provided with a smooth covering layer, which consists advantageously of a ceramic glaze and, in this case, can be produced likewise by compressing or making more dense the surface of the ceramic foam material, either during manufacture of the body unit or of the one-piece component or also the cover plates during the heating process or by subsequent heat treatment. Such a covering layer and particularly such a ceramic glaze exhibits a very fine micro-roughness and is thus anti-adhesive and practically maintenance-free. It is also possible, however, to provide a smooth covering layer of plastics material on the walls of the channels, e.g. of heavy-duty ("duromeric") or "plastomeric" plastics materials.

The actual configuration of the channels in the body unit and the outer wall regions can be chosen corresponding to existing use requirements and with reference to prefabrication, the required duct connections being made via the end faces in the way indicated. Thus, it is possible in particular to provide the component with meandering channel formations, in order to produce especially effective heat exchange. In the desired two-sided provision of channels, the configurations of these channels can be optimally adapted to the desired purposes of use. Thus, in using the component according to the invention as a wall element, a channel formation adapted to this function is selected and another configuration is chosen for use as a floor or ceiling element for under-floor or ceiling heating or cooling. For building renovation purposes, the wall thickness and channel configuration are optimally selected to provide the thermal insulation function, on the one hand, and the heat-exchange function, in particular the heating function, on the other hand.

Further features, advantages and details of the invention will appear from the following description of several embodiments of the invention, given in conjunction with the accompanying drawings, in which:

Fig. 1 shows a part-sectional side view, with one cover plate removed from the associated end face, of an embodiment of a heat-exchanger component according to the invention;

Fig. 2 shows a sectional view of the component of Fig. 1 along II—II;

Fig. 3 and 4 also show cross-sections through parts of other embodiments of components according to the invention;

Figs. 5 and 6 show longitudinal sections through two other embodiments of the component according to the invention, with different duct connections at the end faces.

In Figs. 1 and 2 of the drawing, a first embodiment of a block-shaped or plate-shaped heat-exchanger component for building purposes according to the invention is shown, which can be installed particularly for use as a heating or cooling body, being shown in this embodiment as a wall element with a heat-exchange function on both sides.

The component includes firstly a body unit 1 of ceramic foam material, particularly a ceramically-bonded swelled clay block. This body unit 1 of ceramic foam material is indicated in Figs. 1 and 2 with wide cross-hatching. As Fig. 2 shows, adjacent this body unit 1 and formed in one piece with it, outer wall regions 2 are formed from the same ceramic foam material, though in these outer wall regions 2 the foam material is compressed or densified to have a higher heat conductivity, as illustrated by the narrow cross-hatching in Fig. 2.

In this body unit 1, with its outer wall regions 2 and 3, channels 4 and 5 for conveying a heat-transfer medium are formed on both sides, e.g. they are bored out, so that at least the outwardly-facing channel wall is formed from the material of the outer wall regions 2 or 3, as can be seen from Fig. 2.

The densifying of the foam material in the outer wall regions 2 and 3 is preferably carried out in the pyroplastic state of the foam material, during the manufacturing process. Moreover, as Fig. 2 likewise shows, the actual outer surface of the outer wall regions 2 and 3 containing the channels 4, 5 is enlarged by profiling, here being of wave shape. The channels 4 and 5 are formed in the desired number on both sides as longitudinal channels.

With the component constructed in this way, a two-sided heating and cooling unit according to Fig. 1 can be made. Thus, the parallel longitudinal channels 4 and 5 have open ends at the end faces of the component assembled from the parts 1, 2 and 3 and associated channel ends in the end faces are connected together by means of recesses 6 in the cover plates 7, which cover plates 7 are butted against the end faces of the components 1, 2 and 3, as Fig. 1 shows. Connection is tnen preferably made by adhesion or by suitable coupling means under the action of heat. The cover plate 7 applied at the left in Fig. 1 is also provided with apertures 8, which are associated with the respective upper and lower open channel ends, for their further connection. These apertures 8 are then employed to connect the assembled heating and cooling units to the remaining duct system. The cover plates 7 preferably likewise consist of ceramic foam material, either in the base or body form or also in the more dense form. The channels 5, recesses 6 and apertures 8 illustrated in the sectioned part of Fig. 1 are in practice provided on both sides in accordance with Fig. 2, it will be understood.

In the embodiment illustrated in Fig. 3, the channels 9 in the body unit 1*a* of ceramic foam material are formed as one-sided open longitudinally-extending recesses in the surface of the body unit 1 and are closed by a plate-shaped cover part 10 forming the outer wall region and consisting of ceramic material of increased heat conductivity. The cover part 10 can likewise consist of ceramic foam material made denser so as to have a higher heat conductivity. It can also be seen here that the body unit 1*a* can be simply prefabricated with its channels 9 on one or two sides, the channels 9 being drilled out for example, whereupon the entire component can then be assembled by fitting on the cover plates 10 and thus completing the channels 9.

Fig. 4 shows a modified embodiment. In this embodiment, the component is formed from a plain block-shaped body unit 1*b* of ceramic foam material. The channels 11 are formed as one-sided open longitudinally-extending recesses in a plate-shaped cover part 12 forming an outer wall region, which recesses 11 are closed as shown in Fig. 4, by the associated surface of the body unit 1*b*. Fig. 4 also shows the outer profiling of the plate-shaped cover part 12, which enlarges its surface.

Fig. 5 shows another embodiment of means for the connection of parallel channels 5 in the body unit 1 of ceramic foam material, similar to Fig. 1. The duct connections at the end faces of mutually separate channels 13 are made in a two-sided cover plate 14 and likewise there are connecting apertures in the left hand cover plate 14. The channels 13 can first be provided throughout the cover plate and can then be separated from one another by closure elements 15. With two-sided use of the left-hand cover plate 14, as illustrated, the connecting apertures can be blocked off with closure plugs or the like, as is illustrated for the longitudinal sides by the closure elements 15. Also, in the embodiment according to Fig. 5, channels can naturally be provided on both sides, as illustrated in Fig. 2.

In the embodiment according to Fig. 6, the channels 5*a* are formed in meandering fashion and pass throughout the body unit 1 of ceramic material, such that the connecting sections 5*b* run along the end faces of the body unit 1 and so are open at one side. These connecting sections 5*b* of the channels 5*a* are then covered on both sides of the end faces by cover plates 16, the lefthand cover plate 16 including through-going apertures 17.

All the cover parts and cover plates consist of ceramic material, preferably the same ceramic material as the actual body units 1, 1*a*, 1*b*, most preferably being ceramic foam material made denser to have a higher heat conductivity, as is illustrated in the various drawings by the narrow cross-hatching.

Furthermore, the inner walls of all the channels, connecting ducts and apertures are preferably provided with a smooth covering layer, consisting advantageously of a ceramic glaze. From the embodiments here illustrated and the above description, it can be seen that at least the body units 1, 1*a*, 1*b* can be prefabricated to any desired maximum dimensions and can then be cut to length or otherwise subdivided into the desired end sizes. Also, mid-line separation of a body unit 1 with channels 4 and 5 according to Fig. 1 into two plate-shaped heat-exchanger components each provided with channels on one side is possible, which units can be installed for example as floor, ceiling or wall ducts with a heat exchange function. Fig. 2 shows particularly clearly also that the component according to the invention can be installed as a constructional element in other building components, e.g. as a wall, floor or ceiling element. Figs. 1 and 2 also make it clear, however, that such a component can also be installed as a separate heating and/or cooling body in buildings or also in swimming pools or the like, in order to exert the desired heat-exchanger function.

The component according to the invention can also be provided with vertical apertures for the reception of additional ducts or additional heating elements. Furthermore, in the channels indicated, particularly in view of their corrosive neutrality, additional heating elements or heating ducts can be provided, which can be switched on for use when required as emergency or additional heating. This can be advantageous, for example, particularly for the rapid heating of rooms used only briefly and for frost protection. The entire heat-exchange component according to the invention is thus completely corrosion-free both outside and inside and moreover, because its body unit is of ceramic foam material, it has particularly high sound-damping. Finally, the entire material of the component according to the invention is non-combustible and also non-swellable, which is especially advantageous in view of existing building regulations.

It is important for the invention that the actual channels are provided at least on their outer walls with an outer wall region of higher heat conductivity, whereas inwardly the body unit of ceramic foam material provides not only mechanical strength, but also heat and sound insulation. As already mentioned, it is thus possible to instal such a component at least on the one side for heat supply through the outer wall region of higher heat conductivity and to remove the heat so absorbed through the channels.

As the heat transfer medium, all gaseous or vapour-form and fluid media can be used, particularly water.

The above-described cover parts 10 and 12 and also the cover plates 7, 14, 16 for the end faces can also be made of ceramic or also metallic materials, wherein in the latter case the channel walls are preferably coated and, most preferably, are enamelled. The outer walls of the cover parts 10 and 12, particularly those of metallic materials, can also be provided externally with a suitable coating for the reception of solar energy, so that the entire unit can be used as a form of solar collector. Also, it is possible to provide cover parts and/or cover plates of ceramic material, which can be combined inwardly or outwardly with metallic materials.

The covering layers or the surfaces of the channels can further consist of fibre-reinforced plastics materials, particularly heat-conducting fibre-reinforced plastics materials, the latter serving to improve heat exchange.

Claims

1. A block-shaped or panel-shaped heat-exchanger component for building purposes, particularly heating or cooling units, having ducts therein for conveying a heat-transfer medium, wherein the ducts comprise channels formed in a component comprising a body unit of ceramic foam material and outer wall regions of a material of higher heat conductivity than the body unit, at least the outwardly-facing channel walls being formed of the material of the outer wall regions.

2. A component according to claim 1, wherein the body unit and the outer wall regions are made in one piece of ceramic foam material, the channels are made in the foam material and the outer wall regions are formed by making the foam material denser to have a higher heat conductivity.

3. A component according to claim 1 or 2, wherein at least part of the channels are formed as one-sided open longitudinal recesses in the surface of the body unit, which recesses are

closed by plate-shaped cover parts forming an outer wall region.

4. A component according to claim 1 or 2, wherein at least part of the channels are formed as one-sided open longitudinal recesses in a plate-shaped cover part forming an outer wall region, which recesses are closed by the associated surface of the body unit.

5. A component according to any of claims 1 to 4, wherein a plurality of parallel channels in the longitudinal direction of the component run open-ended into the end faces of the component and associated channel ends are connected together by cover plates with recesses which are locatable against the end faces or in associated cover plates locatable against the end faces.

6. A component according to claim 5, wherein the cover plates for the end faces are provided with apertures which are associated with predetermined open channel ends for further connection.

7. A component according to any of claims 1 to 6, wherein channels are provided in the body unit and in the outer wall regions on two opposed sides of the component.

8. A component according to any of claims 1 to 7, wherein the outer surfaces of the outer wall regions containing the channels are enlarged by profiling.

9. A component according to any of claims 1 to 8, wherein at least the channel walls formed from the material of the body unit are provided with a smooth covering layer.

10. A component according to claim 9, wherein the covering layer comprises a ceramic glaze.

11. A component according to any of claims 1 to 9, wherein the covering layer comprises fibre-reinforced plastics material.

12. A component according to any of claims 1 to 9, wherein the covering layer comprises heat-conducting fibre-reinforced plastics material.

13. A component according to any of claims 1 to 12, wherein the cover parts and/or the cover plates comprise ceramic material.

14. A component according to any of claims 1 to 12, wherein the cover parts and/or the cover plates comprise metallic material.

15. A component according to claim 14, wherein the channel walls of the cover parts and/or the cover plates are enamelled.

16. A component according to claim 14 or 15, wherein the cover parts are provided externally with a coating for the reception of solar energy.

17. A component according to claim 1, substantially as described with reference to Figs. 1 and 2, Fig. 3, Fig. 4, Fig. 5 or Fig. 6 of the accompanying drawing.

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