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(54) RADIATION HEATING APPARATUS

STRAHLUNGSHEIZGERÄT

APPAREIL DE CHAUFFAGE PAR RAYONNEMENT

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Description

[0001] The present invention relates to a radiation heating apparatus according to the preamble of claim 1.

[0002] Heat pumps are widely used for heating indoor environments, often in air-conditioning systems allowing the indoor temperature of the environment to be raised in the winter season and to be reduced in the summer season.

[0003] Prior art has led to very high performance coefficients therefore making the heat pump technology in the heating field competitive than other technologies based on the use of electric energy and on the combustion.

[0004] As regards heating there are several ways for transferring heat conveyed to the indoor environment.

[0005] A first possibility for transferring heat conveyed to the indoor environment is to use a carrier fluid, typically water, which comes in thermal contact with the condenser, absorbs heat from said condenser and then is conveyed into ducts up to heat exchangers, such as radiators or the like, where it transfers heat to the indoor environment by radiation and to the surrounding air by convection.

[0006] Such solution has some drawbacks among which a lower energy efficiency during the several heat exchanges of the carrier fluid, the condenser and the heat exchangers to the environment, and the need of having a dedicated system for the carrier fluid, with a relevant system for pumping such carrier fluid into the ducts, with a consequent increase in production, installation and maintenance costs.

[0007] On the contrary, a second possibility for transferring heat conveyed to the indoor environment provides the use of forced air flow generating means, by means of which said forced air flow is conveyed through said condenser, where it absorbs heat, then it is released in the environment or conveyed through ducts to suitable mouths for releasing and transferring it into the environment.

[0008] The drawback of such solution is that the heat exchange occurs by convection by circulating the surrounding air; this can cause the user to feel less heat due to the phenomenon of the physiological evaporation of body moisture, which is enhanced by the movement of air on the skin, therefore making it necessary to provide a higher amount of heat in order to reach a higher temperature with the user feeling the same heat.

[0009] Document EP0269282 discloses a radiation heating apparatus according to the preamble of claim 1.

[0010] The present invention provides to solve the prior art drawbacks by a radiation heating apparatus showing the combination of features of claim 1.

[0011] Said condenser comprises a plurality of condensation ducts which are arranged according to a predetermined arrangement and which are connected to a manifold supplying the conduction fluid in its gaseous state and within which condensation ducts said conduction fluid in its gaseous state is converted into the liquid state releasing condensation heat thereto.

[0012] According to an embodiment said radiant members are composed of the shell surfaces of the condensation ducts, such shell surfaces of the condensation ducts being provided with fins or with surfaces for the heat exchange with surrounding air.

[0013] According to a further embodiment said radiant members are finned elements which can be applied on said condensation ducts such to be in thermal contact therewith.

[0014] According a preferred embodiment each one of said radiant members that can be applied on said condensation ducts is provided with a through hole for housing at least a condensation duct and it is in thermal contact therewith.

[0015] Radiant members can have several shapes and size.

[0016] According to an embodiment said radiant members are substantially cylindrical elongated elements, through which said longitudinal hole housing a condensation duct passes and they have fins arranged lengthwise the shell surface and radially oriented.

[0017] In a preferred embodiment said radiant members are parallelepiped shaped elongated elements having such a thickness that said hole housing a condensation duct passes therethrough lengthwise and on the side surfaces they have fins lenghtwise arranged and parallel each other.

[0018] By such embodiment, when two or more condensation ducts are provided arranged one near the other such to subtend an ideal plane, fins of the individual radiant members are oriented parallel each other and perpendicularly to the plane subtended by the individual condensation ducts, while the extension of said radiant members in the direction of the distance between the individual condensation ducts is such that said radiant members of adjacent condensation ducts are in contact one another by side contact surfaces facing each other. Therefore an assembly of condensation ducts with the corresponding radiant members forms a substantially continuous radiant member extending along said alignment plane of said condensation ducts.

[0019] It has to be noted that the configurations described above can be directly provided on the condensation ducts without the aid of radiant members that can be fitted thereon.

[0020] According to a further embodiment said condensation ducts are arranged according to a predetermined arrangement and are connected in parallel to a manifold supplying the conduction fluid in its gaseous state and the shell surfaces of the condensation ducts are arranged along a envelope tangent surface thereof or at diametrically opposite sides along two envelope surfaces tangent to the shell surfaces of said condensation ducts.

[0021] Said radiant heat exchanger is therefore composed of said condenser and said radiant members com-

posed of one or more radiant plates each one extending along one of said envelope surfaces tangent to the shell surfaces of said condensation ducts respectively.

[0022] Said condensation ducts are arranged one near the other at a predetermined distance and are arranged along a surface that is flat or curved at least according to an axis of curvature, said radiant plate being flat or curved respectively.

[0023] This allows radiant plates to have any shape and curvature, according to the arrangement, size and curvature of the ducts, whose shell surfaces are the envelope tangent surfaces along which said plates extend.

[0024] In an advantageous emodiment there are provided two radiant plates parallel each other with condensation ducts interposed therebetween in contact with each one of said two plates.

[0025] The condensation ducts and the radiant members are made of high thermal conductivity material.

[0026] A further improvement consists in the fact that the diameter, the length and the number of the condensation ducts are optimized on one hand in relation to the heat transfer and the condensation from gaseous state to liquid state of said conduction fluid, and on the other hand in relation to the reduction of the gurgling acoustic level generated by said state conversion.

[0027] In particolar the ratio between the diameter and the length of each condensation duct is comprised between 0.01 and 0.02, and is preferrably about 0.015.

[0028] In a preferred and not limitative embodiment the invention provides an apparatus as described hereinbefore, housed within a cabinet having at one of its sides, preferably the front side, a recess intended for housing said radiant heat exchanger such that said radiant heat exchanger is substantially included in the volume of said cabinet.

[0029] Moreover said radiant heat exchanger is spaced from the walls of said recess such that there is an air channel passing between said radiant heat exchanger and said recess.

[0030] Thus the radiant heat exchanger acts in every respects as a normal radiator, both transferring heat to the environment by radiation, and by convection with the surrounding air, the latter passes through said channel between the radiant heat exchanger and said recess wherein such heat exchanger is housed, is heated and then released into the environment.

[0031] Preferably said plates in thermal contact with the condensation ducts have a rectangular, flat shape, are composed of aluminium and have a finned surface such to incrase the surface to volume ratio of said radiant plates and/or the surface for the heat exchange with the surrounding air, thus supporting the heat being transferred by the radiant heat exchanger to the environment.

[0032] Advantageously the finning of said surface of said radiant plates has such a size on one hand to maximize the heat transfer to the environment and on the other hand however preserving a pleasant aesthetic appearance for gratifying the user.

[0033] In a further embodiment the apparatus has a second heat exchanger composed of a condenser with air flow heat exchange means and of means generating a forced air flow through said heat exchange means of the condenser, a surrounding air intake port, and a port for releasing air into the environment being provided.

[0034] In a further embodiment the apparatus comprises means for generating a forced cooling air flow which can be operated as an alternative and/or in combination with said heat exchange means to the environment by radiation and/or forced air flow.

[0035] Such means generating a forced cooling air flow are composed of an evaporator/condenser and of heat exchange means associated thereto and of means generating a forced air flow through said heat exchange means of the evaporator/condenser, which air is taken from the environment upstream of said evaporator/condenser and it is released into the environment after the heat exchange with the evaporator.

[0036] In a further embodiment the apparatus has photovoltaic means for generating electric energy, said means having such a size that the surface generating the electric energy exposed to the sun guarantees enough electric energy for independently feeding the heating apparatus.

[0037] This is possible due to the low energy consumption guaranteed by the present invention in comparison with prior art heating systems.

[0038] It is possible to reach this energy autonomy both as regards a single user, and above all as regards mains supply with a power supply company, where energy provided to the mains supply and energy taken from the mains supply is substantially equal.

[0039] In further embodiments the apparatus is housed into a cabinet having such a shape and size that it can be placed under a window; otherwise it is housed into a cabinet having such a shape and size that it can be suspended on a wall and/or ceiling; otherwise it has said heat exchangers that can be fitted on a wall such as common radiators, and the possible means generating the forced heating or cooling air flow mounted on a wall or ceiling, or as an alternative they can be arranged far from the location where said forced air flow is released and spread in the environment, such forced air flow being conveyed by ducts to suitable mouths releasing and spreading it into the environment.

[0040] Further characteristics and improvements are the subject of the claims.

[0041] These and other characteristics and advantages of the present invention will be more clear from the following description of some embodiments shown in annexed drawings wherein:

Fig.1 is a diagram of the operation of the present invention with a radiant heat exchanger;

Fig.2 is a diagram of operation of the present invention with a radiant heat exchanger and with a forced heating air flow heat exchanger;

Fig.3 is a diagram of the operation of the present invention with a radiant heat exchanger and with a forced cooling air flow heat exchanger;

Fig.4 is an embodiment of the apparatus of the present invention, according to which heat exchangers are housed into a cabinet;

Fig.5 is a section view of said embodiment of the apparatus of the present invention;

Fig.6 is an embodiment of said radiant members;

Fig.7 shows three of the possible sections of said radiant members;

Fig.8 is a cross-section view of a part of an embodiment of said radiant heat exchanger;

Fig.9 shows the conversion from the gaseous state to the liquid state of the conduction fluid within condensation ducts having a different diameter;

Fig.10 shows said embodiment of said radiant heat exchanger, with the front radiant plate omitted for clarity purposes.

Fig.1 shows a diagram of the operation of the present invention in winter mode, wherein an outdoor environment 4 and an indoor environment 5 are shown, which are thermally separated by a wall 45.

[0042] In the outdoor environment 4 there is provided an outer heat exchanger 3, composed of an evaporator 31, heat exchange means 32 and means 33 generating an air flow through said heat exchange means 32, where the conduction fluid passes from the liquid state to the gaseous state, absorbing heat from the environment.

[0043] In the outdoor environment 4 there is also provided a compressor 2, which as an alternative can be placed in the indoor environment 5 according to a further embodiment, which is shown by way of example in figure 2.

[0044] The indoor environment 5 is provided with a radiant heat exchanger 1 wherein said conduction fluid is conveyed after having been pressurized by said compressor 2, and said radiant heat exchanger 1 is composed of a condenser 11 wherein the conduction fluid passes from the gaseous state to the liquid state, transferring heat (the so called condensation latent heat) to said condenser 11, and of one or more high thermal conductivity radiant members 12 thermally contacting said condenser 11, which transfer heat to the environment by radiation and convection by being heated.

[0045] For an efficient working of the condenser 11, it is important that the conduction fluid is able to release easily heat to the environment during the passage to the liquid state.

[0046] For this reason, in an embodiment of the present invention, the said radiant members 12 have a thermal conductivity wich is higher than 40 $W \times K^{-1} \times m^{-1}$, and preferably higher than 100 $W \times K^{-1} \times m^{-1}$.Fig. 2 shows a diagram of the operation of the present invention according to a further embodiment with respect to figure 1, still in the winter mode, providing, in addition to said radiant heat exchanger 1, a forced heating air flow heat exchanger 6, composed of a condenser 61 wherein the conduction fluid passes from the gaseous state to the liquid state, transferring heat to said condenser 61, of heat exchange means 62 and of forced air flow generating means 63 generating said forced air flow 64 and conveying it through said condenser 61 and/or said heat exchange means 62 heating it and then releasing it into the environment.

[0047] Such forced heating air flow heat exchanger 6 is connected in parallel to said radiant heat exchanger 1 and can be activated or deactivated by means of valves V1 and V2.

[0048] Figure 3 shows a diagram of the operation of the present invention according to a further embodiment with respect to fig.1, which can operate also in summer mode and providing, in addition to said radiant heat exchanger 1, a forced cooling air flow heat exchanger 7, which can be used as an alternative to said radiant heat exchanger 1, thus allowing the apparatus to operate alternately in a mode heating or cooling the environment.

[0049] In the environment cooling mode the evaporator 31 acts as a condenser, namely the flowing direction of the fluid is reversed and the evaporator/condenser 31 receives the pressurized conduction fluid from the compressor 2, and by converting said conduction fluid from the gaseous state to the liquid state it transfers heat to the outdoor environment 4.

[0050] Said forced cooling air flow heat exchanger 7 is composed of an evaporator 71 wherein the conduction fluid is converted from the liquid state to the gaseous state, absorbing heat, of heat exchange means 72 and of forced air flow generating means 73 which generate said forced air flow 74 and convey it through said evaporator 71 and/or said heat exchange means 72, cooling the air and then releasing it into the environment.

[0051] Such forced cooling air flow heat exchanger 7 is connected in parallel to said radiant heat exchanger 1 and it can be activated or deactivated via valves V3, V4, V5, V6.

[0052] When valves V3 and V5 are opened, valves V4 and V6 are closed, as seen in figure by broken lines, said radiant heat exchanger 1 is activated, said forced cooling air flow heat exchanger 7 is deactivated and the system works in a heating mode.

[0053] As an alternative, when valves V4 and V6 are opened, valves V3 and V5 are closed, said forced cooling air flow heat exchanger 7 is activated, said radiant heat exchanger 1 is deactivated, the fluid reverses its direction, and the system operates in cooling mode.

[0054] Advantageously valves V3, V4, V5 and V6 can be replaced by a single, properly connected, four-way valve, which adjusts the flowing direction of the conduction fluid coming out from the compressor 2.

[0055] By selectively closing the four valves in combination with the flowing direction of the conduction fluid it is possible to have four operating modes:

- winter mode wherein valves V4 and V6 are closed

and the heat exchanger 7 is excluded from the circuit, valves V3 and V5 are opened, the evaporator/condenser 31 acts as an evaporator and the heat exchanger 1 transmits heat to the indoor environment; such mode corresponds to that shown in fig.1.

- winter mode wherein valves V3 and V5 are closed and the radiant heat exchanger 1 is excluded from the circuit, valves V4 and V6 are opened, the evaporator/condenser 31 acts as an evaporator and the heat exchanger 7 transmits heat to the indoor environment.
- winter mode wherein valves V3, V4, V5 and V6 are opened, the evaporator/condenser 31 acts as an evaporator and the heat exchangers 1 and 7 transmit heat to the indoor environment; such mode corresponds to that shown in fig. 2.
- summer mode wherein valves V3 and V5 are closed and the radiant heat exchanger 1 is excluded from the circuit, valves V4 and V6 are opened, the evaporator/condenser 31 acts as a condenser and the heat exchanger 7 brings cooling air within the indoor environment.

[0056] Fig. 4 shows an embodiment of the apparatus of the present invention, according to which the heat exchangers are housed within a cabinet 8, and said cabinet 8 has a front recess 81 intended for housing said radiant heat exchanger 1, a surrounding air intake port 82 and a port 83 for releasing air into the environment, through which ports the surrounding air is withdrawn, heated or cooled, and realased into the environment, a forced air flow heat exchanger, not shown in the figure, being provided into the cabinet.

[0057] Fig. 5 is a cross-section view of said embodiment of the apparatus of the present invention, according to which heat exchangers are housed within a cabinet 8.

[0058] Said cabinet 8 has said front recess 81 intended for housing said radiant heat exchanger 1, said radiant heat exchanger 1 being composed of said condenser 11 and said radiant members 12, and moreover said radiant heat exchanger 1 being spaced from the walls of said recess 81 such that an air channel 84 is formed passing between said radiant heat exchanger 1 and said recess 81.

[0059] Said air channel 84 is run by an air flow 18, heating the air that finally is released into the environment.

[0060] Said cabinet 8 has also said surrounding air intake port 82, through which the surrounding air, by said forced air flow generating means 63, is withdrawn and conveyed through said heat exchanger 6, then released into the environment, after having been heated, through said port 83 for releasing air into the environment.

[0061] As already said, in the same configuration, by reversing the flowing direction of the condution fluid such heat exchanger 6 can be used as a refrigerator for generating a forced cooling air flow, instead of an heating one, to be used as an alternative to said radiant heat exchanger 1.

[0062] Fig. 6 shows a front view of the radiant members 12, composed of parallelepiped shaped elongated elements 120 having such a thickness that a longitudinal hole 122 housing a condensation duct passes therethrough and having fins 121 arranged lenghtwise on the side surfaces.

[0063] Said radiant members 12 that can be seen in the figure can be put one near the other, each one applied on a condensation duct, and at the front they can be provided with the flat surface 123 that can be seen in the figure.

[0064] In a further embodiment they can be rotated by 90° about the longitudinal axis passing by the longitudinal hole 122 such that the finned surface 124 is on the front thereof.

[0065] Fig.7 shows three examples of possible sections of said radiant members 12.

[0066] Section A is the same section shown in figure 6, wherein fins 121 are lengthwise arranged on the parallelepiped shaped elongated element 120, the longitudinal hole 122 housing a condensation duct passes therethrough.

[0067] Section B is substantially equal to section A but fins 121 are arranged in a different way.

[0068] Section C shows a section of a radiant member composed of a substantially cylindrical element 125 through which said longitudinal hole 122 housing a condensation duct passes and it is composed of fins 121 which are lengthwise arranged on the shell surface and are radially oriented.

[0069] In an alternative embodiment the radiant member is composed of the condensation duct itself, which has such a shape that fins 121 are lentghwise arranged and radially oriented on the shell surface.

[0070] Fig.8 shows a section view of a part of an embodiment of said radiant heat exchanger 1, which radiant heat exchanger 1 is composed of a condenser 11, which is composed in turn of a plurality of ducts 111, and of two radiant members 12 in the form of plates made of high thermal conductivity material, preferably of aluminium, in thermal contact with said ducts 111, which radiant plates 12 have fins 121 extending parallel each other throughout all the extension of the radiant plates 12, said fins 121 being intended for increasing the surface to volume ratio of said radiant members 12 and/or the surface for the thermal exchange with the surrounding air.

[0071] Broken lines 86 and 87 are the back wall and the open front wall respectively of said recess of said cabinet wherein said radiant heat exchanger 1 is housed.

[0072] Fig.9 shows the gaseous to liquid state conversion of the conduction fluid within the condensation ducts having a different diameter.

[0073] Within a condenser the conduction fluid in the gaseous state transmits heat to the condenser itself, at the beginning it being converted to the liquid state along the inner walls of the ducts of said condenser; thus there is the situation where the conduction fluid is in its liquid

state along the walls of the ducts but it is in its gaseous state yet at the core of said ducts.

[0074] Such condition leads to relative movements between the gaseous state and the liquid state of said conduction fluid, and such movements can be heard from the outside as gurgling noises.

[0075] In the prior art the noise generated by the forced air flow generating means, such as fans or the like, makes hard to hear said gurgling noises; on the contrary, with an apparatus as the one according to the present invention, wherein the forced air flow is not provided or is considerably reduced, such gurgling noises can be more evident, this being a drawback.

[0076] This is overcome by suitably sizing the ducts: the figure shows two ducts E and F, having the same length x, with a diameter D and d respectively, where D > d; in both the ducts the liquid state 113 is already condensed on the duct walls and the gaseous state 112 is in the core, persisting for a predetermined length, before being completely condensed.

[0077] Such predetermined length changes depending on the diameter and so on the surface/volume ratio of the duct, and it is L for duct E and 1 for duct F, where L > 1.

[0078] Therefore, by using ducts with a smaller diameter, the length of the duct portion where the gaseous state and the liquid state coexist is reduced, reducing the acoustic level of the generated gurgling noise; moreover a greater number of ducts is necessary, increasing the radiant surface the volume being the same, obtaining a better transfer of heat, and reducing the speed of the refrigerant fluid passing through the condensation ducts.

[0079] The fact that the transfer of the condensation heat occurs at a short portion 1 of the duct instead of at a large portion of the whole length of the duct, is not a drawback due to the high thermal conductivity materials that are selected, preferably metals, in particular copper as regards ducts and aluminium for radiant members in thermal contact with said ducts, reducing the dishomogeneity in transferring heat between the upper portion and the lower portion of the radiant heat exchanger.

[0080] Particularly, for the optimization of the reduction of the acoustic level of the generated gurgling noise in relation to the release of heat, the ratio between the diameter and the length of each condensation duct is comprised between 0.01 and 0.02, and is preferably about 0.015.

[0081] According to an embodiment of the present invention the diameter of each condensation duct is between 0.3 cm and 1 cm, in particular between 0.4 cm and 0.8 cm, and the length of each condensation duct is between 20 cm and 80 cm, in particular between 40 cm and 60 cm.

[0082] Away from this reference values, it is possible to foreseen every desired shape or number or dimension of the condensation ducts.

[0083] Fig. 10 shows said embodiment of said radiant heat exchanger 1, where radiant members are as plates, and wherein the front radiant plate is omitted for clarity purposes and the rear radiant plate 12 is in thermal contact with the condenser 11, which is composed of a plurality of ducts 111.

Claims

1. Radiation heating apparatus composed of a heat pump that compresses by means of a compressor (2) a conduction fluid in the gaseous state causing it to be transformed to the liquid state into a condenser (11) consequently said condenser (11) transferring heat to the environment (5),
it comprises radiant heat exchangers with the environment (5) which are composed of said condenser (11) comprising a plurality of condensation ducts (111) and of one or more finned radiant members (12) made of a material with thermal conductivity higher than 40 $W \times K^{-1} \times m^{-1}$, and preferably higher than 100 $W \times K^{-1} \times m^{-1}$, which radiant members (12) are applied on said condensation ducts (111) and are in thermal contact with the condenser (11) for transferring heat of condensation from said condenser (11) to said radiant members (12),
said device has a second heat exchanger (6, 7) which can act as a condenser or as an evaporator by reversing the flow direction of the fluid, with means for the heat exchange with an air flow and means for generating a forced air flow through said heat exchange means of the evaporator/condenser (61, 71),
said second heat exchanger (6, 7) is connected in parallel to said radiant heat exchanger (1) and can be activated or deactivated by means of valves (V1, V2),
said heat exchangers are housed into a cabinet (8) having:

   - a surrounding air intake port (82) and a port (83) for releasing the air into the environment (5), which air is taken from the environment (5) upstream of said second heat exchanger (6, 7) and reintroduced into the environment (5) after the heat exchange with the said second heat exchanger (6, 7) **characterised in that**
   - on one of the sides of the cabinet, preferably the front side, a recess (81) intended for housing said radiant heat exchanger such that said radiant heat exchanger is substantially included into the volume of said cabinet (8).

2. Apparatus according to claim 1, **characterized in that** said radiant heat exchanger is composed of a condenser (11) connected to a manifold supplying the conduction fluid in the gaseous state and within which condensation ducts (111) said conduction fluid is transformed from the gaseous state to the liquid state transferring the heat of condensation thereto.

3. Apparatus according to one or more of the preceding claims, **characterized in that** each one of said radiant members (12) is provided with a through hole for housing at least a condensation duct (111) and it is in thermal contact therewith.

4. Apparatus according to one or more of the preceding claims, **characterized in that** said condensation ducts (111) are connected in parallel and the shell surfaces of said condensation ducts (111) are arranged along a envelope tangent surface thereof or along two envolpe tangent surfaces on diametrically opposite sides of the shell surfaces of said condensation ducts (111), with reference to the longitudinal central axis of said condensation ducts (111), and said radiant members (12) are composed of one or two radiant plates (12) each one extending along one of said envelope surfaces tangent to the shell surfaces of said condensation ducts (111) respectively.

5. Apparatus according to claims 1 or 2, **characterized in that** the condensation ducts (111) are arranged one near the other at a predetermined distance one from the other and are arranged along a flat or curved surface according to at least an axis of curvature, said radiant plate (12) being flat or curved respectively.

6. Apparatus according to one or more of the preceding claims, **characterized in that** it has two parallel radiant plates (12) with the condensation ducts (111) interposed therebetween, in contact with each one of said two plates (12).

7. Apparatus according to one or more of the preceding claims, **characterized in that** the diameter, the length and the amount of the condensation ducts (111) are optimized on one hand in relation to the heat transfer and to the condensation from the gaseous state to the liquid state of said conduction fluid, and on the other hand in relation to the reduction of the acoustic level of the gurgling generated by said transformation of state.

8. Apparatus according to one or more of the preceding claims, **characterized in that** the ratio between the diameter and the length of each condensation duct (111) is comprised between 0.01 and 0.02, and is preferably about 0.015.

9. Apparatus according to one or more of the preceding claims, wherein said radiant heat exchanger is spaced from the walls of said recess (81) such that an air channel passing between said radiant heat exchanger and said recess (81) is formed.

10. Apparatus according to one or more of the preceding claims, **characterized in that** said radiant members (12) are made of aluminium and have a finned surface such that the surface to volume ratio of said radiant members (12) and/or the surface for the heat exchange with the surrounding air is increased.

11. Apparatus according to one or more of the preceding claims, **characterized in that** said means for generating a forced flow of cooling air are operated as an alternative to said means for the heat exchange with the environment (5) by radiation and/or by a forced air flow.

12. Apparatus according to one or more of the preceding claims, **characterized in that** it has photovoltaic means for generating electric energy, said means having such dimensions that the surface generating the electric energy exposed to the sun guarantees enough electric energy for independently feeding the heating apparatus, both in the case of a single user, and in the case of a main system.

13. Apparatus according to one or more of the preceding claims, **characterized in that** said cabinet (8) having such a size and shape to be placed under a window.

14. Apparatus according to one or more of the preceding claims, **characterized in that** said cabinet (8) having such a size and shape to be suspended on a wall and/or ceiling.

15. Apparatus according to one or more of the preceding claims, **characterized in that** it has said wall-mountable heat exchangers such as common radiators, and said means generating the forced flow of heating and/or cooling air arranged on a wall or ceiling, or as an alternative arranged away from the location where said forced flow of air is released and spread into the environment (5), such forced flow of air being conveyed through ducts towards suitable mouths for releasing and spreading it into the environment (5).

16. Apparatus according to one or more of the preceding claims **characterized in that** it is composed of a common air-conditioning device.

17. Radiation heating method **characterized in that** it provides the following steps:

- compressing a conduction fluid in the gaseous state by means of a compressor (2);
- flowing said pressurized conduction fluid in the gaseous state to a condenser (11)
- transforming said fluid from the pressurized gaseous state to the liquid state in said condenser (11), said condenser (11) being composed of a plurality of condensation ducts (111) which are arranged according to a predetermined arrange-

ment and which are connected to a manifold supplying the conduction fluid in the gaseous state and within which condensation ducts (111) said conduction fluid in the gaseous state is transformed to the liquid state transferring heat of condensation thereto
- transferring heat to the environment (5) by radiation and convection from radiant heat exchangers with the environment (5) which are composed of said condenser (11) and of at least a finned radiant member (12) made of a material with thermal conductivity higher than 40 $W \times K^{-1} \times m^{-1}$, and preferably higher than 100 $W \times K^{-1} \times m^{-1}$, , which radiant member (12) can be applied on at least one of said condensation ducts (111) and is in thermal contact with the condenser (11) for transferring heat of condensation from said condenser (11) to said radiant member or members (12)- flowing said conduction fluid in the liquid state to an evaporator (31) for resuming the refrigeration cycle, wherein a second heat exchanger (6, 7) can act as a condenser or as an evaporator by reversing the flow direction of the fluid and has means for the heat exchange with an air flow and means for generating a forced air flow through said heat exchange means of the evaporator/condenser (61, 71),

said second heat exchanger (6, 7) is connected in parallel to said radiant heat exchanger (1) and can be activated or deactivated by emans of valves (V1, V2),
said heat exchangers are housed into a cabinet (8) having:

- on one of its sides, preferably the front side, a recess (81) intended for housing said radiant heat exchanger such that said radiant heat exchanger is substantially included into the volume of said cabinet (8)
- a surrounding air intake port (82) and a port (83) for releasing the air into the environment (5), which air is taken from the environment (5) upstream of said second heat exchanger (6, 7) and reintroduced into the environment (5) after the heat exchange with the said second heat exchanger (6, 7).

Patentansprüche

1. Strahlungsheizgerät bestehend aus einer Wärmepumpe, die
mit Hilfe eines Kompressors (2) eine leitende Flüssigkeit in gasförmigem Zustand zusammendrückt, wodurch sie in einem Kondensator (11) in den flüssigen Zustand umgewandelt wird, und anschließend gibt der Kondensator (11) die Wärme in die Umgebung (5) ab.
bestehend aus Wärmetauschern mit der Umgebung (5) durch Strahlung , die aus dem genannten Kondensator (11) mit mehrere Kondensationsröhren (111) und ein oder mehrere gerippte Strahlerelemente (12) aus einem Material mit einer Wärmeleitfähigkeit, die höher ist als 40 W x K-1x m-1 und vorzugsweise höher als 100 W x K-1x m-1, welche Strahlerelemente (12) auf die Kondensationsröhren (111) aufgebracht sind und sich in thermischem Kontakt mit dem Kondensator (11) befinden, um die Kondensationswärme vom Kondensator (11) zu den Strahlerelementen (12) zu übertragen,
dieses Gerät verfügt über einen zweiten Wärmeaustauscher (6, 7), der als Kondensator oder als Verdampfer fungieren kann, durch eine Inversion der Flussrichtung der Flüssigkeit, mit Mitteln für den Wärmeaustausch mit einem Luftstrom und Mitteln, die einen Zwangsluftstrom durch dieses Wärmeaustauschmittel des Verdampfers/Kondensators (61, 71) erzeugen,
dieser zweite Wärmeaustauscher (6, 7) ist parallel an den Strahlungswärmeaustauscher (1) angeschlossen und kann mit Hilfe der Ventile (V1, V2) aktiviert oder deaktiviert werden,
diese Wärmeaustauscher sind in einem Schrank (8) untergebracht, der:

- einen umgebenden Luftansaugstutzen (82) und einen Stutzen (83) aufweist, um die Luft in die Umgebung (5) abzuleiten, welche Luft aus der Umgebung (5) flussaufwärts des zweiten Wärmeaustauschers (6, 7) entnommen wird und nach dem Wärmeaustausch mit diesem zweiten Wärmeaustauscher (6, 7) wieder in die Umgebung (5) abgegeben wird

dadurch gekennzeichnet dass

- auf einer Seite des Schrankes, vorzugsweise auf der Vorderseite, einen Einschnitt (81) vorgesehen ist, in dem der Strahlungswärmeaustauscher untergebracht ist, so dass dieser Strahlungswärmeaustauscher sich im Wesentlichen in diesem Schrank(8)raum befindet.

2. Ein Gerät gemäß Anspruch 1, **dadurch gekennzeichnet dass** der Strahlungswärmeaustauscher aus einem Kondensator (11) besteht, der mit einem Anschlussstück verbunden ist, das die leitende Flüssigkeit im gasförmigen Zustand liefert und in dessen Kondensationsröhren (111) die genannte leitende Flüssigkeit vom gasförmigen Zustand in den flüssigen Zustand umgewandelt wird, wobei Kondensationswärme übertragen wird.

3. Gerät gemäß einer oder mehrerer der vorhergehen-

den Ansprüche, **dadurch gekennzeichnet dass** jeder der besagten Strahlerelemente (12) mit einer Durchgangsbohrung versehen ist, um mindestens eine Kondensationsröhre (111) darin aufzunehmen und ist in thermischen Kontakt mi diesen.

4. Ein Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** diese Kondensationsröhren (111) parallel angeschlossen sind und die Manteloberfläche dieser Kondensationsröhren (111) sind entlang einer tangentialen Hüllfläche oder entlang von zwei tangentialen Hüllflächen, auf den diametral gegenüberliegenden Seiten der Manteloberflächen der Kondensationsröhren (111) in Bezug auf die zentrale Längsachse der Kondensationsröhren (111) angeordnet und die Strahlerelemente (12) bestehen aus ein oder zwei Strahlerplatten (12), von der sich jede entlang der Hüllfläche erstreckt welche tangential zu den Mantelflächen der Kondensationsröhren (111) ist.

5. Gerät gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet dass** die Kondensationsröhren (111) nahe nebeneinander in einem vorgegebenen Abstand voneinander und entlang einer flachen oder gekrümmten Fläche entsprechend mindestens einer Krümmungsachse angeordnet sind, wobei die Strahlerplatte (12) flach bzw. gekrümmt ist.

6. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** es zwei parallele Strahlerplatten (12) mit den dazwischengefügten Kondensationsröhren (111) aufweist, die in Kontakt mit jeder der beiden Platten (12) sind.

7. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** der Durchmesser, die Länge und die Anzahl der Kondensationsröhren (111) einerseits in Bezug auf die Wärmeübertragung und auf die Kondensation vom gasförmigen Zustand in den flüssigen Zustand der leitenden Flüssigkeit und andererseits in Bezug auf die Reduzierung der akustischen Höhe des Glucksens, das durch die Umwandlung des Zustandes erzeugt wird, optimiert sind.

8. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** das Verhältnis zwischen dem Durchmesser und der Länge jeder Kondensationsröhre (111) zwischen 0,01 und 0.02 liegt und vorzugweise 0,015 ist.

9. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, in dem der besagte Strahlungswärmeaustauscher in einem Abstand von den Wänden des Einschnittes (81) angeordnet ist, so dass ein Luftkanal zwischen dem Strahlungswärmeaustauscher und dem Einschnitt (81) gebildet wird.

10. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** die Strahlungselemente (12) aus Aluminium bestehen und eine gerippte Oberfläche haben, so dass das Verhältnis Oberfläche gegen Volumen der Strahlungselemente (12) bzw. die Oberfläche für den Wärmeaustausch mit der Umgebungsluft erhöht wird.

11. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** besagte Mittel zur Erzeugung eines Zwangsluftstroms der Kühlluft werden als Alternative zu dem Mittel für den Wärmeaustausch mit der Umgebung (5) durch Strahlung bzw. durch einen Zwangsluftstrom betrieben.

12. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** photovoltaische Mittel zur Erzeugung von Strom vorgesehen sind, welche solche Abmessungen aufweisen, dass die Oberfläche, die die elektrische Energie erzeugt und die der Sonne ausgesetzt ist, genug Strom garantiert, um das Wärmegerät sowohl im Falle eines Einzel-nutzers, als auch bei einem Zentralsystem selbständig zu speisen.

13. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass**, der Schrank (8) eine solche Größe und Form hat, dass er unter einem Fenster angeordnet werden kann.

14. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** der Schrank (8) eine solche Größe und Form hat, dass er an einer Wand bzw. an der Decke aufgehängt werden kann.

15. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** es die an der Wand montierbaren Wärmeaustauscher wie z.B. gebräuchliche Heizkörper aufweist, und dieses Mittel einen Zwangsheizungsfluss bzw. Kühlluftfluss erzeugt, das an einer Wand oder Decke oder alternativ entfernt von der Stelle angebracht ist, wo dieser Zwangsluftstrom hinausgelassen und in der Umgebung (5) verteilt wird, wobei dieser Zwangsluftstrom durch Röhren zu entsprechenden Öffnungen zum Ablassen und Verteilen in die Umgebung (5) zugeleitet wird.

16. Gerät gemäß einem oder mehrerer der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** es aus einem handelsüblichen Klimagerät besteht.

17. Verfahren zur Erwärmung durch Strahlung, **dadurch gekennzeichnet dass** folgende Schritten vorgesehen sind:

- eine Leitmedium die im gasförmigen Zustand ist unter Druck setzen mit Hilfe eines Kompressors (2);
- der unter Druck stehende Medium zu einem Kondensator (11) zuleiten;
- Umwandeln des besagten Medium im Kondensator (11) aus dem gasförmigen in den flüssigen Zustand der besagte Kondensator (11) bestehend aus mehreren Kondensationsröhren (111), die entsprechend einer vorgegebenen Anordnung arrangiert sind und die mit einem Anschlussstück verbunden sind, das das gasförmige Leitmedium zufuehrt und in welchen Kondensationsröhren (111) dieser Leitmedium vom gasförmigen Zustand in den flüssigen Zustand umgewandelt wird und die Kondensationswärme dorthin übertragen wird;
- Übertragen der Kondensationswärme in die Umgebung (5) durch Strahlung und Konvektion zwischen den Strahlungswärmeaustauschern und der Umgebung (5), die aus dem Kondensator (11) und mindestens einem gerippten Strahlungselement (12) aus einem Material mit einer Leitfähigkeit höher als 40 W x K-1x m-1 und vorzugsweise höher als 100 W x K-1x m-1 bestehen, wobei das Strahlungselement (12) auf mindestens eine der genannten Kondensationsröhren (111) aufgebracht werden kann und in thermischem Kontakt mit dem Kondensator (11) zur Übertragung der Kondensationswärme vom Kondensator (11) zum Strahlungselement oder den Strahlungselementen (12) ist, indem die Leitflüssigkeit im flüssigen Zustand zu einem Verdampfer (31) zur Wiederaufnahme des Kältekreislaufes strömt,
- wobei ein zweiter Wärmeaustauscher (6, 7) durch Umkehr der Fließrichtung der Flüssigkeit als Kondensator oder als Verdampfer fungieren kann und Mittel zum Wärmeaustausch mit einem Luftstrom und Mittel zur Erzeugung eines Zwangsluft-stromes durch dieses Wärmeaustauschmittel des Kondensators/Verdampfers (61, 71) aufweist,

der besagte zweite Wärmeaustauscher (6, 7) ist parallel am Strahlungswärmeaustauscher (1) angeschlossen und kann mit Hilfe der Ventile (V1, V2) aktiviert oder deaktiviert werden,
die besagten Wärmeaustauscher sind in einem Schrank (8) untergebracht, der:

- auf einer seiner Seiten, vorzugweise auf der Vorderseite, einen Einschnitt (81) für die Unterbringung dieses Strahlungswärmeaustauscher aufweist, so dass der Strahlungswärmeaustauscher sich innerhalb dieses Schrankes (8) befindet,
- einen umgebenden Luftansaugstutzen (82) und einen Stutzen (83) aufweist, um die Luft in die Umgebung (5) abzuleiten, welche Luft aus der Umgebung(5) flussaufwärts des zweiten Wärmeaustauscher (6, 7) entnommen wird und nach dem Wärmeaustausch mit diesem zweiten Wärmeaustauscher (6, 7) wieder in die Umgebung (5) abgegeben wird.

Revendications

1. Appareil de chauffage par rayonnement composé d'une pompe à chaleur qui comprime par un compresseur (2) un fluide de conduction à l'état gazeux provoquant sa transformation à l'état liquide dans un condenseur (11) et par conséquent, ledit condenseur (11) transfère la chaleur à l'environnement (5), il comprend des échangeurs de chaleur par rayonnement vers l'environnement (5) formés par ledit condenseur (11) comprenant plusieurs conduits de condensation (111) et par un ou plus éléments radiants à ailettes (12) faits d'un matériau ayant une conductivité thermique supérieure à 40 $WxK^{-1}xm^{-1}$, et de préférence supérieure à 100 $WxK^{-1}xm^{-1}$, lesquels éléments radiants (12) sont appliqués sur lesdites conduits de condensation (111) et ils sont en contact thermique avec le condenseur (11) pour transférer la chaleur de condensation dudit condenseur (11) auxdites éléments radiants (12),
ledit dispositif a un deuxième échangeur de chaleur (6, 7) qui peut agir comme un condenseur ou comme un évaporateur par inversion du sens d'écoulement du fluide, avec des moyens pour l'échange de chaleur avec un flux d'air et des moyens pour la génération d'un flux d'air forcé à travers lesdits moyens d'échange de chaleur de l'évaporateur/condenseur (61, 71),
ledit deuxième échangeur de chaleur (6, 7) est connecté en parallèle audit échangeur de chaleur par rayonnement (1) et il peut être activé ou désactivé au moyen de vannes (V1, V2),
lesdits échangeurs de chaleur sont logés dans une caisse (8) ayant :

- sur un des cotés de la caisse, de préférence le coté avant, une niche (81) destinée à loger ledit échangeur de chaleur par rayonnement de sorte que ledit échangeur de chaleur par rayonnement est pratiquement compris dans le volume de ladite caisse (8)

caractérisé par

- une bouche d'aspiration d'air environnant (82)

et une bouche (83) pour libérer l'air dans l'environnement (5), cet air est tiré de l'environnement (5) en amont dudit deuxième échangeur de chaleur (6,7) et réintroduit dans l'environnement (5) après l'échange de chaleur avec ledit deuxième échangeur de chaleur (6,7).

2. Appareil selon la revendication 1, **caractérisé en ce que** ledit échangeur de chaleur rayonnant est constitué par un condensateur (11) connecté à un collecteur fournissant le fluide de conduction à l'état gazeux et à l'intérieur desdites conduits de condensation (111) ledit fluide de conduction est transformé à partir de l'état gazeux à l'état liquide transférant la chaleur de condensation à celui-ci.

3. Appareil selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** chacun desdits éléments radiants (12) est pourvu d'un trou traversant pour loger au moins un conduit de condensation (111) et il est en contact thermique avec celui-ci.

4. Appareil selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits conduits de condensation (111) sont connectés en parallèle et les surfaces de la coquille desdits conduits de condensation (111) sont disposés le long d'une surface tangente à l'enveloppe de celui-ci ou le long de deux surfaces tangentes à l'enveloppe sur des côtés diamétralement opposés des surfaces de la coquille desdits conduits de condensation (111), en référence à l'axe médian longitudinal desdits conduits de condensation (111), et lesdits éléments rayonnants (12) sont composés d'une ou deux plaques rayonnantes (12) chacune s'étendant le long de l'une desdites surfaces d'enveloppe tangent aux surfaces de la coquille desdits conduits de condensation (111), respectivement.

5. Appareil selon les revendications 1 ou 2, **caractérisé en ce que** les conduits de condensation (111) sont disposés l'un près de l'autre à une distance prédéterminée l'un de l'autre le long d'une surface plate ou courbe selon au moins un axe de courbure, étant ladite plaque rayonnante (12) plate ou courbe respectivement.

6. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** il y a deux plaques rayonnantes parallèles (12) avec les conduits de condensation (111) interposés entre elles, en contact avec chacune des dites deux plaques (12).

7. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** le diamètre, la longueur et le numéro des conduits de condensation (111) sont optimisés d'un côté en relation avec l'échange de chaleur et avec la condensation de l'état gazeux à l'état liquide dudit fluide de conduction, et de l'autre côté en relation avec la réduction du niveau acoustique du gargouillement généré par ladite transformation d'état.

8. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** le rapport entre le diamètre et la longueur de chaque conduit de condensation (111) est compris entre 0,01 et 0,02, et de préférence se situe aux environs de 0,015.

9. Appareil selon une ou plusieurs des revendications précédentes, quand ledit échangeur de chaleur par rayonnement est éloigné des parois de ladite niche (81) de manière qu'un couloir d'air qui passe entre ledit échangeur de chaleur par rayonnement et ladite niche (81) se forme.

10. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits éléments radiants (12) sont faits d'aluminium et ils ont une surface à ailettes telle que le rapport de la surface et le volume de ces éléments radiants (12) et/ou la surface pour l'échange de chaleur avec l'air environnant est augmenté.

11. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits moyens pour générer un flux forcé d'air rafraîchissant sont actionnés comme une alternative auxdits moyens pour l'échange de chaleur avec l'environnement (5) par rayonnement et/ou par un flux d'air forcé.

12. Appareil selon une ou plusieurs des revendications précédents, **caractérisé en ce qu'**il a des moyens photovoltaïques pour générer de l'énergie électrique, étant donné que ces éléments ont des dimensions telles que la surface qui génère l'énergie électrique exposée au soleil garantit assez d'énergie électrique pour alimenter indépendamment l'appareil de chauffage, soit en cas d'un utilisateur unique, soit en cas d'un système principal.

13. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite caisse (8) a une dimension et une forme telles qui peut être placée sous une fenêtre.

14. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite caisse (8) a une dimension et une forme telles qui peut être suspendu au mur et/ou au plafond.

15. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il a lesdits échangeurs de chaleurs qui peuvent être fixés au mur comme des radiateurs normales, et que lesdits éléments qui génèrent le flux d'air forcé chauffant

et/ou rafraîchissant fixés au mur or au plafond, ou comme une alternative placés loin de la place où ledit flux d'air forcé est délivré et distribué dans l'environnement (5), ledit flux d'air forcé est transporté par des conduits vers des bouches adéquates pour sa livraison et sa distribution dans l'environnement (5).

16. Appareil selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** il est composé par un appareil de climatisation normal.

17. La méthode de chauffage par rayonnement est **caractérisée en ce qu'**elle requière les pas suivants :

- comprimer un fluide de conduction à l'état gazeux par un compresseur (2);
- écouler ledit fluide de conduction sous pression dans son état gazeux jusqu'à un condensateur (11)
- transformer ledit fluide de son état gazeux sous pression à l'état liquide dans ledit condensateur (11), ledit condensateur étant composé par plusieurs conduits de condensation (111) qui sont arrangés selon une disposition prédéterminée et qui sont connectés à un collecteur fournissant le fluide de conduction à l'état gazeux et à l'intérieur desdites conduits de condensation (111) ledit fluide de conduction est transformé à partir de l'état gazeux à l'état liquide transférant la chaleur de condensation à celui-ci

  - le transfert de la chaleur à l'environnement (5) par rayonnement et convection des échangeurs de chaleur par rayonnement avec l'environnement (5) qui sont formés par ledit condensateur (11) et par un ou plus éléments radiants à ailettes (12) faits d'un matériau ayant une conductivité thermique supérieure à 40 $WxK^{-1}xm^{-1}$, et de préférence supérieure à 100 $WxK^{-1}xm^{-1}$, ledit élément radiant (12) peut être appliqué sur au moins un desdits conduits de condensation (111) et il est en contact thermique avec le condensateur (11) pour transférer la chaleur de condensation dudit condensateur (11) au(x)dit(s) élément(s) radiant(s) (12) - ledit fluide de conduction écoulant dans l'état liquide jusqu'à un évaporateur (31) pour recommencer le cycle de réfrigération,

où un deuxième échangeur de chaleur (6, 7) peut agir comme un condensateur ou comme un évaporateur par inversion du sens d'écoulement du fluide et a les moyens pour l'échange de chaleur avec un flux d'air et les moyens pour la génération d'un flux d'air forcé à travers lesdits moyens d'échange de chaleur de l'évaporateur/condensateur (61, 71),
ledit deuxième échangeur de chaleur (6, 7) est connecté en parallèle audit échangeur de chaleur par rayonnement (1) et il peut être activé ou désactivé au moyen de vannes (V1, V2),
lesdits échangeurs de chaleur sont logés dans une caisse (8) ayant :

- sur une de ses côtés, de préférence sur le côté avant, une niche (81) destinée à loger ledit échangeur de chaleur par rayonnement de sorte que ledit échangeur de chaleur par rayonnement est pratiquement compris dans le volume de ladite caisse (8)
- une bouche d'aspiration de l'air environnant (82) et une bouche pour délivrer l'air dans l'environnement (5), et ledit air est pris de l'environnement (5) en amont dudit deuxième échangeur de chaleur (6, 7) et introduit à nouveau dans l'environnement (5) après l'échange de chaleur avec le deuxième échangeur de chaleur (6, 7).

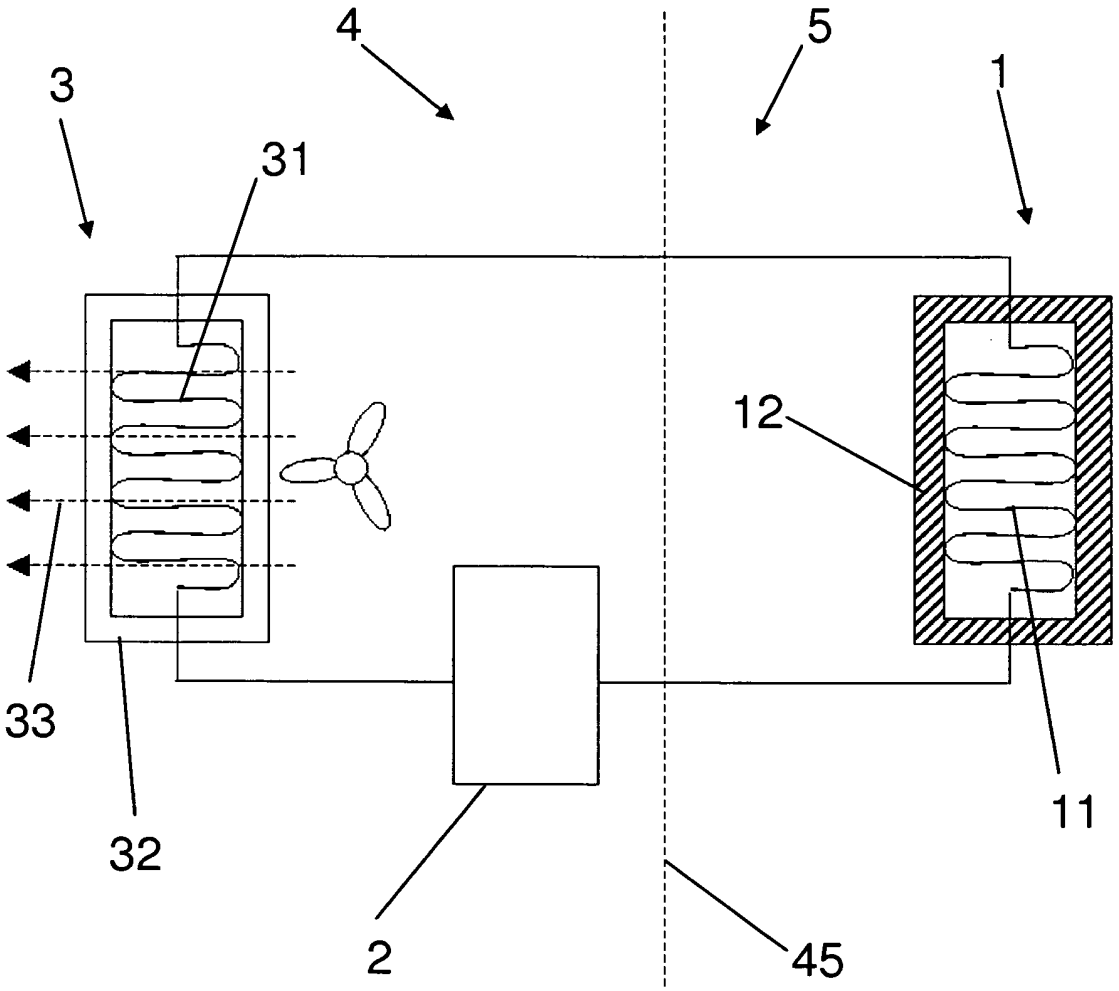


Fig. 1

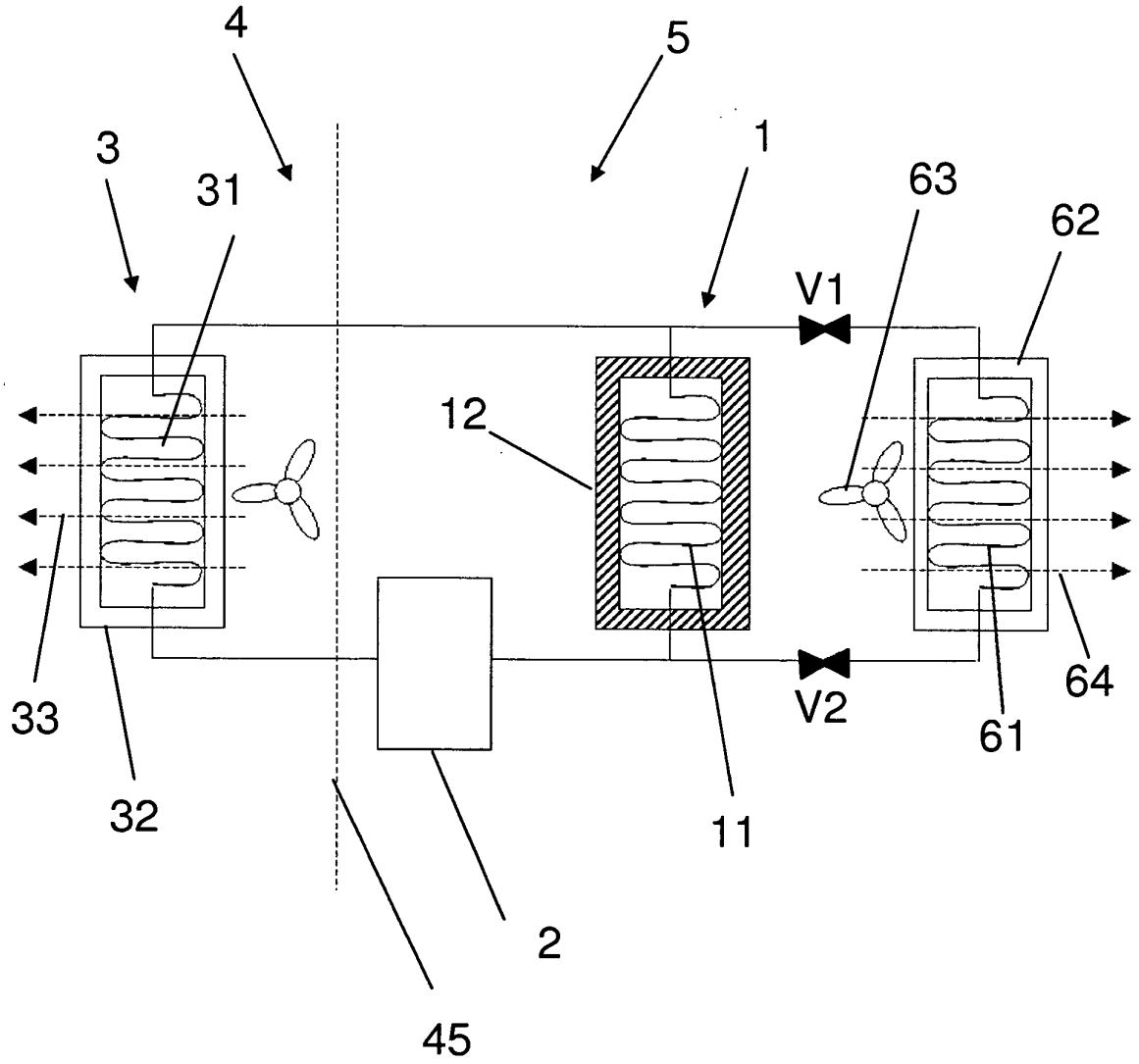


Fig. 2

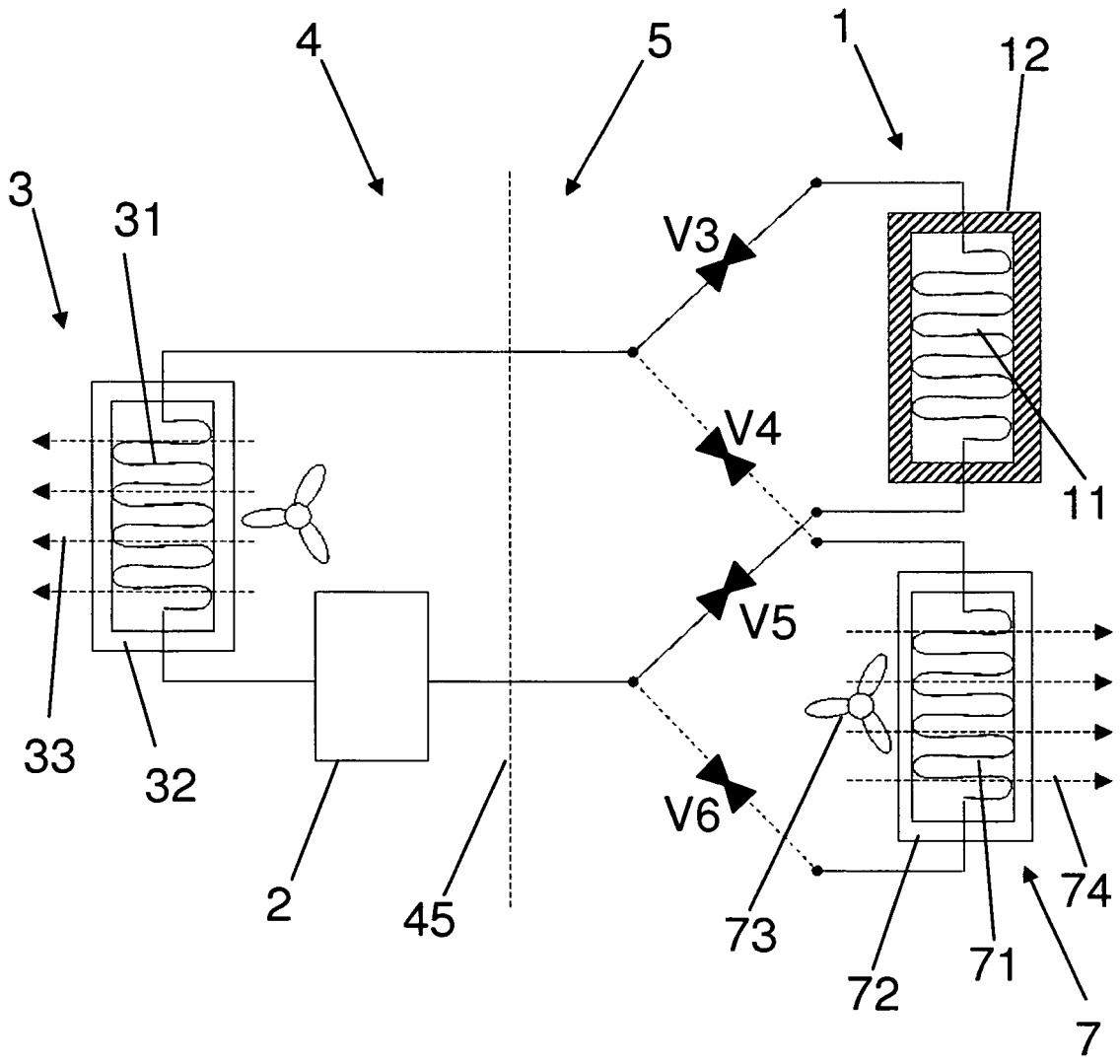


Fig. 3

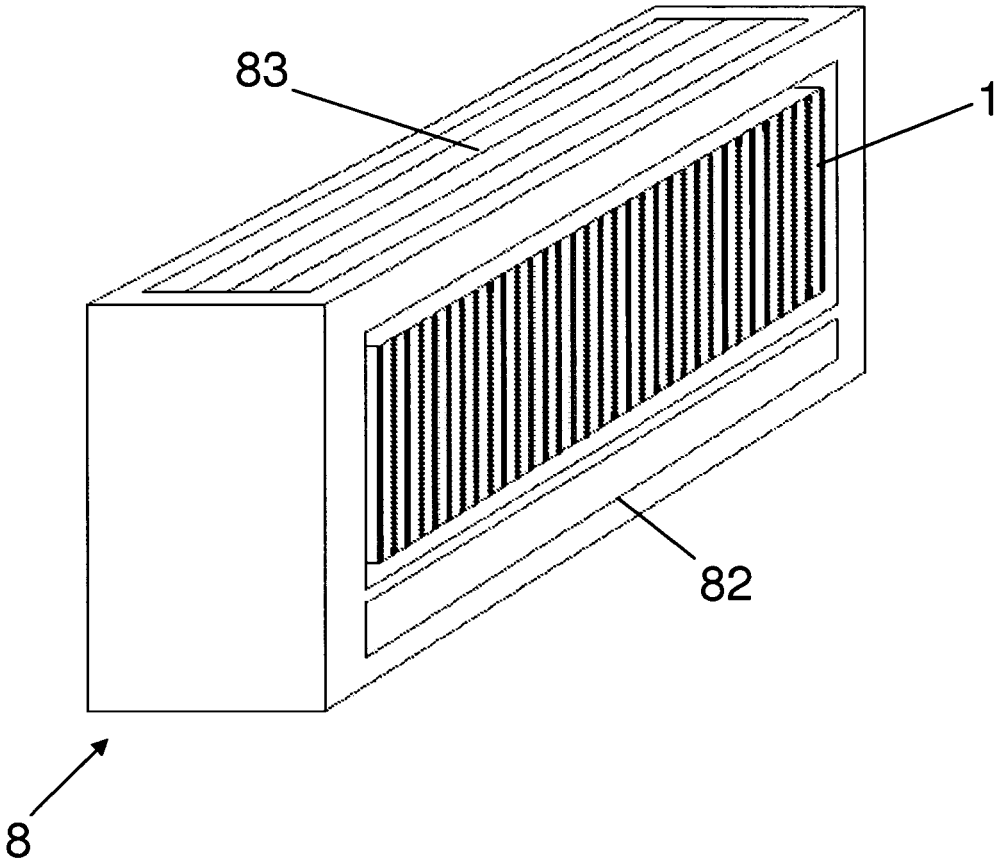


Fig. 4

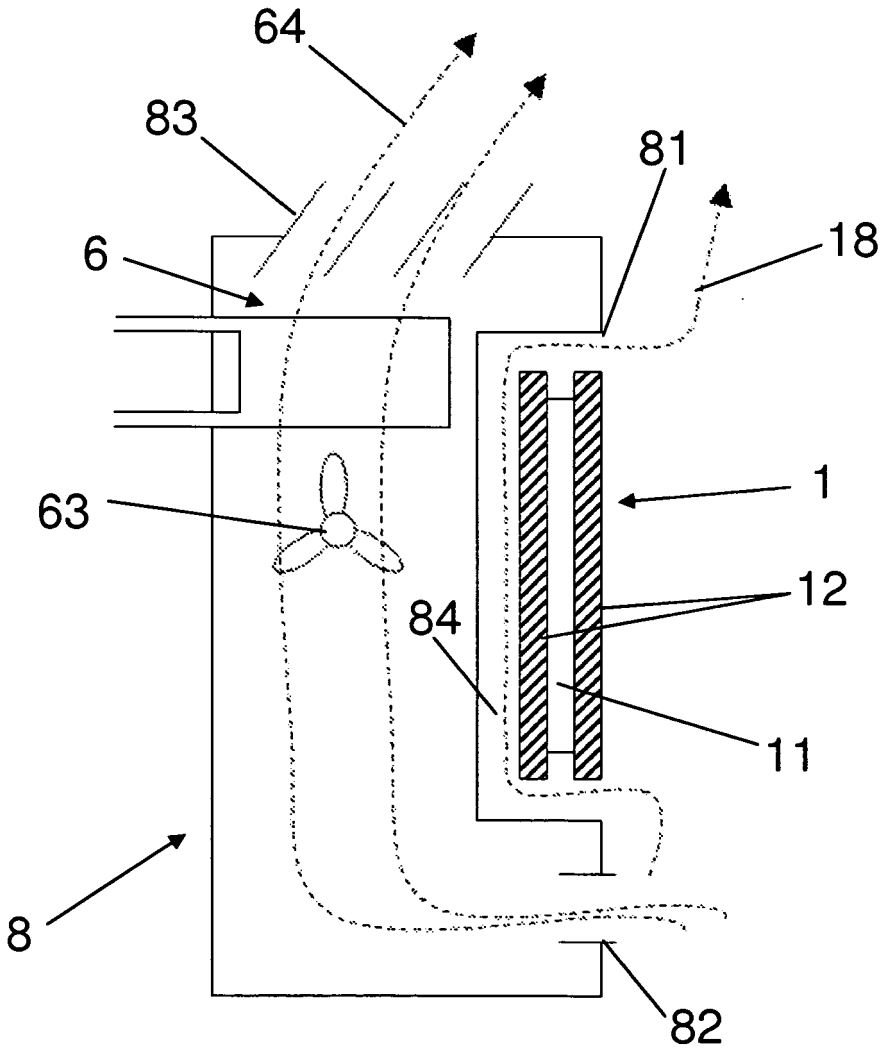


Fig. 5

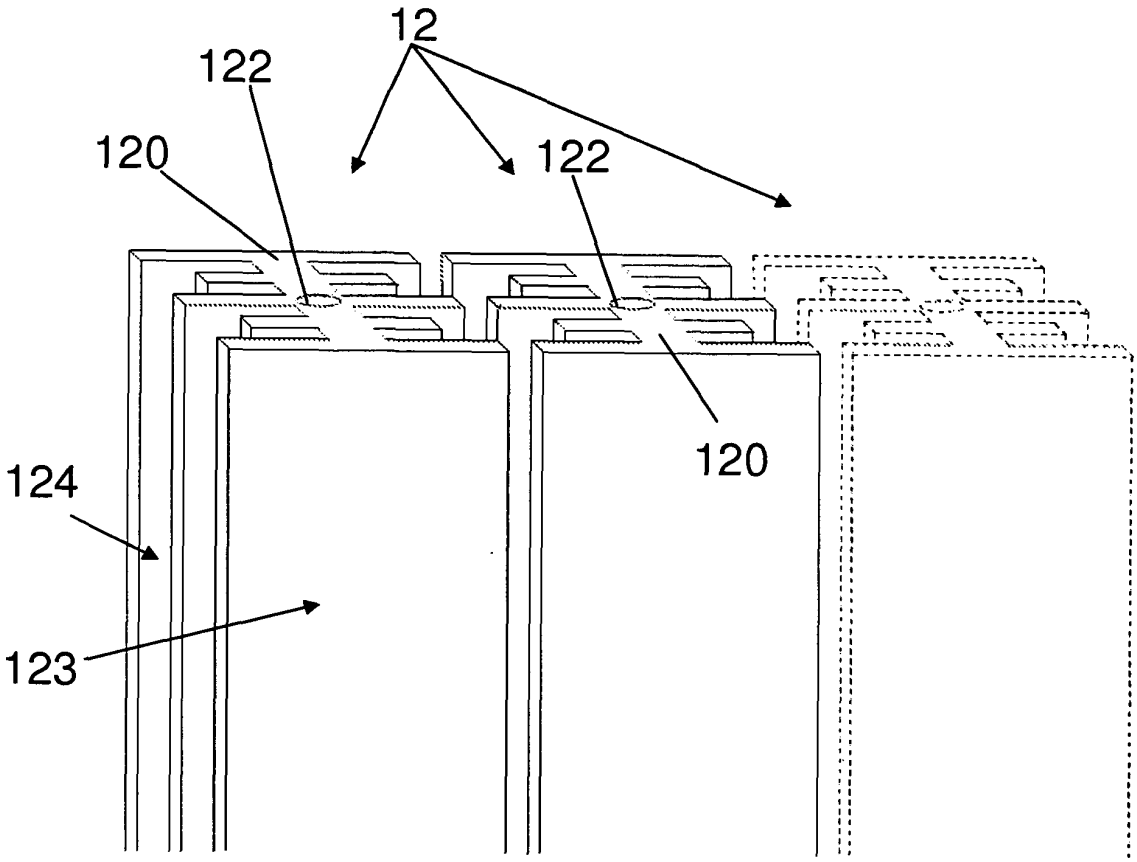


Fig. 6

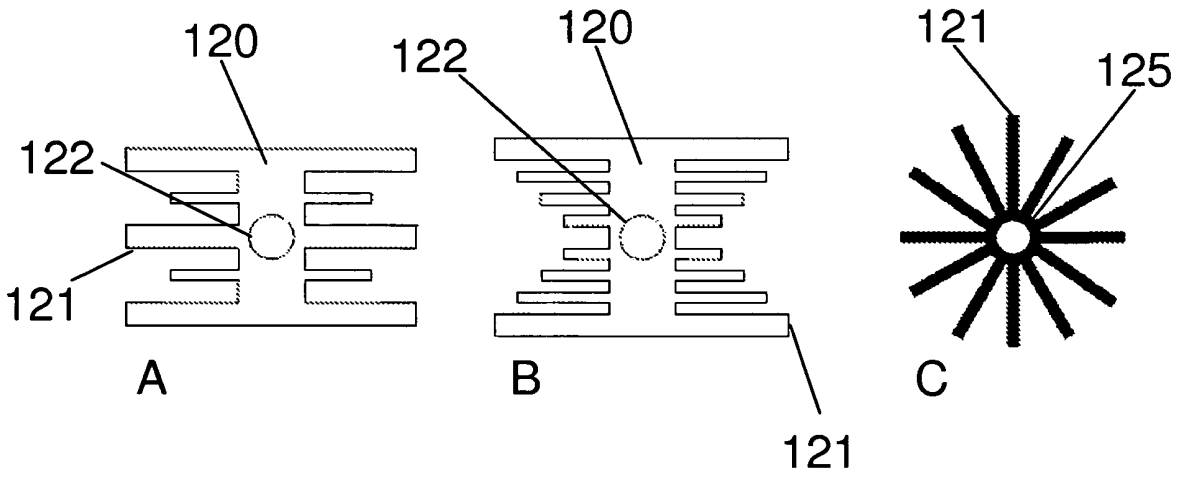


Fig. 7

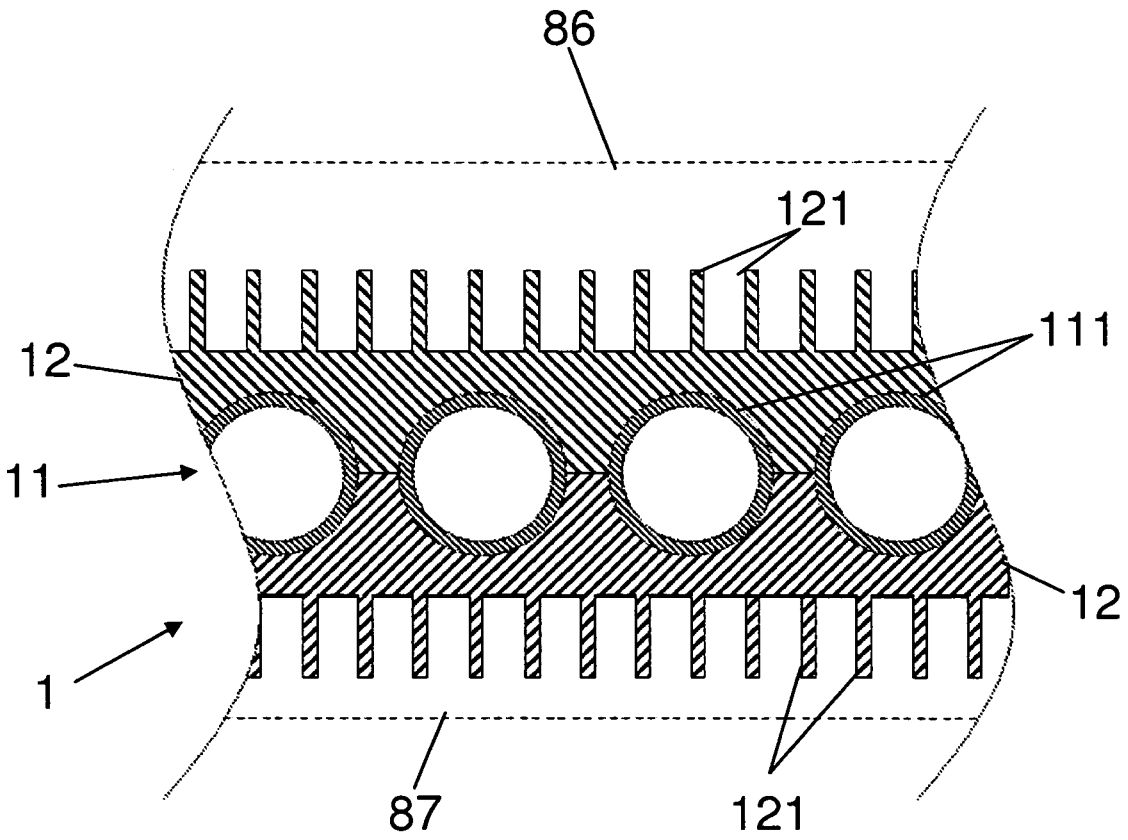


Fig. 8

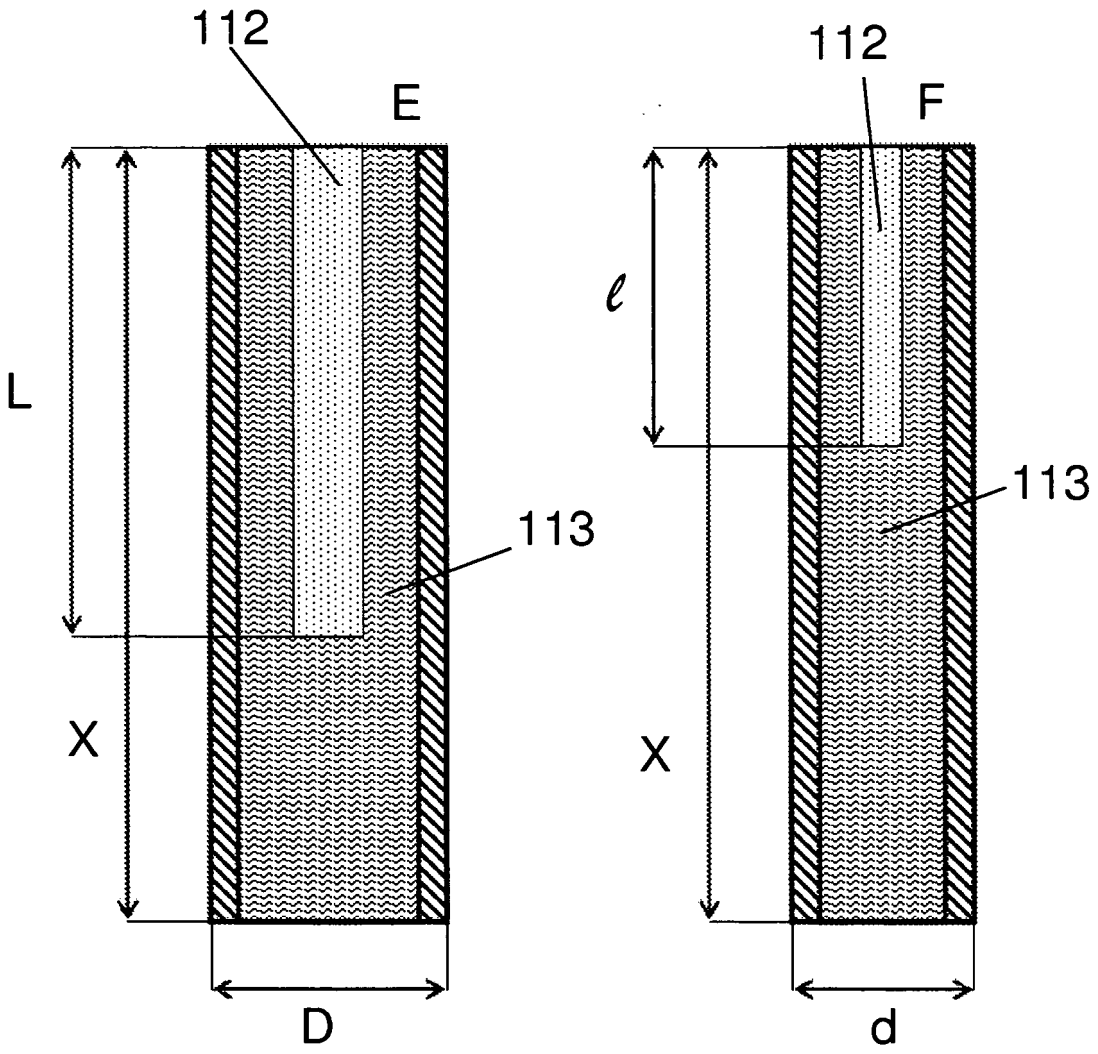


Fig. 9

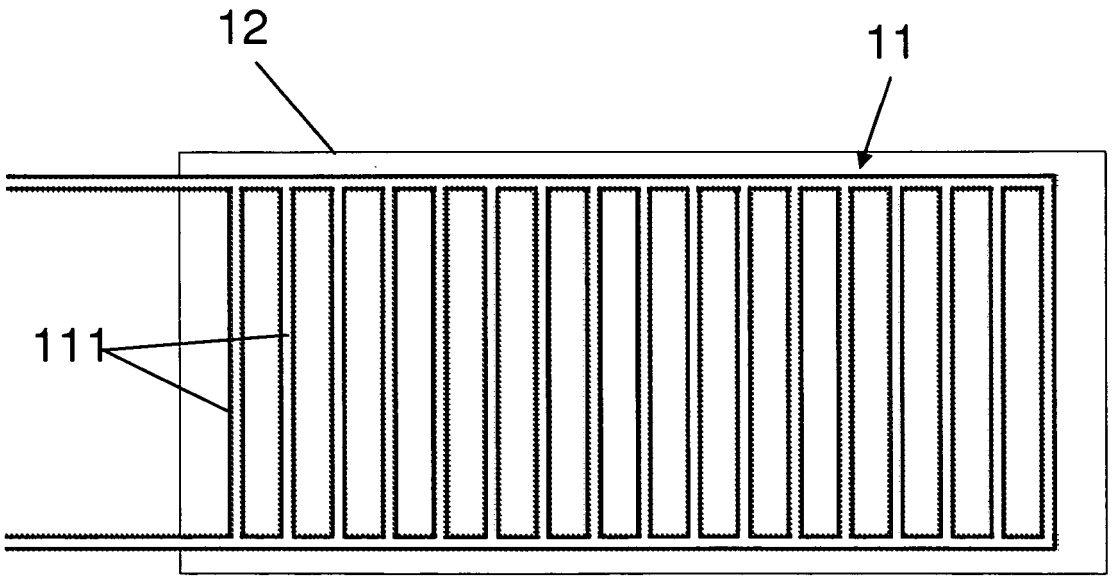


Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0269282 A **[0009]**