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(71) Applicant *(for all designated States except US)*: CONDENSER ITALIANA S.R.L. [IT/IT]; Via Milano, 19, I-21027 Ispra (IT).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: LOCATELLI, Vincenzo [IT/IT]; Via Trieste, 12, I-20053 Lecco (IT). LOCATELLI, Gianbattista [IT/IT]; Via Aspromonte, 52, I-20053 Lecco (IT). LOCATELLI, Matteo [IT/IT]; Via Aspromonte, 52, I-20053 Lecco (IT).

(74) Agent: MODIANO, Guido; Modiano & Associati, Via Meravigli, 16, I-20123 Milano (IT).

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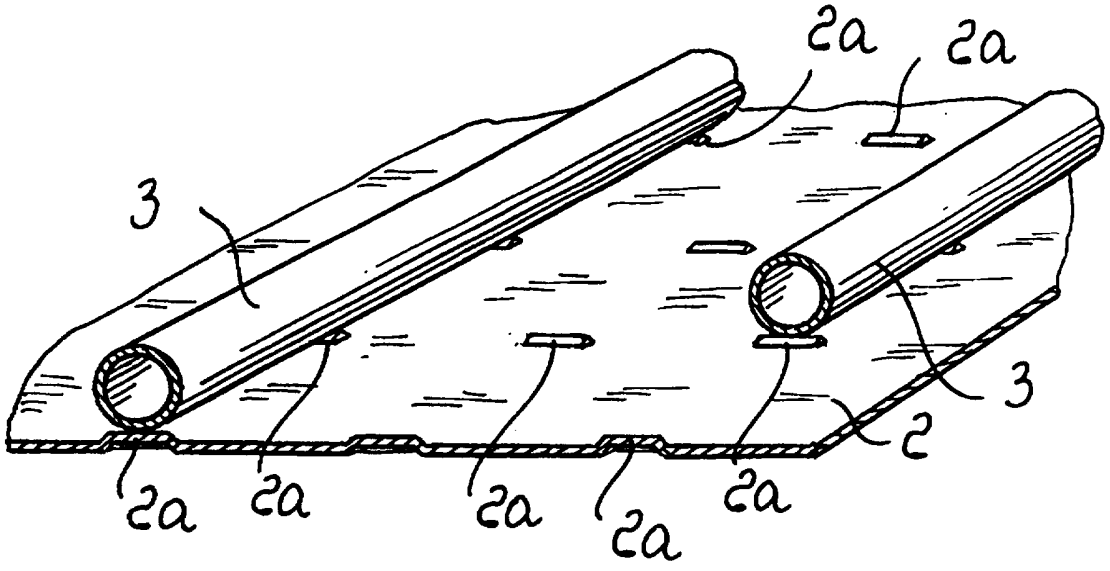


(57) Abstract

The heat exchanger for refrigeration devices, particularly for refrigerators for household use, has at least one plate-like element (2) and one tubular element (3) for the passage of the working fluid of the refrigeration device. The tubular element (3) is connected to one face of the plate-like element (2), which has, in the regions affected by the tubular element (3), raised portions (2a) at which the tubular element (3) is welded to the plate-like element (2).

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# HEAT EXCHANGER FOR REFRIGERATION DEVICES, PARTICULARLY FOR REFRIGERATORS FOR HOUSEHOLD USE

## Technical Field

The present invention relates to a heat exchanger for refrigeration devices, particularly for refrigerators for household use.

## Background Art

It is known that two heat exchangers are used in the production of refrigerators for household use: an evaporator, which has the purpose of generating cold, i.e., of absorbing and removing heat from the inside of the refrigerator; and a condenser, which has the purpose of transferring the heat removed from the inside of the refrigerator to the environment where said refrigerator is located.

As regards evaporators for refrigerators for household use, evaporators that are connected to the outer surface of the casing (usually made of synthetic material) that delimits the refrigeration cell of the refrigerator are used increasingly. These evaporators are furthermore embedded, on the cell casing side, in foamed material that provides the required thermal insulation of the cell with respect to the outside environment.

The evaporators that are currently used for this application are generally constituted by a secondary plate-like element, on a face of which a primary tubular element is connected; the fluid of the refrigerator circulates in said primary tubular element, which is connected to one of the faces of the plate-like element that is fixed, by means of its other face, to the outer surface of the casing that

delimits the cell of the refrigerator.

Some types of evaporator that are currently commercially available are substantially constituted by a secondary plate-like element made of aluminum, which has, on one of its faces, an adhesive substance by means of which the coil-shaped aluminum tubular element is connected to the secondary plate-like element; said secondary plate-like element also has, on its other face, an adhesive layer that provides the connection of the plate-like element to the casing of the cell. In these types of evaporator, the tubular element is sometimes appropriately flattened so as to increase the surface area of contact with the plate-like element, i.e, so as to increase the surface that allows heat exchange by conduction between the tubular element and the plate-like element.

These types of evaporator have the drawback that they require the use of high-quality materials, which are expensive. Furthermore, owing to the fact that contact between the plate-like element and the tubular element occurs with the interposition of a layer of adhesive material, heat transmission is penalized and thermodynamic efficiency is reduced. Another drawback with this type of evaporator is constituted by the fact that the curved parts of the tubular element are not connected to the plate-like element or are connected loosely and in a manner that is poorly effective in terms of heat exchange.

Furthermore, the positioning of these types of evaporator on the refrigeration cell is troublesome and requires great manual skill.

Another type of evaporator that is currently used

entails, with respect to the above-described model, the addition of a strip of adhesive tape with a "curtain-like" arrangement at the straight portions of the tubular element. This type of evaporator has the same problems as the one mentioned earlier, plus the fact that accumulations of moist air may occur between the adhesive tape and the plate-like element, producing condensation that can freeze, altering the contact between the tubular element and the plate-like element.

Another type of evaporator is constituted by a steel plate-like element and by a tubular element also made of steel, constituted by a tube with spiral-shaped external protrusions, which is connected to the plate-like element by virtue of an electric welding process that causes the adhesion of the tubular element to the plate-like element at the regions of the spiral-shaped raised portions of the tube that are in contact with a face of the plate-like element.

Although this type of evaporator allows to use materials that have a lower cost than previously described evaporators, it has problems in maintaining the flatness of the unit constituted by the tubular element and by the plate-like element. Another drawback of this type of evaporator is the need to perform an additional process for forming a spiral on the tubular element, which requires the use of specific machines and therefore unavoidably increases production costs.

Another type of evaporator that is currently proposed is constituted by a plate-like element made of galvanized or aluminized steel plate or of aluminum plate, on one face of which a galvanized or aluminized or aluminum tubular element

is fixed by means of adhesive. This type of evaporator has the problem of a less than optimum strength of the adhesive that is used to connect the tubular element to the plate-like element and of a heat exchange that is not fully satisfactory between the plate-like element and the tubular element. Furthermore, this type of evaporator requires high precision in the positioning of the tubular element on the strip of adhesive that is used to fix it to the plate-like element.

Yet another type of evaporator is constituted by a plate-like element made of aluminum plate that is appropriately deformed so as to produce, on its side adapted to be applied to the casing of the refrigeration cell, seats that surround the tubular element, which is constituted by a tube of aluminized or galvanized steel or of aluminum, inside which the working fluid of the refrigerator passes. This type of evaporator has the drawback that it requires the use of materials that have relatively high costs, as well as the problem of not being able to produce intimate adhesion or full contact adhesion of the plate-like element to the curved parts of the tubular element. Furthermore, with this type of evaporator, in the seats for the tubular element, between the plate-like element and the outside wall of the casing of the refrigeration cell, there are cavities inside which moisture can accumulate; this moisture can be dangerous, since it can cause the formation of ice, which acts as a separator wedge between the tubular element and the plate-like element as well as between the plate-like element and the surface of the casing of the refrigeration cell.

The condensers that are currently used for refrigerators for household use are substantially of three types.

A first type of condenser is constituted by a plurality of tubular elements that have a coil-like shape and inside which the working fluid of the refrigerator circulates; a plurality of wires is applied to said tubular elements by welding and has the purpose of increasing the heat exchange surface of the tubular element.

This type of condenser provides good heat exchange efficiency, but it has the drawback that it has high production costs, particularly due to the fact that it is necessary to perform a large number of welds.

A second type of condenser comprises a plate-like element that is deformed so as to form a plurality of seats that accommodate the tubular element in which the working fluid of the refrigerator passes. This type of evaporator has low production costs, since it does not require the execution of welds, but it has the drawback that it has a reduced heat exchange efficiency due to the limited adhesion between the tubular element and the plate-like element.

A third type of condenser is constituted by a plurality of portions of plate-like elements that have, at two opposite perimetric sides, seats that are substantially shaped like the Greek letter omega and are arranged so as to face the seats of the contiguous plate-like portions, so as to form seats for the passage of the tubular element in which the working fluid of the refrigerator circulates. The various plate-like portions are welded proximate to the omega-shaped deformations, so as to achieve contact by

adhesion with the outer lateral surface of the tubular element.

These types of condenser have a good ratio between production cost and heat exchange efficiency, but their heat exchange efficiency is nonetheless penalized with respect to condensers having a plurality of wires, since contact by adhesion between the tubular element and the plate-like portions still penalizes the transmission of heat from the tubular element to the plate-like portions.

Disclosure of the Invention

The aim of the present invention is to solve the above-described problems by providing a heat exchanger for refrigerators, which according to the requirements can be used as an evaporator or as a condenser and has low production costs, at the same time ensuring high heat exchange efficiency.

Within the scope of this aim, an object of the invention is to provide a heat exchanger in which the connection between the tubular element, inside which the working fluid of the refrigerator circulates, and the plate-like element is very close, with an assured contact that is not subject to changes during long-term operation.

Another object of the invention is to provide a heat exchanger which, when used as an evaporator, can be fully applied to the back wall of the refrigeration cell and in such a manner as to assuredly eliminate the possibility of regions of no-contact between the two surfaces, except possibly for very small portions, thus ensuring high heat exchange efficiency.

Another object of the invention is to provide a heat

exchanger for refrigerators that can be manufactured with cycles of a standardized type and with high automation.

Another object of the invention is to provide a heat exchanger which, in its embodiment as an evaporator, limits the danger of an accumulation of moisture between the plate-like element and the tubular element.

With this aim, these and other objects in view, there is provided a heat exchanger for refrigeration devices, particularly for refrigerators for household use, comprising at least one plate-like element and one tubular element for the working fluid of the refrigerator, said tubular element being connected to one face of said plate-like element, characterized in that said plate-like element has, in the regions affected by said tubular element, raised portions at which said tubular element is welded to said plate-like element.

Brief Description of the Drawings

Further characteristics and advantages of the invention will become apparent from the description of some preferred but not exclusive embodiments of the heat exchanger according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a perspective view of a heat exchanger according to the invention, in its embodiment as an evaporator;

figure 2 is a perspective view of a portion of the evaporator shown in figure 1, with a portion of the tubular element removed for greater clarity;

figure 3 is an enlarged-scale sectional view of figure 1, taken along the plane III-III;

figure 4 is a front view of the heat exchanger in a first embodiment as a condenser;

figure 5 is a perspective view of a portion of the condenser shown in figure 4;

figure 6 is a front view of a second embodiment of the heat exchanger according to the invention in its embodiment as a condenser;

figure 7 is a perspective view of a portion of the condenser shown in figure 6;

figure 8 is a perspective view of a portion of a third embodiment of the heat exchanger according to the invention, in its embodiment as a condenser.

Ways of carrying out the Invention

With reference to figures 1 to 3, the heat exchanger according to the invention, in its embodiment as an evaporator, generally designated by the reference numeral 1, comprises a plate-like element 2 and a tubular element 3 that is connected to one face of the plate-like element 2.

The plate-like element 2 is preferably constituted by a steel plate, but it could also be constituted by a laminated part made of another metallic material.

The tubular element 3 is preferably constituted by a steel tube, but it could also be made of another type of metallic material.

According to the invention, the plate-like element 2 has, at the regions that are adapted to be intimately connected to the tubular element 3, raised portions 2a at which the tubular element 3 is welded to the plate-like element 2.

The tubular element 3 forms a coil-shaped path and the

raised portions 2a of the plate-like element 2 can be appropriately provided at the curved parts 3a of the tubular element 2 as well, so as to ensure welding of the tubular element 3 to the plate-like element 2 also at said curved parts as well.

The portions 2a can be obtained, in a simple manner, by means of an operation for producing the plastic deformation of the plate-like element 2, for example by means of an operation for forming studs that have very small individual dimensions and as a whole form a surface that is very small, in percentage, with respect to the total surface area of the plate-like element 2, and also do not alter the flatness of the plate-like element 2 both during the formation of the studs and during the welding of the plate-like element 2 and the tubular element 3.

The portions 2a can be arranged along straight segments that can be substantially perpendicular or parallel to the axis of the tubular element 3, in the various regions of its extension, or along raised portions that are circular or have another shape or are in any case adapted for the welding of the tubular element 3.

In its embodiment as a condenser, shown in figures 4 and 5, the heat exchanger according to the invention is manufactured substantially in the same manner as the evaporator in the embodiment described with reference to figures 1 to 3, with the optional addition, in the regions of the plate-like element 2 that are not occupied by the tubular element, of fins 4 to increase natural ventilation. Said fins 4 can be obtained for example by simple blanking and deformation of the plate-like element 2.

In figures 4 and 5, the same reference numerals have been maintained for the elements that substantially correspond to the elements that have already been described with reference to figures 1 to 3.

In its embodiment as condenser, shown in figures 6 and 7, the plate-like element, generally designated by the reference numeral 2, is constituted by a plurality of plate-like segments 8 that are mutually connected by means of the overlap of one of their perimetric sides.

As shown in particular in figure 7, said plate-like segment 8 can have, at the region of a plate-like segment 8 that is adapted to overlap the perimetric region of the contiguous plate-like segment 8, a deformed region 8a that forms a seat in which a portion of the tubular element 3 is accommodated. Raised portions 2a are formed on said deformed region 8a, at the regions that face the tubular element 3, in a manner similar to what has been described with reference to the previous embodiments, on the side directed toward the tubular element 3; the tubular element 3 is welded to the plate-like segment 8 at said raised portions. The same is provided on the perimetric portion of the contiguous plate-like segment 8 that is adapted to face the deformed portion 8a.

At the portions 2a, the tubular element 3, as already described with reference to the previous embodiments, is welded to the plate-like segments 8, and said welding, in addition to achieving the adhesion of the tubular element 3 to the plate-like segments 8, also achieves the mutual connection of the plate-like segments 8.

In its embodiment as a condenser, shown in figure 8,

the plate-like element, generally designated by the reference numeral 2, is again constituted by a plurality of plate-like segments 9 that are mutually connected, by overlapping, at two opposite perimetric sides. In this embodiment, in the mutual overlap region, the plate-like segments 9 have an omega-shaped deformed region 9a that forms a seat inside which the tubular element 3 is accommodated. At said omega-shaped deformed region 9a there are, in a manner similar to what has been described with reference to the previous embodiments, raised portions 2a that protrude toward the tubular element 3 and at which the tubular element 3 is welded to the plate-like segments 9.

It is furthermore possible to provide spot welds 10 that mutually join the various plate-like segments 9. In this manner, the present invention improves one of the known methods.

Fins 4 that facilitate natural ventilation can also be provided on the plate-like segments 9 in the embodiments shown in figures 6 to 8.

In practice, the heat exchanger according to the invention can be produced simply starting from a plate made of steel or of another metallic material that is subjected to indentation, for example directly during the process for blanking or chamfering and optional plastic deformation, as described with reference to figures 6 to 8, so that the raised portions 2a, appropriately spaced from one another, are on the face of the plate-like element on which the tubular element 3 is adapted to be arranged.

The tubular element 3 is then rested on the portions 2a and is connected to the plate-like element 2 by electric

welding, taking care to provide continuous contact between the tubular element 3 and the plate-like element 2 along a generatrix of said tube, in addition to the intimate contact (melting) assured by the spot welds, at which part of the secondary exchange surface (plate-like element 2) becomes primary indeed because of the physical continuity that occurs as a consequence of the welds.

Then, if the plate-like element 2 and the tubular element 3 are made of steel, a surface treatment is performed with galvanization, or electrophoresis, or other known types of surface treatment to achieve optimum corrosion resistance.

The heat exchanger according to the invention, by virtue of the large number of regions of intimate contact between the tubular element 3 and the plate-like element 2 due to the electric spot welding performed at the regions where the tubular element 3 rests on the raised portions 2a of the plate-like element 2, as well as to the adjacent arrangement of the tubular element 3 with respect to the plate-like element 2 in the regions between the spot welds, ensures high efficiency in heat exchange between the tubular element 3 and the plate-like element 2, also ensuring high efficiency during long-term operation.

It should be noted that in its embodiment as an evaporator, the heat exchanger is adapted to be connected, by means of the face of the plate-like element 2 that is not occupied by the tubular element 3, to the outside wall of the casing that delimits the refrigeration cell. In this manner one achieves full insulation of the tubular element 3 with respect to the wall of the refrigeration cell, avoiding

contact of the tubular element with the moisture that can filter, due to permeability, through the wall that delimits the refrigeration cell. The formation of condensation between the plate-like element 2 and the tubular element 3 of the evaporator is thus avoided.

The application of the evaporator to the refrigeration cell is completed, in a conventional manner, by an injection of foamed material that covers the evaporator on its opposite side with respect to the refrigeration cell.

It should be noted that the heat exchanger according to the invention, by not requiring particular treatments of the tubular element, but merely requiring operations that are simple and quick to perform on the plate-like element, can be produced with machines of a standardized type and therefore with low production costs.

In practice it has been observed that the heat exchanger according to the invention fully achieves the intended aim, since it is capable of ensuring high heat exchange efficiency and low production costs and is practically free from the formation of condensation and corrosion problems when used as an evaporator.

The heat exchanger thus conceived is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may furthermore be replaced with other technically equivalent elements.

In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to the requirements and the state of the art.

## CLAIMS

1. Heat exchanger for refrigeration devices, particularly for refrigerators for household use, comprising at least one plate-like element and one tubular element for the working fluid of the refrigerator, said tubular element being connected to one face of said plate-like element, characterized in that said plate-like element has, in the regions affected by said tubular element, raised portions at which said tubular element is welded to said plate-like element.

2. Heat exchanger according to claim 1, characterized in that said tubular element is arranged on said plate-like element along a coil-shaped path.

3. Heat exchanger according to claim 1, characterized in that said raised portions are formed by studs of said plate-like element that protrude from its face that is connected to said tubular element.

4. Heat exchanger according to claim 2, characterized in that said raised portions also affect curved parts of said tubular element.

5. Heat exchanger according to claim 1, characterized in that said raised portions lie along substantially straight portions transversely to the axis of said tubular element.

6. Heat exchanger according to claim 1, characterized in that said raised portions lie along substantially straight segments parallel to the axis of said tubular element.

7. Heat exchanger according to claim 1, characterized

in that said tubular element, in a region between two contiguous raised portions, lies in contact with said plate-like element.

8. Heat exchanger according to claim 1, characterized in that said raised portions have a substantially circular shape.

9. Heat exchanger according to claim 1, characterized in that said plate-like element and said tubular element are made of steel.

10. Heat exchanger according to claim 1, characterized in that said plate-like element and said tubular element are made of steel subjected to a surface treatment.

11. Heat exchanger according to claim 1, characterized in that said plate-like element is constituted by multiple plate-like segments that are mutually superimposed at two opposite perimetric sides.

12. Heat exchanger according to claim 11, characterized in that said plate-like segments have, in the regions of mutual overlap, a deformed region that forms a seat accommodating portions of said tubular element.

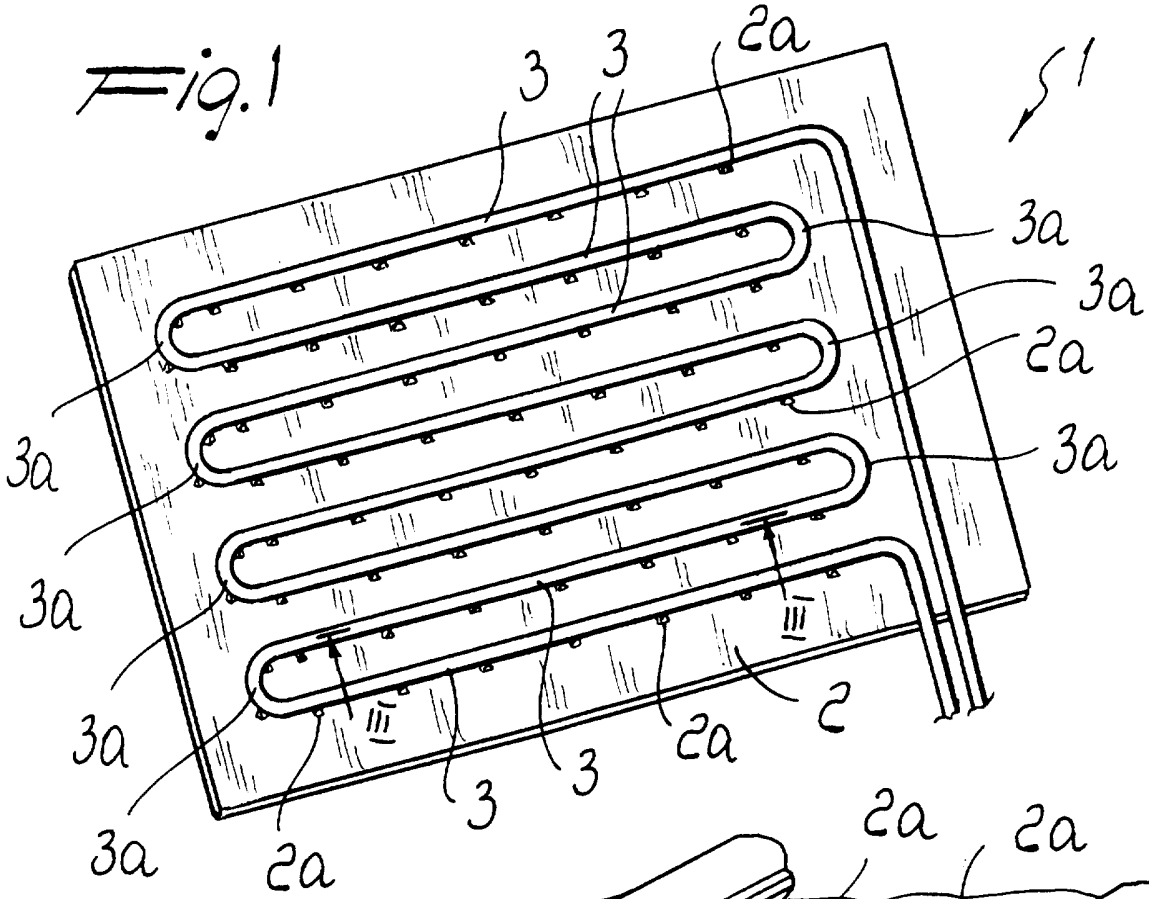
13. Heat exchanger according to claim 11, characterized in that said plate-like segments are provided with said raised portions at the regions that face said tubular element and in that said plate-like segments are mutually connected by the welding to said tubular element at said raised portions.

14. Heat exchanger according to claim 1, characterized in that said plate-like element has ventilation fins in the regions thereof that are not occupied by said tubular element.

15. Method for producing heat exchangers for refrigerators, characterized in that it comprises the steps of:

- subjecting to plastic deformation at least one plate-like element, made of a material that can be subjected to electric welding, in preset regions, so as to form raised portions on one face of said plate-like element;
- positioning, on said face of the plate-like element, a tubular element made of a material that can be subjected to electric welding, resting it on said raised portions; and
- connecting said tubular element to said plate-like element by electric spot welding, which affects the regions where said tubular element rests on said plate-like element.

Fig. 1



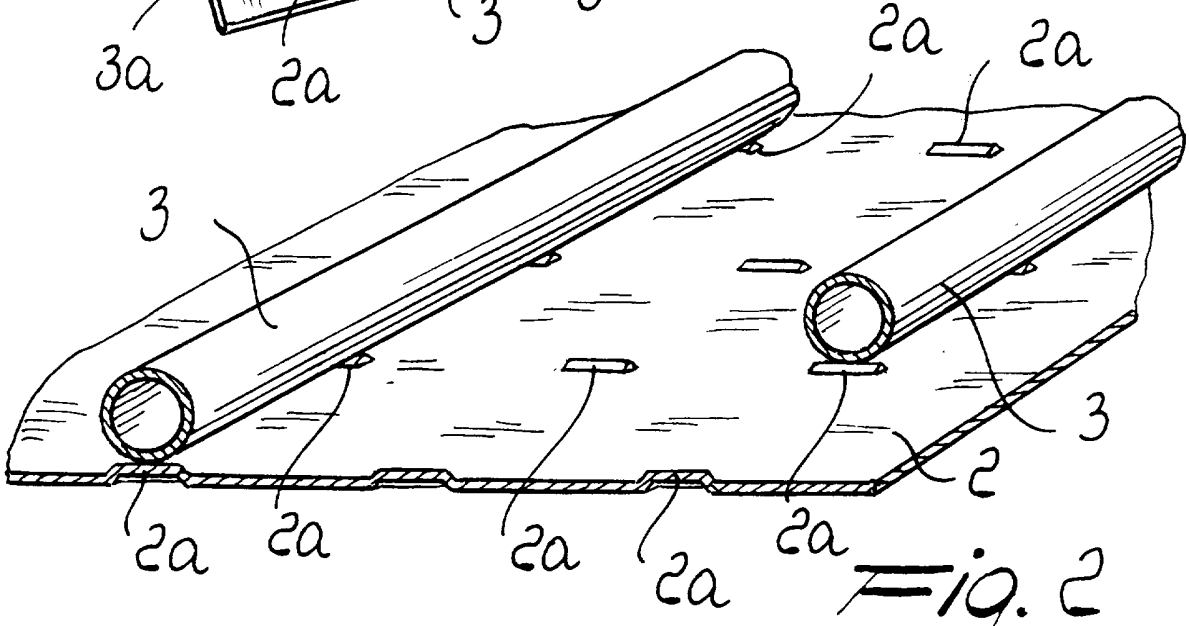




Fig. 2

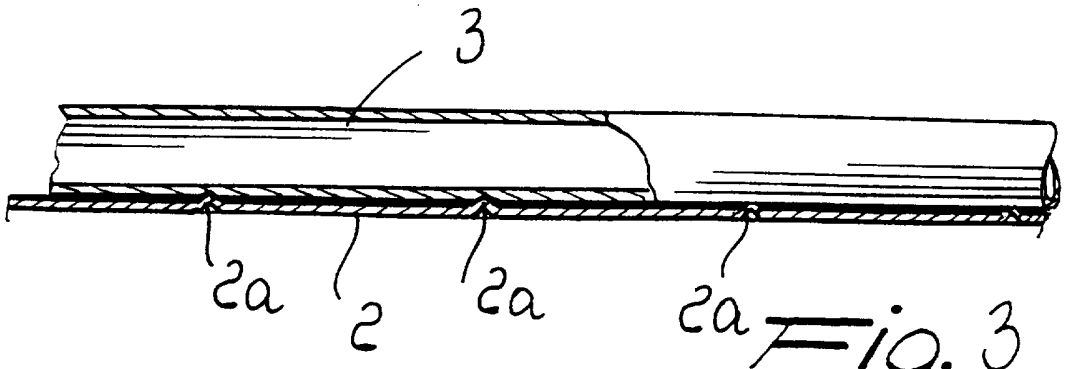



Fig. 3

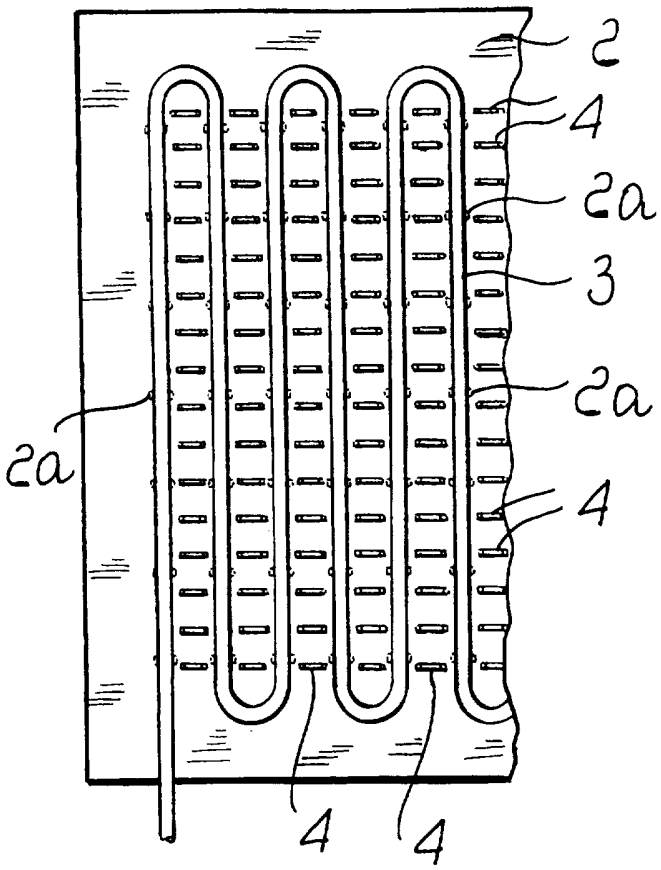



Fig. 4

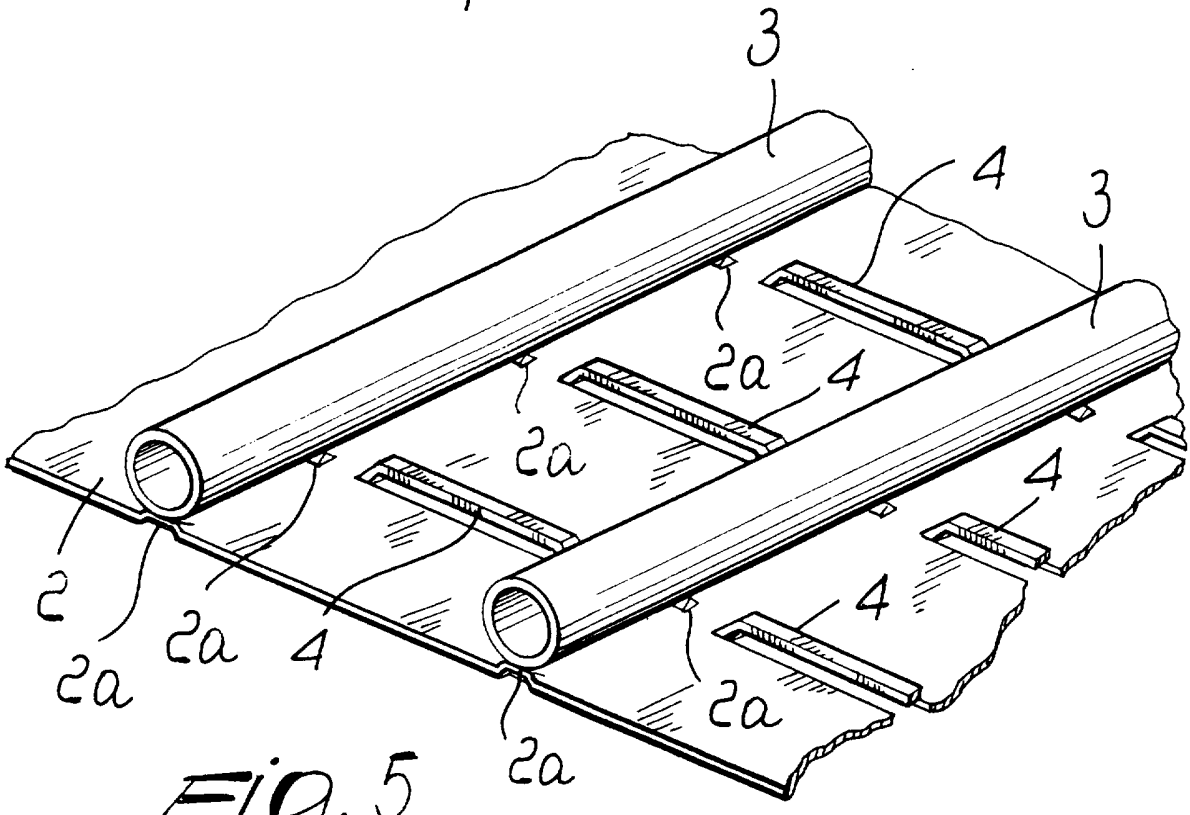



Fig. 5

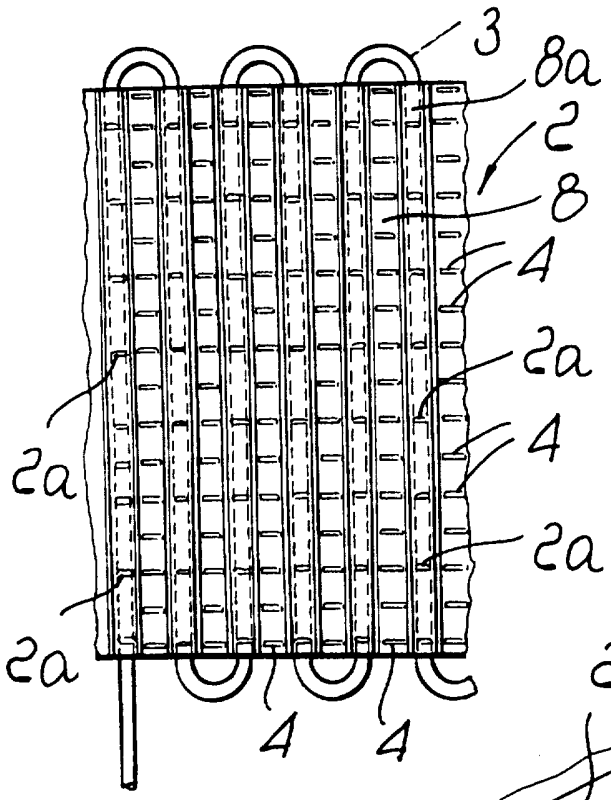



Fig. 6

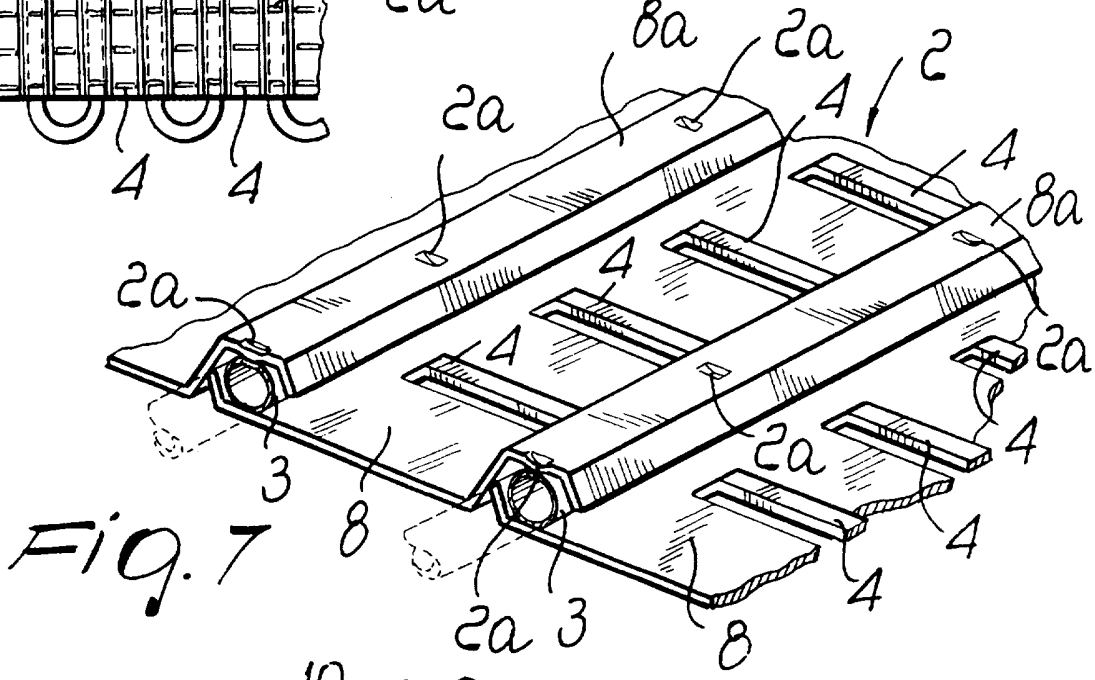



Fig. 7

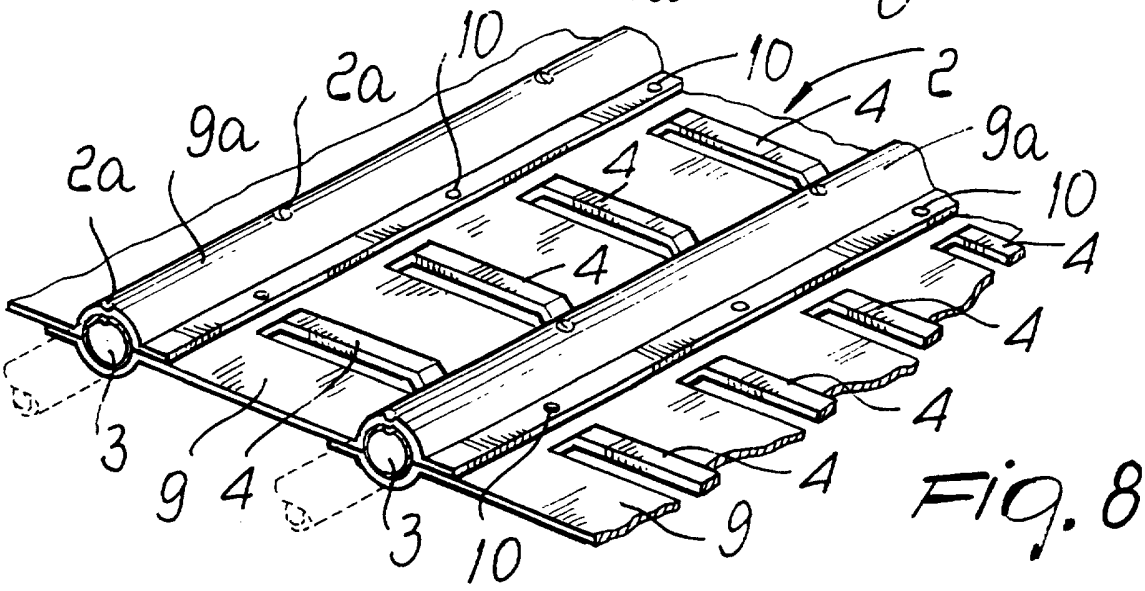



Fig. 8

# INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/IT 96/00085

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F28F1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F28F F24J

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | GB,A,2 115 131 (FULTON LTD) 1 September 1983<br>see page 1, line 122 - page 2, line 80;<br>figures 1,2,5,6 | 1-3,5,6,<br>9,14,15 |
| Y | --- | 11-13 |
| Y | US,A,4 158 908 (BLOCK ET AL) 26 June 1979<br>see column 3, line 20 - column 4, line 39;<br>figures 1-6 | 11-13 |
| | --- | |
| X | EP,A,0 057 091 (BION & CO LTD) 4 August 1982<br>see page 5, line 1 - page 5, line 16<br>see page 7, line 1 - page 7, line 16;<br>figure 1 | 1-3,6,<br>14,15 |
| Y | --- | 4 |
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Int onal Application No
PCT/IT 96/00085

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