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(54) **Modular heat exchanger, particularly for clothes dryers, washingdrying machines and the like**

(57) A cross-flow heat exchanger or condenser, comprising easily assembled modular conduits (10, 100, 200) for a first fluid which define channels (12, 120) for a second fluid, wherein the conduits (10, 100, 200) have, in their end regions (10A, 100A, 200A), a dimension (a) greater than a corresponding dimension (b) of their intermediate region (10B, 10C, 100B. 100C; 200B, 200C), said intermediate region contributing to the formation of said channels (12, 120) with other conduits combined in correspondence with their end regions.

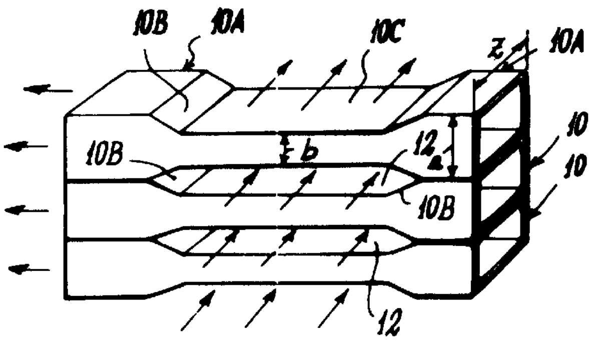

Fig. 2

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Description

This invention relates to a non-coaxial, modular heat exchanger usable as a condenser, particularly in clothes dryers, washing-drying machines and the like, in accordance with the introduction to the accompanying claim 1.

Heat exchangers and condensers are based on heat transfer between two physically separated fluid streams. In the particular case of heat exchangers and condensers used in the aforesaid machines, to which the invention particularly relates, the heat transfer takes place between streams of atmospheric air (functioning as a cooling fluid) and streams, crosswise to the preceding, formed from heated moist air originating from clothes drying, and which has to lose its moisture, by cooling, before being returned into contact with the clothes to be dried. Traditional heat exchangers or condensers consist of a series of substantially parallel channels traversed by one of the fluids and spaced apart from each other by spacers, such that between said channels there are formed sealed conduits to be traversed by the other of the fluids. One example of such a heat exchanger/condenser is shown in Figure 1 in which the reference numeral 1 indicates the rectangular channels of constant cross-section (generally metal tubes), 2 indicates the spacers and 3 indicates the conduits between said channels. The arrows illustrate the cross flows of the two fluids. Because they use spacers and sealing materials or products to provide a seal, the known arrangements are complicated both in terms of the number of additional parts to be used and in terms of the process and the means used to provide the seal.

GB-A-2,033,569 describes a heat exchanger for clothes dryers which comprises a plurality of substantially rectangular tubes spaced apart from each other by metal section bars which are welded to the tubes. The ends of the section bars are welded to L-bent plates. Their construction involves considerable welding work and many parts, and is therefore complicated.

DE-A-19505641 describes a heat exchanger composed of a plurality of spaced-apart flat conduits. Undulated metal plates are provided in the spaces between the conduits and are fixed thereto.

This known construction is particularly complicated and costly.

EP-B1-0223995 describes a cross-flow heat exchanger in which a plurality of flat channels are maintained spaced apart by plastic endpieces provided both with parallel grooves receiving and supporting the ends of these flat channels, and with apertures for entry and respectively exit to and from the interspaces between said channels. This arrangement involves the use of separate endpieces for supporting the flat channels and for spacing them apart.

DE-C2-3242845 describes a cross-flow heat exchanger formed from layers of mutually offset tubes. The ends of the tubes of each layer are bent about and fixed into substantially tubular spacers, or welded to spacers. The construction is complicated and costly. An object of the present invention is to provide a cross-flow heat exchanger or condenser of simple construction, which is free of additional spacer elements, and does not require special sealing means.

A further object of the invention is to provide a cross-flow heat exchanger or condenser, which by virtue of the particular design of its constituent elements enables high heat transfer between the processed fluids to be obtained.

These and further objects which will be more apparent from the detailed description given hereinafter are attained by a heat exchanger or condenser in accordance with the accompanying claims.

The invention will be more apparent from the ensuing description of some preferred embodiments thereof given by way of non-limiting example and illustrated on the accompanying drawings, in which:

Figure 1 is a schematic perspective view of the arrangement of the state of the art;
Figure 2 is a schematic perspective view of a first embodiment of the invention;
Figure 3 is a schematic perspective view of a second embodiment of the invention;
Figure 4 is a detailed section showing a possible method of connecting two superposed conduits;
Figure 5 is a perspective view of an element of the heat exchanger/condenser, this element having its surface structured in such a manner as to increase heat transfer between the fluids;
Figure 6 is a section on the line A-A of Figure 5;
Figures 7a, 7b, 7c, 7d and 7e show respectively a side view, an end view, sections on the lines X-X and Y-Y and a plan view of a modification of the element; and
Figures 8a, 8b and 8c show respectively an exploded view, a perspective view and a side view of a further embodiment of the invention.

With reference to Figure 2, the heat exchanger/condenser represented therein is formed from a plurality of superposed conduits 10 of variable cross-section, their end regions 10A bilaterally comprising parallel flat faces, followed by inclined regions 10B, and then an intermediate region 10C bilaterally comprising flat faces. In this example the conduit has a constant width "z" along the whole of its length, and a height "a" which in the end regions 10A is greater than the height "b" of the intermediate region 10C (and of the connection regions 10B).

As can he seen from the figure, according to an important aspect of the invention the end regions act as a direct support for the conduits stacked one on another, and can be securely joined together for example by adhesives (or other bonding or sealing elements) applied on the mutually bearing faces of these ends.

The inclined regions 10B and the intermediate regions 10C of two superposed conduits 10 together form (or delimit) channels 12 for the flow of a fluid different from that which flows through the conduits 10.

In the embodiment of Figure 3, the aforedescribed conduits 10 alternate with "flat" conduits 11 arranged to adhere to the upper and lower faces (with respect to the drawings) of the ends 10A, to hence obtain channels 12A between the stacked conduits 10 and 11.

As already stated, the various conduits can be joined together by conventional adhesives applied to those faces to be superposed (see Figure 5 in which the adhesive-carrying region is indicated by 13).

With reference to Figure 4, the conduits can be joined together by clinching, ie by folding the projecting edges 14 of one side of the ends 10A of one of the conduits about the adjacent edge of the end of the other conduit, possibly positioning within the fold a simple gasket for example of rubber 21 . Alternatively, these conduits can be joined together in any other manner, for example by a male-female joint by providing suitably shaped projections at their ends.

In addition, as shown in Figures 5 and 6, the surfaces of the intermediate regions 10C and of the inclined regions 10B can be structured to improve heat transfer between the fluid streams, or to improve rigidity of the conduit. In these figures, the structure shown comprises depressions or concavities 20 in these surfaces, which can alternate with or be replaced by convexities 21. The concavities 20 of opposed walls of the region 10C of a conduit 10 can be in mutual contact to further stiffen this region.

In the embodiment of Figures 7a-7e the dimension (height) "a" of the end regions 10A is again greater than the corresponding dimension "b" of the intermediate region 10C, but the other dimension (width) "Z_1" of this latter is different (greater in the example) from the dimension "Z_2" of the end regions 10A for supporting other conduits. In the example the inclined regions 10B are of frusto-pyramidal shape with a rectangular cross-section.

The conduits are preferably of metal (for example aluminium).

They can however also be of synthetic material filled with metal to increase the heat transfer coefficient.

Figures 8a, 8b and 8c show a further embodiment of the invention in which the mutually superposed conduits 100 and 200 are differently shaped in pairs. In the example, with a conduit 100 having convex-curved ends, there is associated a conduit 200 having concave-curved ends 200A which mate with the convex ends 100A of the adjacent conduit 100. The conduits 100 and 200 can have a completely concave or convex shape or comprise portions (for example 100A) concave or convex and other portions (for example 100B, 100C) convex or concave. In all cases the shape of these conduits at their ends 100A and 200A is such as to enable them to be stacked and to form between them channels 120 which optimize heat transfer.

A plurality of these pairs of conduits 100 and 200 are hence superposed and preferably maintained coupled by a seal ring 300 of traditional type which acts both as a sealing element and as a securing element for the "pack" of conduits.

At one end of the "pack", an end conduit 100 or 200 of this assembly could be replaced by an assembly closure piece shaped as the missing conduit. This piece can be a closed piece, not defining a conduit.

As stated, in Figures 8a, 8b and 8c the conduits can have concave parts (such as the end parts of the conduits 100A) alternating with other intermediate convex parts, and can have intermediate portions 100B, 100C, 200B, 200C with rounded or sharp edges.

In all the described cases, the conduits can be rectilinear or curvilinear along their major axis. Moreover the cross-section through these conduits can be rectangular (or polygonal) or curvilinear (for example elliptical). This cross-section can have a constant perimeter along the entire length of the conduits or can have different perimeters at different points of them.

The conduits shown in the figures can be produced by one of the following known methods or by a combination thereof:

a) bending sheet metal;
b) deformation (pressing by internal pressure applied by a fluid (gas or liquid));
c) gluing;
d) deep drawing.

The following two clarifications need to be made:

1) the term "rectangular" as used herein embraces embodiments in which the end regions are of square cross-section;
2) as the heat exchanger can be used not only in the position shown in the figures (for which reason the term "stacked" conduits is used) but also in a position rotated either about an axis parallel to that of the conduits or about an axis parallel to that of the channels, the term "stacked" embraces the term "side-by-side", and the and the terms "height" and "width" are interpreted in a manner relative to the various configurations which the conduits can assume and referred to those indicated by "a", "b" and "Z" on the drawings, and moreover in the claims the term "corresponding" signifies that the dimensions "a" and "b" are those measured on one and the same external side of the conduits.

Claims

1. A cross-flow heat exchanger or condenser, comprising conduits (10, 100, 200) for a first fluid which define channels (12, 120) for a second fluid, characterised by comprising conduits (10, 100, 200)

having, in their end regions (10A, 100A, 200A), a dimension (a) greater than a corresponding dimension (b) of an intermediate region (10B, 10C, 100B. 100C; 200B, 200C), which contributes to the formation said channels (12, 120) with other conduits associated in correspondence with their end regions.

2. A cross-flow heat exchanger or condenser as claimed in claim 1, characterised in that the other (Z) of the two dimensions (a, Z; b, Z) of the cross-section through the conduit is constant along the entire length of the conduit.

3. A heat exchanger or condenser as claimed in at least one of the preceding claims, characterised by comprising rectangular conduits (11) of constant cross-section along their entire length interposed between conduits (10) with differential regions.

4. A heat exchanger or condenser as claimed in claim 2 or 3, characterised in that the cross-section through the conduit (10, 100, 200) varies along its length.

5. A heat exchanger or condenser as claimed in claims 2 and 4 or 3 and 4, characterised in that the conduits (10, 100, 200) are rectilinear.

6. A heat exchanger or condenser as claimed in one or more of the preceding claims, characterised in that the conduits (10, 100, 200) are curvilinear.

7. A heat exchanger or condenser as claimed in one or more of the preceding claims, characterised in that the conduits (10 and 10, 11) are joined together by gluing, clinching or a male-female connection, or by fixing or heat-shrinking elements.

8. A heat exchanger or condenser as claimed in one or more of the preceding claims, characterised in that a part of the conduit surface is structured to increase heat transfer and/or conduit rigidity.

9. A heat exchanger or condenser at least as claimed in claim 1, characterised in that the other dimension (Z) of the conduit is greater in its intermediate region (10C, 100C, 200C) than in its end regions (10A, 100A, 200A).

10. A clothes dryer or washing-drying machine incorporating a heat exchanger or condenser in accordance with at least claim 1.

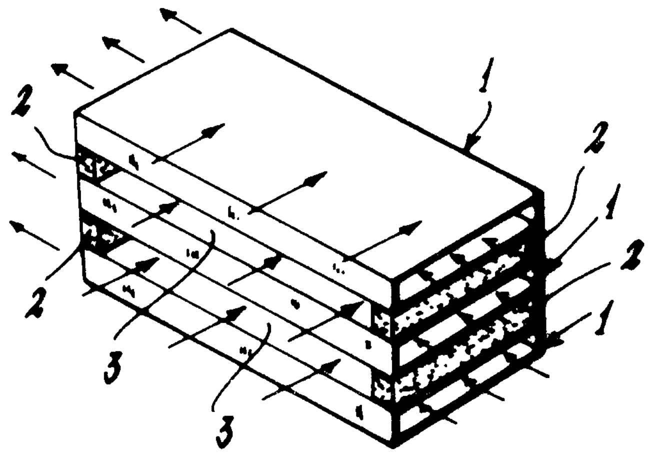

Fig. 1

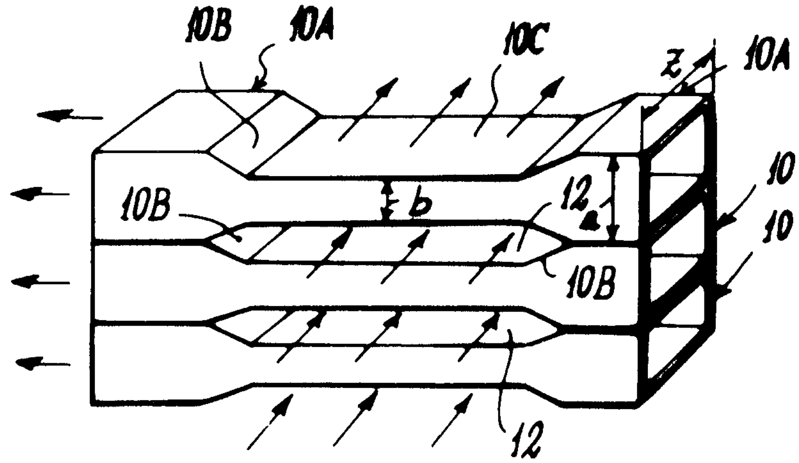

Fig. 2

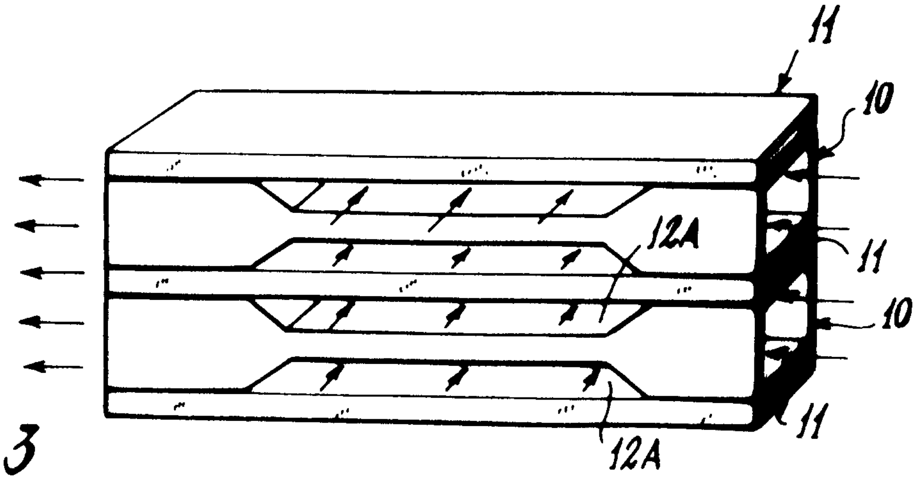

Fig. 3

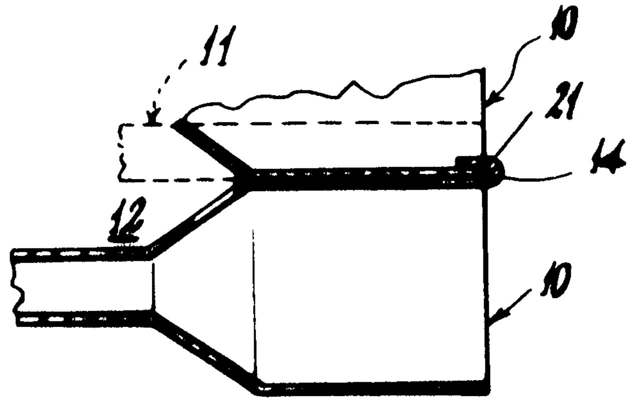

Fig. 4

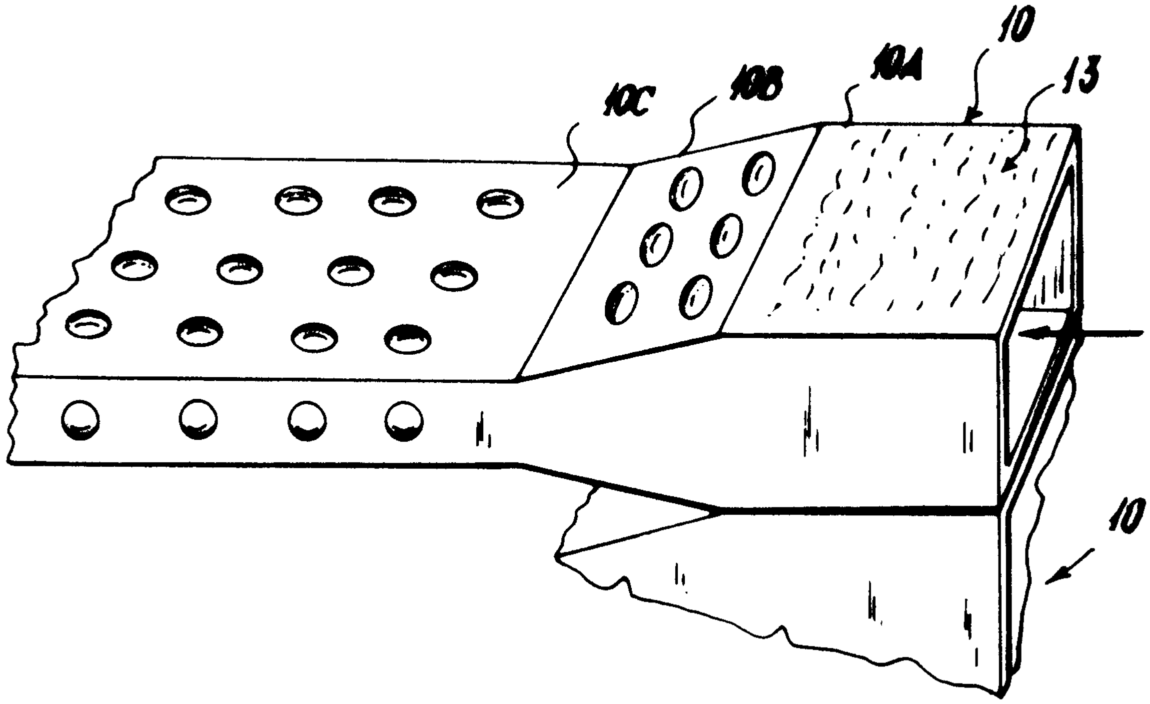

Fig. 5

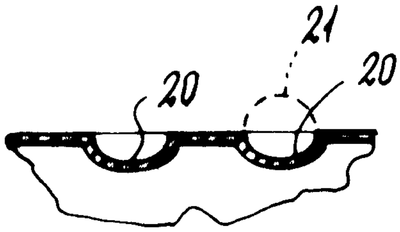

Fig. 6

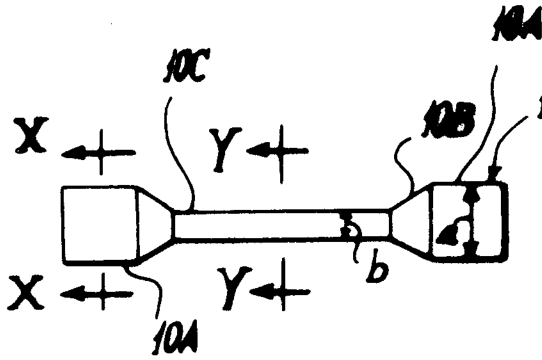

Fig. 7a

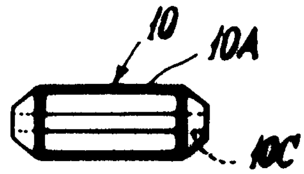

Fig. 7b

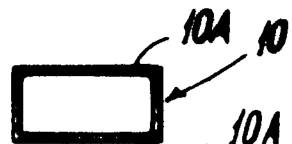

Fig. 7c

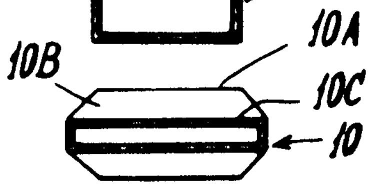

Fig. 7d

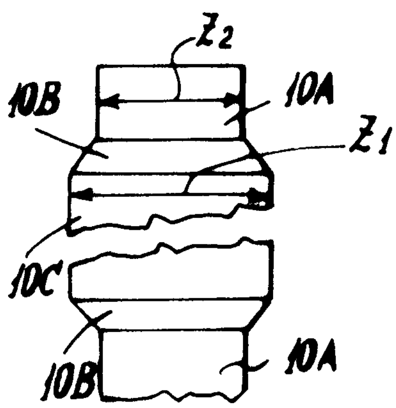

Fig. 7e

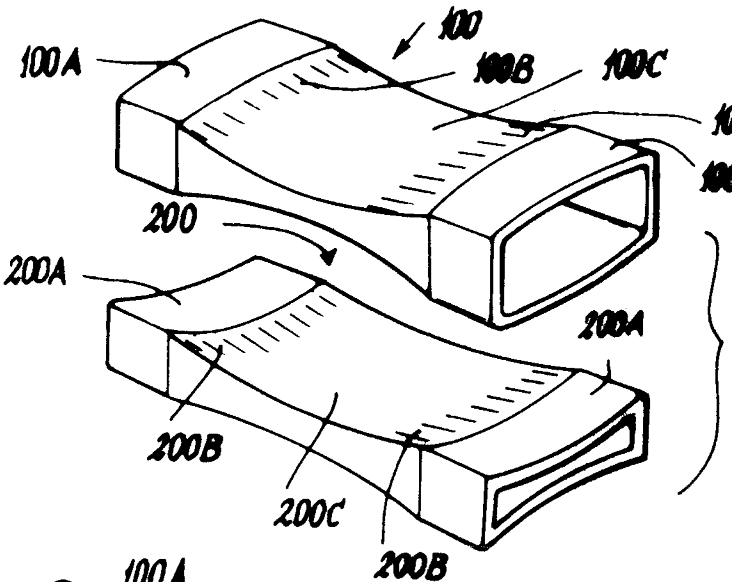

Fig. 8a

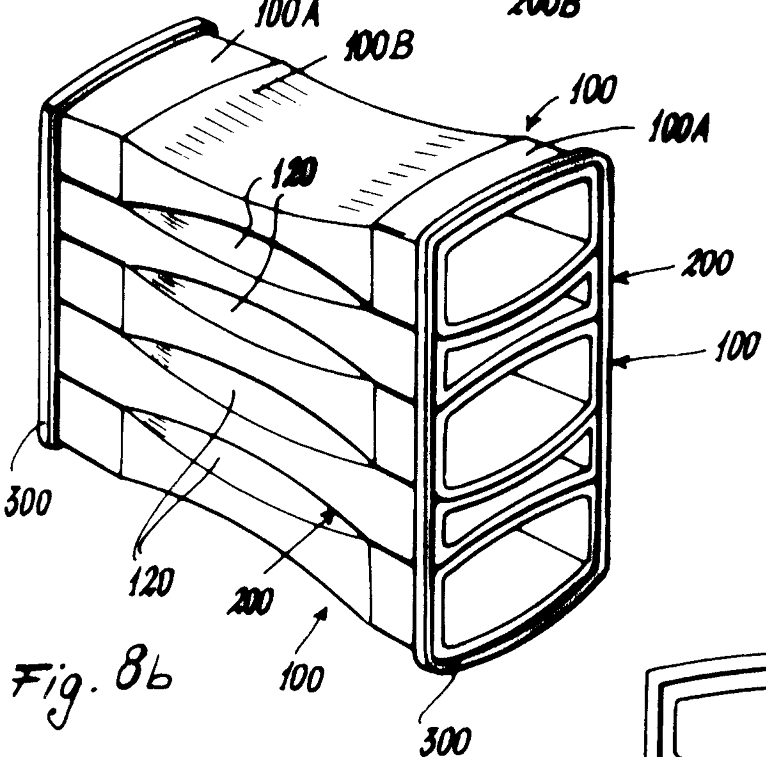

Fig. 8b

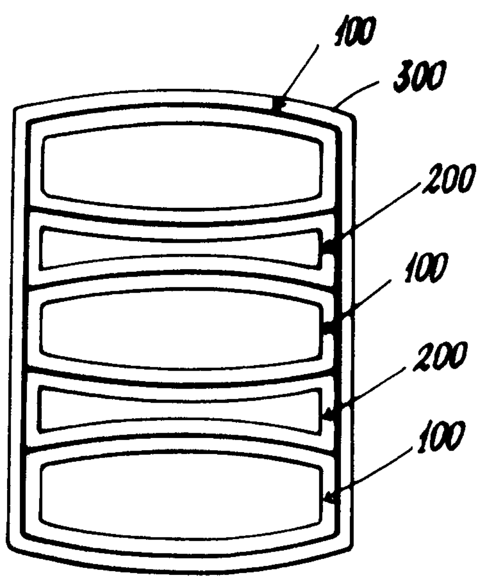

Fig. 8c