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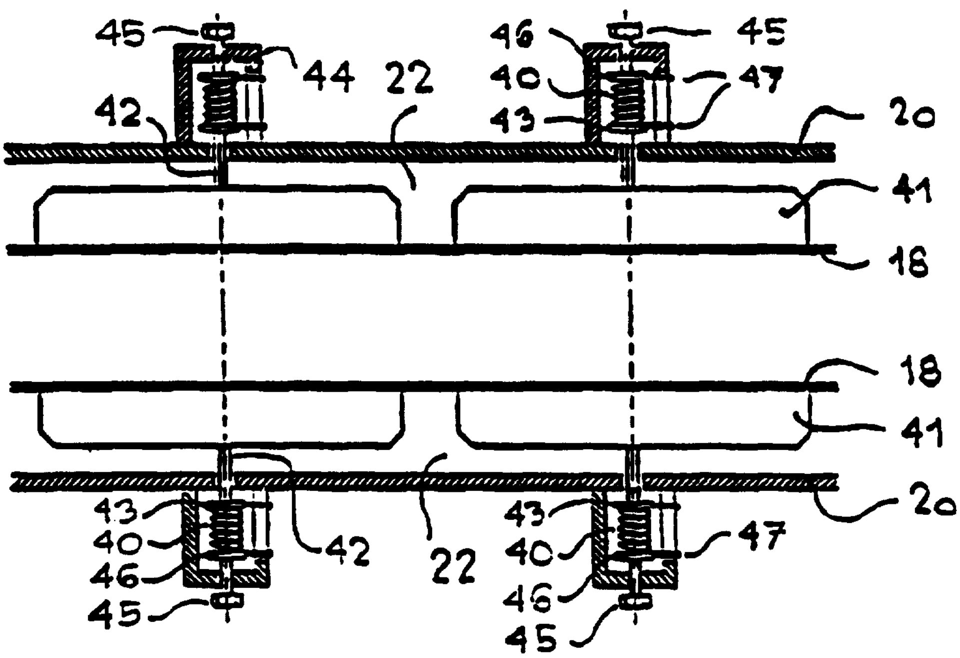


(57) Abstract

For heat exchangers with non-welded construction of the core (1) formed by a plurality of plates being incorporated in a frame there is designed a structure having at least one of the frame wall members in a contact with adjacent end board (18) of the core (1) by means of a plurality of resilient members (4) furnished with a spring (40) attached by means of a first contact member to the end board (18) and by means of a second contact member to the wall member. The first contact member comprises a rod (42) protruding through the wall member and attached to the spring (40) disposed on the outside surface of the wall member. The second contact member comprises a control member for adjustment of the resilient member (4) compressive force.

A HEAT EXCHANGER

Technical Field

The invention relates to a heat exchanger having a core structure formed by a plurality of plates spaced apart by spacing means defining channels between adjacent plates for heat-exchanging media flow, the core being incorporated in a frame including a pair of parallel-spaced rigid wall members mutually connected by post members.

Background of the Invention

There exists a wide range of heat exchangers which have a core comprising a system of channels providing for flows of heat exchanging media, the core being covered and held together by a rigid frame supporting also all inlets and outlets. Among most common types there is a plate-type exchanger the core of which consists of a plurality of spaced plates defining the flow channels. To avoid excessive stress due to different heat load of individual parts with welded constructions, the sealing of edges is also provided for by a clamped construction of the core. With such a fully non-welded core compression forces must remain sufficiently strong during all operation cycles when the plates are repeatedly heated up and cooled down and therefore expand and contract continuously. The thermal expansion forces are usually much stronger than the clamping ones and each plate has thus a certain freedom to move with respect to adjacent plates. Such an arrangement allows for improved ability to withstand severe thermal shocks during operation when compared to a fully welded construction. On the other hand it manifests certain leakage that cannot be avoided. Such a construction is known from PCT US83/00552 presenting resilient spacers between adjacent plate edges to accommodate this thermal expansion of plates during thermal cycles and minimize the leakage of one heat-exchanging media, mostly a fluid one, into the other one. These spacers are exposed to direct contact with the heat exchanging media, the effect of which, combined with high temperature, is responsible for erosion, corrosion and fatigue of these resilient spacers resulting in their decreased compressive force and finally in an increased leakage rate. Known arrangements do not allow for this gradual degradation of the resilient spacers. As the compressive force of resilient spacers is rather low, to achieve an effective sealing this design is suitable for cores manifesting a certain degree of flexibility and therefore only for cores consisting of relatively thin plates. On the other hand it is sensitive to thermal shocks taking place during rapid start-ups or shut-downs which may bring the plates in a condition of plastic deformation which the spacers cannot follow sufficiently and an excessive leakage again occurs. The above discussed construction is thus limited to low pressure application only.

Disclosure and Object of the Invention

The foregoing problems are solved by a heat exchanger having a plate core disposed within a frame including a pair of spaced rigid wall panels, constructed in accordance with the present invention, where at least one of the wall members is in a contact with adjacent end board of the core by means of a plurality of resilient members. Such resilient member comprises a spring attached by means of a first contact member to the end board and by means of a second contact member to the wall member. Further in accordance with the present invention the first contact member comprises a rod protruding through the wall member and attached to the spring arranged on the outside surface the wall member. Still further in accordance with the invention the second contact member comprises a control member for adjustment of the resilient member compressive force, the control member being advantageously a screw. In a preferred embodiment the core comprises rectangular plates having a portion along the first pair of opposed sides bent at the right angle to the plate flat surface and then bent outwardly thus forming first contact wings to the appropriate first contact wings of a plate being adjacent at one side, while a portion along the second pair of opposed sides of the plate is bent at right angle in the opposite direction and then bent outwardly forming a second contact wing to the appropriate second contact wing of a plate being adjacent at the other side. Another preferred embodiment comprises a core furnished with rectangular plates having a portion along the first pair of opposed sides bent at the right angle to the plate flat surface and then bent outwardly thus forming first contact wings to the appropriate first contact wings of a plate being adjacent at one side, while the second pair of opposed sides of the plate provides for contact faces matching with appropriate contact faces of the plate at the other side by means of rigid spacing bars sealed to the plates by welds. For both preferred embodiments it applies that between adjacent first contact wings there is clamped a rigid cover bar with open holes for heat-exchanging media flow into channels. It is still further in accordance with the invention that behind the cover bar there is placed an insert comprising two parallel-spaced sheets defining three passages within the channel, providing the open holes of the cover bar tapers inwardly and opens from a set distance into the inside passage.

It is an object of the invention to minimize the leakage rate by non-welded constructions of heat exchangers with a plate-type core applying additional clamping force through resilient members which can be adjusted according operation conditions and moreover adjusted separately at different places of the core. It is a further object of the invention to construct a non-welded core showing improved self-sealing characteristic features, which can be further improved by partial use of weld sealing while keeping all the advantages of non-welded core even for high-pressure applications. As a special feature of the construction there is avoided a condensation of vapors included in the hot flow when coming into contact with cold part of the exchanger as it is common with present constructions.

Brief Description of the Drawings

By way of examples the invention will be now described with reference to the accompanying drawings. Fig. 1 presents a basic arrangement of the core and the frame. Fig. 2 shows embedding of the core within a frame. Fig. 3 illustrates distribution of resilient elements and first contact members along the core. Fig. 4 offers the first preferred embodiment of the core and Fig. 5 shows shapes of two adjacent plates of the core according Fig.4. Fig. 6 gives details of the arrangement of two adjacent plates of the core according Fig. 4. Figs. 7, 8 present two types of spacing means and Fig. 9 illustrates application of weld sealings. Fig. 10 presents another preferred shaping of core plates and Fig. 11 illustrates respective arrangement of the core comprising plates according Fig. 10. Fig 12 presents a core end board and Fig. 13 shows the end board cross-section B-B from the Fig. 12. Figs. 14, 15 and 16 give an example of an insert and its positioning in a core channel. Figs.17, 18 show arrangements of the exchanger inputs and outputs.

Description of Preferred Embodiments

Referring to Fig. 1, there is shown a heat exchanger having a core 1 incorporated in a frame 2. The structure of the core 1 is formed by a stack of plates 10 spaced apart by spacing means defining channels 3 between adjacent plates 10 for flows of heat-exchanging media.

The core 1 as seen in Fig 4, consists of rectangular plates 10 having portions along the first pair of opposed sides bent at right angle to the plate 10 flat surface and subsequently bent outwards thus forming the first contact wings 11 to appropriate first contact wings 11 of plate 10 being adjacent at one side, while portions along the second pair of opposed sides of the plate 10 are bent at right angle in the opposite direction and subsequently also bent outwards, thus forming second contact wings 12 to appropriate second contact wings 12 of the plate 10 being adjacent at the other side. The shaping of two adjacent plates 10 is illustrated in Fig. 5. The contact wings of the two adjacent plates 10 being in direct mutual contact provide for side walls of a channel 3 formed by these two plates 10. Between the other contact faces of the same two adjacent plates 10 there is clamped a cover bar 13, representing one of applied spacing means. The cover bar 13 is of a rigid construction and has elongated open holes 14 allowing for heat-exchanging media flow into the core 1 channels 3. The open holes 14 may be of any shape and number and may be distributed along the cover bar 13 in any manner giving enough room for heat-exchanging media to flow in and out. The cover bar 13 is held in the position by clamping forces excersized by adjacent contact wings 11, 12 of each pair of the adjacent plates 10. To improve sealing effect gaskets 16 may be inserted between appropriate contact surfaces. The contact face 15 of the cover bar 13 may be smooth or may be machined for more efficient clamping. Fig. 7 gives an example of such an arrangement, which shows longitudinal ridges on the contact surface 15.

Apart from the above discussed cover bars 13 defining side walls of the chanels 3 within the core 1 there are used spacing means providing mechanical support to the plates 10 against the differential pressure, which may occure on the two sides of the plate 10. Fig. 6 shows spacers 17 which are anchored in the cover bars 13 and constituted by round rods which keep the opposing cover bars 13 in a constant position and prevent a displacement of the cover bars during operation cycles. It is obvious to specialists in the field that the cover bars 13 may be mechanically locked in position in many other ways and that such spacers 17 may be of many different shapes and also their anchoring into cover bars 13 may be performed in various manners as illustrated in Fig. 8, presenting cover bars 13 which are held in position by turned up edges of contact wings 11 and spacers 17 having a form of dimples pressed in the plate 10 surface. The spacers 17 may be also produced in form of cylindrical studs which are welded upon the plate 10 flat surface as shown in Fig. 9. A complete stack of plates 10 is shown in Fig. 4. The plate pack is positioned between two end boards 18, which are relatively thin membranes and completed with corner elements 19. These elements are connected to end boards 18 by bolting, welding or by means of any other conventional means.

The frame 2 consists of a pair of parallel-spaced rigid panels 20, which are kept at the set distance by means of rigid beams 21 attached at their corners by bolting, welding or other means. Such a rigid structure of the frame 2 allows for sustaining the core weight and operation loads. Both the upper and bottom panels 20 are the two ones of six wall members constituting a housing of the heat exchanger. The other wall members comprise heat-exchanging media inlets and outlets. The distance between the panels 20 is somewhat larger than the height of the core 1, defined by the distance betwen outer faces of end boards 18, thus creating a gap 22 between the outer face of each of the end boards 18 and an inner face of appropriate adjacent panel 20. This gap 22 is filled with insulation material ensuring that the panels 20 remain at temperature equal to or very close to that of ambient atmosphere when the core 1 is exposed to operation conditions. It is obvious that the invention can be utilized for heat-exchangers manifesting various types of flow configuration within the core 1, the inlets 28 and the outlets 29 being located on different or on the same side of the exchanger-body. In order to achieve diverse configurations, side covers 23 are used to cover part of flow openings, such as open holes 14 on the core sides, as seen from Figs. 17 and 18. To facilitate flows within the core 1 spacers 17 may be curved and shaped as guiding vanes or separate guiding vanes may be used inside the channels 3 in order to prevent flow maldistribution. The design of such spacers 17 or guiding vanes is of a conventional nature and a large variety of the flow guiding systems can be conceived without changing the concept of the invention. Nevertheless one of such systems is described within the invention. A double sheet insert 30 is placed into each of the channels 3, just behind the cover bar 13 at the core 1 cold inlet side. Both sheets 31 of the insert 30 are of the same shape and they are held spaced and in a position which is paralel to plates 10 by conventional means. Fig. 16 presents pins 32 which are welded to the sheets 31. As further seen from Fig. 14 the open holes 14 of the cover bar 13 are conically shaped as a convergent nozzle. This shape increases the velocity of incomming flow delivering a relatively strong jet stream at the entrance into the channel 3. The inside opening 33 of the open hole 14 is narrower than the distance between both sheets 31. The sheet 31 leading edges are positioned at a small distance from the inside opening 33. The strong jet flow comming through the inside opening 33 into the inside passage 34, defined by both sheets 31, creates a suction effect resulting in a return flow through outside passages 35, which are defined by each of the insert 30 sheets and the adjacent plate 10. This return flow travelling along a part of the plate 10 surface is therefore of a higher temperature than the incoming flow from the outside. This preheated flow is mixed with the cold flow at the entrance and thus the stream of a fluid matter to be heated, which flows through channels 3, is therefore of a temperature which is sufficient to prevent undesirable condensation of acids on the core 1 plates 10.

Fig. 2 and Fig. 3 show a plurality of resilient members regularly distributed between each of the frame 2 panels 20 and the adjacent core 1 end boards 18. Each resilient member comprises a spring 40 attached by means of a first contact member to the cover board 18 and by a second contact member to the panel 20. The first contact member comprises a pad 41 resting upon the end board 18 and supporting a rod 42 which protrudes through the panel 20 wall and is attached to the first spring seat 43 disposed on the outside surface of the panel 20. The second contact member comprises a spring casing 44 which is attached to the panel 20 outside surface and a control member for adjustment of a compressive force of the spring 40, the control member being disposed between the spring 40 and the spring casing 44. In the embodiment there is used a screw 45 inserted into a threaded hole in the spring casing 44 and resting upon the second spring seat 46. The spring 40 compressive force is set by the screw 45 and is a function of mutual distance of both spring seats 43, 46, the said distance being indicated by needles 47 attached to each of the spring seats 43, 46. Such resilient members increasing clamping forces of contact wings 11, 12 may be mounted either to only one of the panels 20 or to both of them.

The end boards 18 are from one side exposed to a flow of one of the heat-exchanging media, on the other side they are in a contact with a heat insulation.

Therefore the end boards 18 are exposed to more severe thermal gradients than the plates 10. While plates 10 inside the core 1 are free to expand, end boards 18 connected to corner structural elements 19 are restricted in their ability to accomodate thermal expansion forces. To overcome this feature stress breakers are built in the core 1 end boards 18. Within the flat surface of the end boards 18 there are implemented diagonally directed cuts 30, which are bridged by hollow ribs 31, as shown in Figs. 12, 13. The ribs 31 allow for absorption of any irregularity of thermal expansion of the end boards 18. Besides this one other similar solutions may be utilised.

Though the concept of the invention has been developped as an improvement to non-welded constructions manifesting free thermal expansion of all plates 10, additional sealing along edges of the first contact wings 11 carried out by means of welds 24 may be also applied as shown Fig. 9. Figs. 10 and 11 present another preferred embodiment of the core 1. The rectangular plates 10 have the portion along the first pair of opposed sides again bent at the right angle to the flat surface of the plate 10 and then bent outwards thus forming the first contact wings 11 to the appropriate first contact wings 11 of the plate 10 being adjacent at one side, but the flat second pair of opposed sides of the plate 10 constitutes a contact face matching with appropriate contact face of the adjacent plate 10 at the other side by means of solid spacing bars 27 with no openings or holes. The spacing bars 27 are welded to the adjacent plate 10 edges, while the cover bars 13 along the first contact wings 11 are inserted loosely as described with the first core 1 embodiment. In this case the two adjacent plates 10 with spacing bars 27 inbetween form a solid unit but all such units are still free to move as they are mutually separated only by cover bars 13 inserted between the first contact wings 11. Thus the advantages of non-welded construction are maintained.

Industrial applications

The present invention is designed for heat exchangers having non-velded cores, made either of metallic plates, covered or not covered with protective coatings or made even of non-metallic plates.

C L A I M S

1. A heat exchanger having a core formed by a plurality of plates spaced apart by spacing means, defining channels between adjacent plates for heat-exchanging media flow, the core being incorporated in a frame including a pair of mutually interconnected parallel-spaced rigid wall members, c h a r a c t e r i z e d i n, t h a t at least one of the wall members is in a contact with adjacent end board (18) of the core (1) by means of a plurality of resilient members.

2. A heat exchanger structure according to claim 1, c h a r a c t e r i z e d i n, t h a t the resilient member (4)) comprises a spring (40) attached by means of a first contact member to the end board (18) and by means of a second contact member to the wall member.

3. A heat exchanger according to any of claims 1 and 2, c h a r a c t e r i z e d i n, that the first contact member comprises a rod (42) protruding through the wall member and attached to the spring (40) disposed on the outside surface the wall member.

4. A heat exchanger according to any of claims 1, 2, 3, c h a r a c t e r i z e d i n, t h a t the second contact member comprises a control member for adjustment of the resilient member (4) compressive force.

5. A heat exchanger according to any of claims 1 to 5, c h a r a c t e r i z e d i n, t h a t the core (1) comprises rectangular plates (10) having a portion along the first pair of opposed sides bent at the right angle to the plate (10) flat surface and then bent outwardly thus forming first contact wings (11) to the appropriate first contact wings (11) of a plate (10) being adjacent at one side, while a portion along the second pair of

opposed sides of the plate (10) is bent at right angle in the opposite direction and then bent outwardly forming a second contact wing (12) to the appropriate second contact wing (12) of a plate (10) being adjacent at the other side.

6. A heat exchanger according to any of claims 1 to 5, c h a r a c t e r i z e d i n, t h a t the core (1) comprises rectangular plates (10) having a portion along the first pair of opposed sides bent at the right angle to the plate (10) flat surface and then bent outwardly thus forming first contact wings (11) to the appropriate first contact wings (11) of a plate (10) being adjacent at one side, while the second pair of opposed sides of the plate (10) provides for contact faces matching with appropriate contact faces of the plate (10) at the other side by means of rigid spacing bars (27) sealed to the plates (10) by welds.

7. A heat exchanger according to any of claims 5 to 6, c h a r a c t e r i z e d i n, that between adjacent contact wings (11,12) there is clamped a rigid cover bar (13) with open holes (14) for heat-exchanging media flow into channels (3).

8 A heat exchanger structure according to claim 7, c h a r a c t e r i z e d i n, that behind the cover bar (13) there is placed an insert (30) comprising two paralel-spaced sheets (31) defining three passages within the channel (3), providing the open holes (14) of the cover bar (13) tapers inwardly and opens from a set distance into the inside passage (34).

9. A heat exchanger according any of claims 1 to 5, c h a r a c t e r i z e d i n, that at least one core end board (18) is provided with longituudinal and/or transverse cuts (30) bridged by hollow ribs (26).

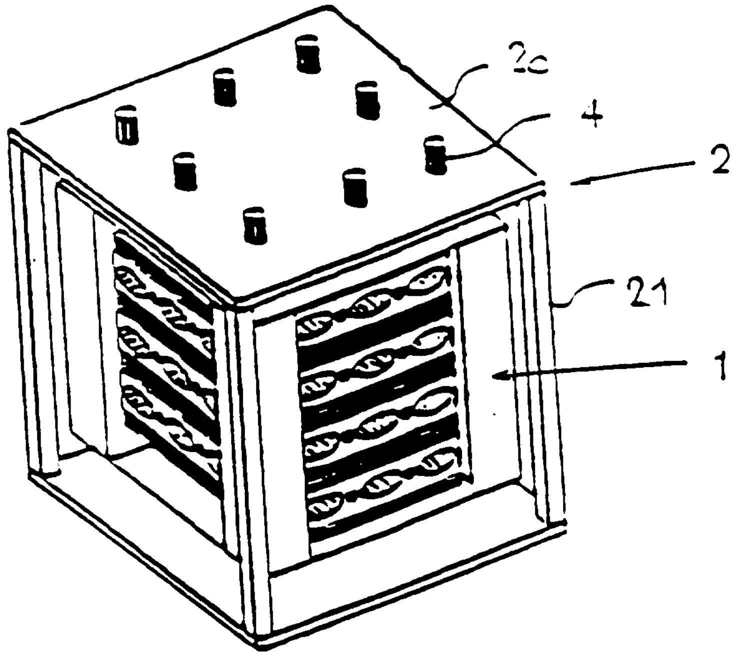


FIG.1

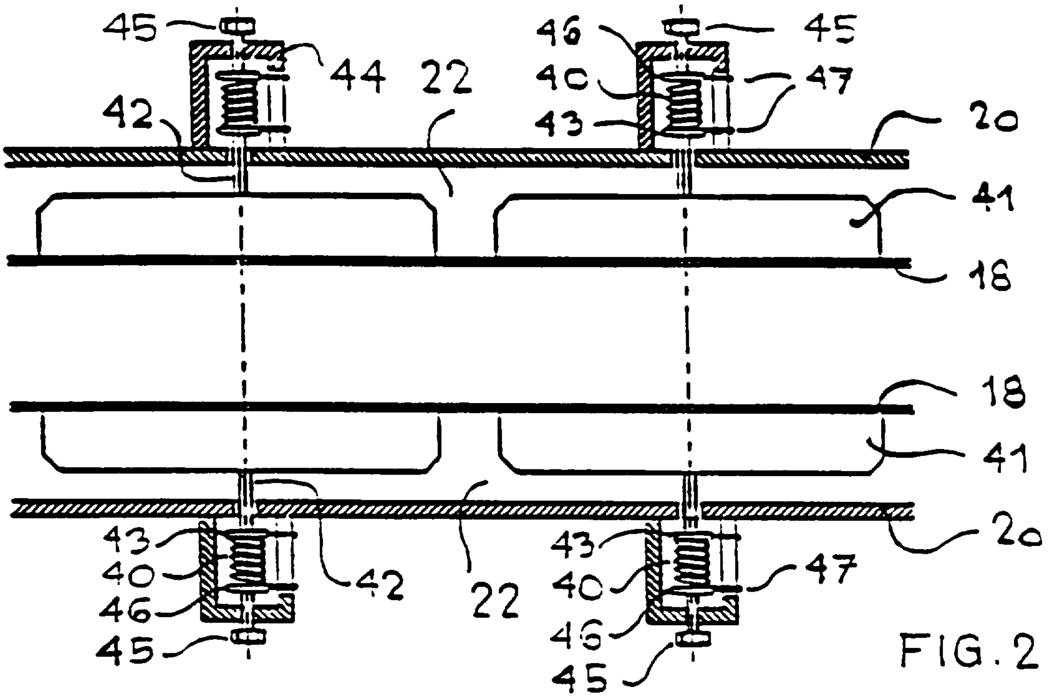


FIG.2

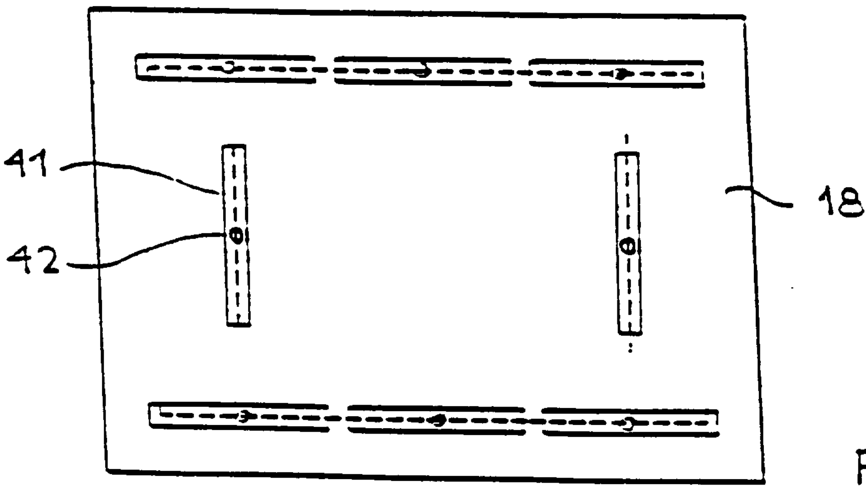


FIG.3

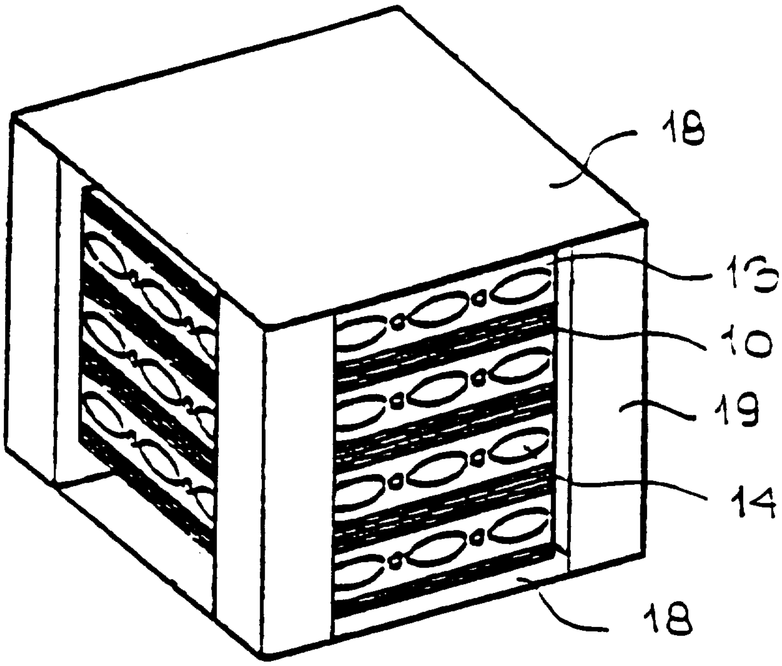


FIG. 4

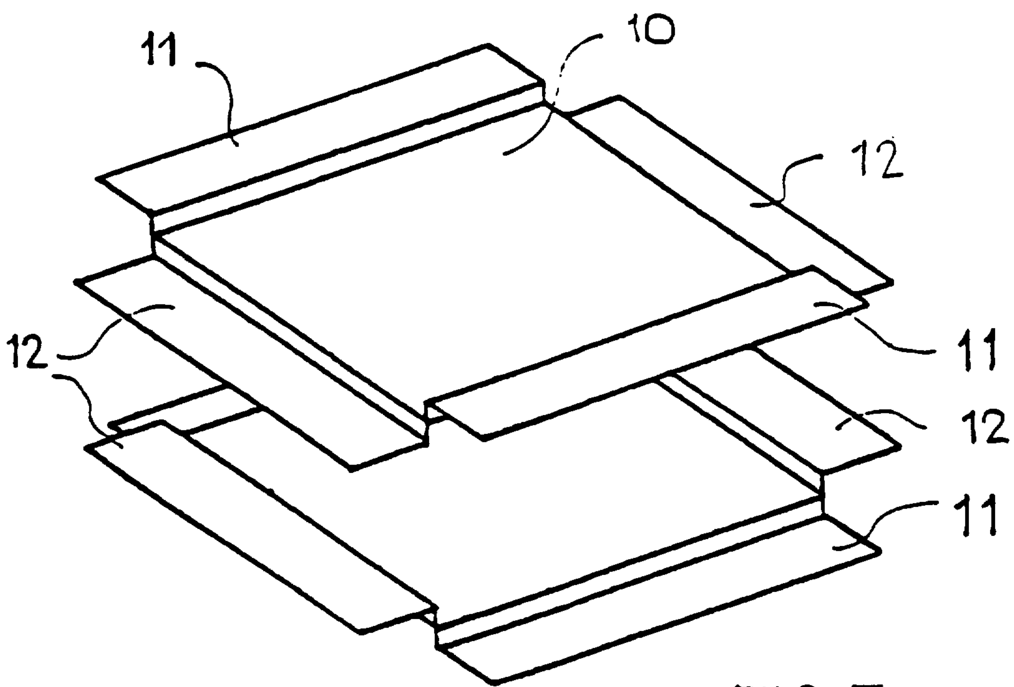


FIG. 5

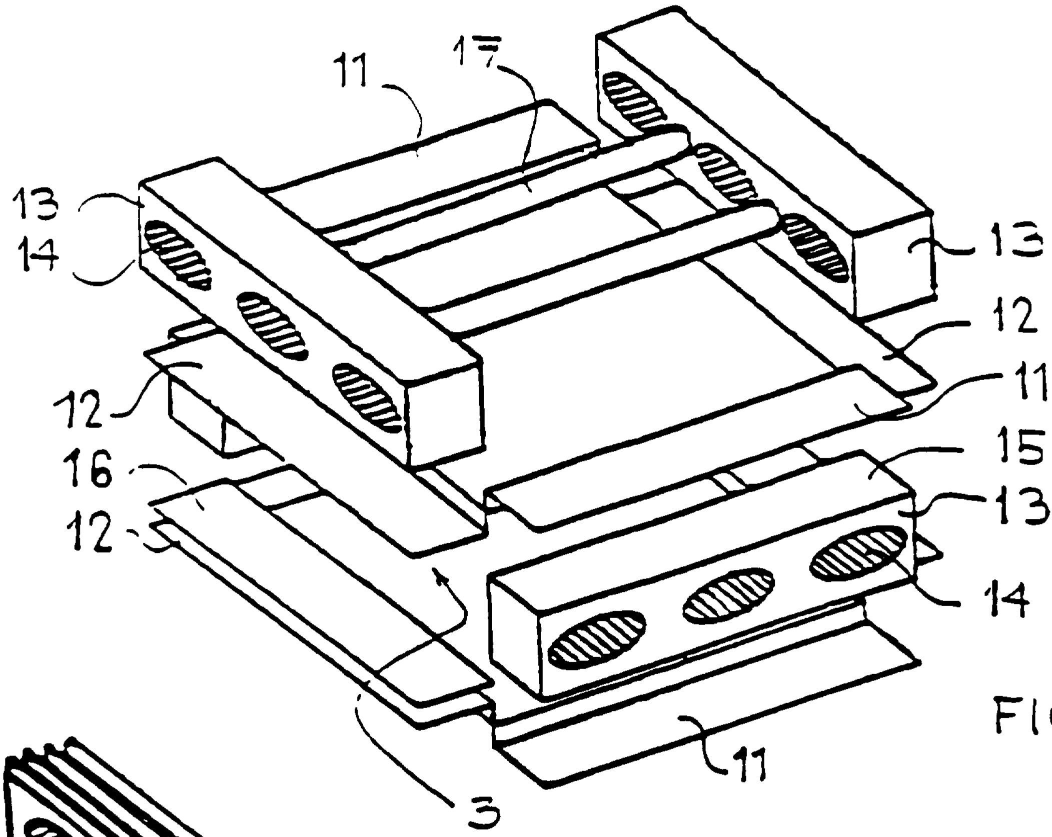


FIG. 6

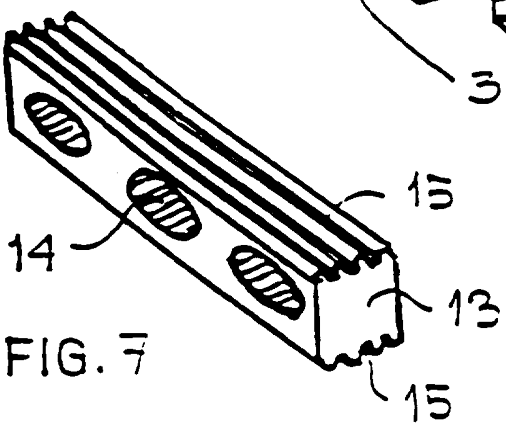


FIG. 7

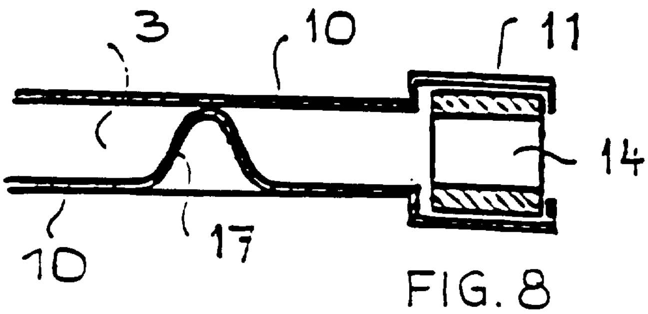


FIG. 8

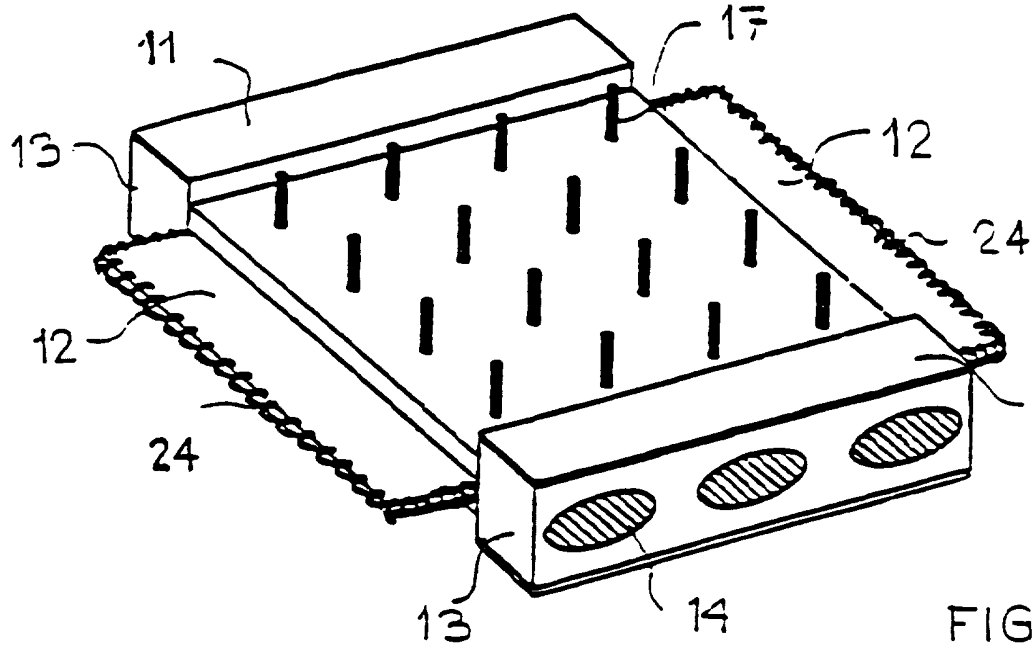


FIG. 9

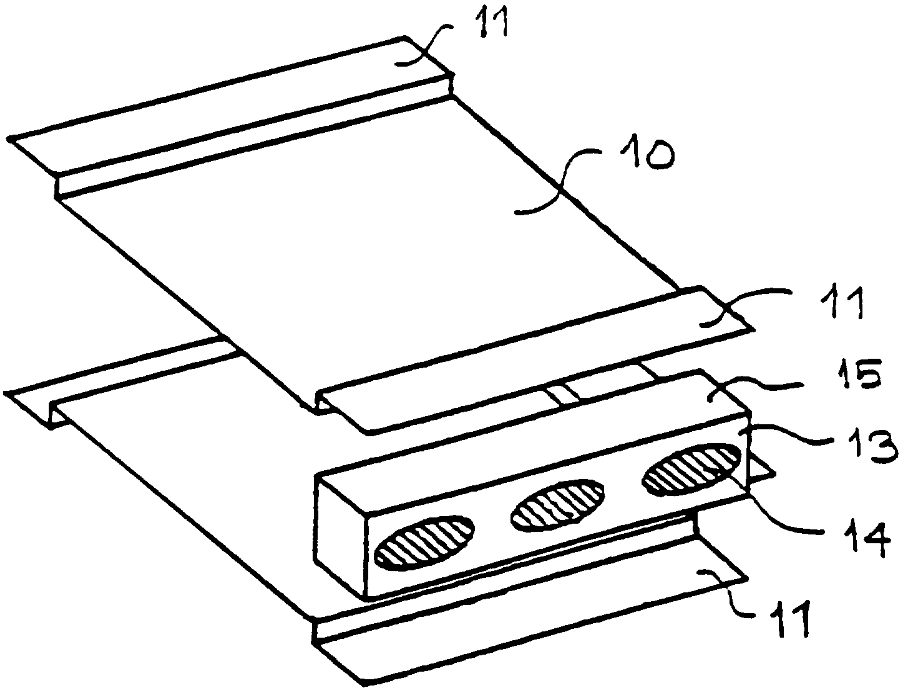


FIG.10

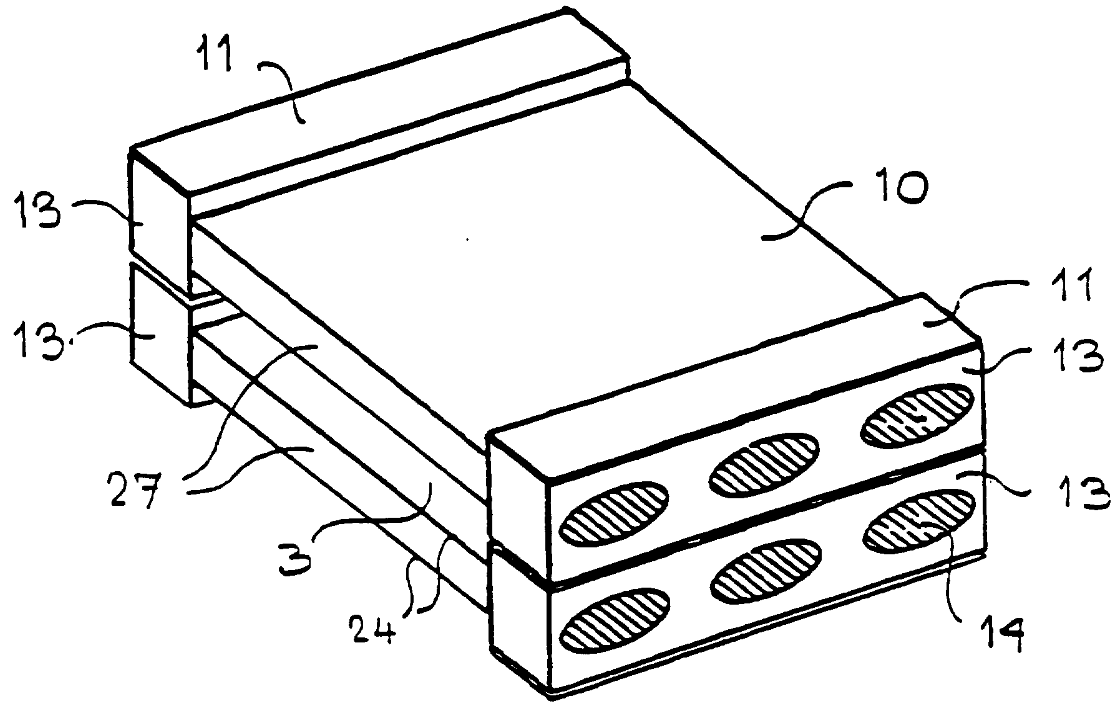
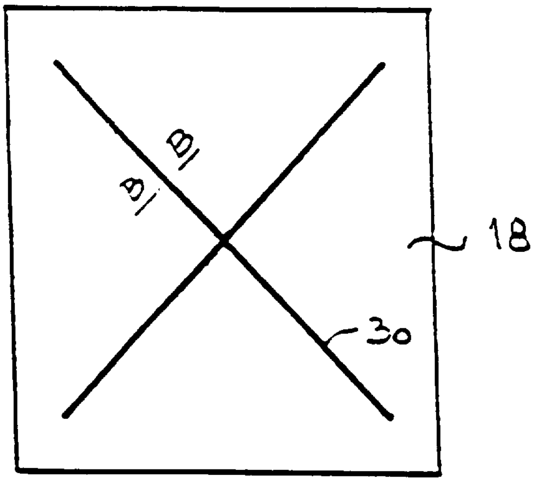


FIG.11



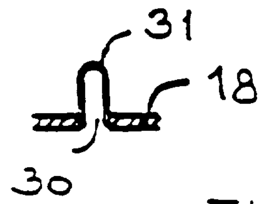


FIG. 13

FIG. 12

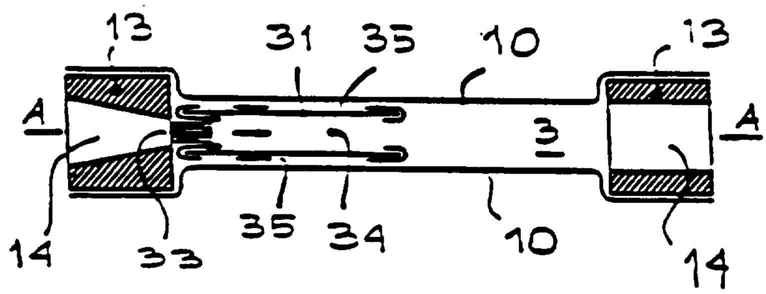


FIG. 14

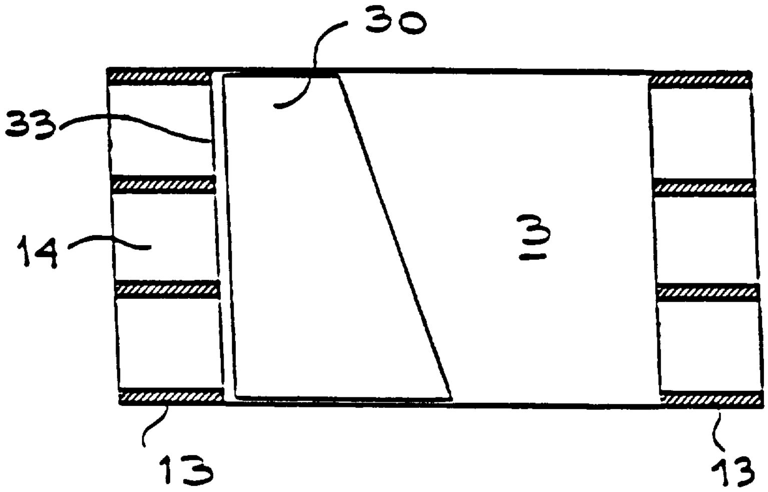


FIG. 15

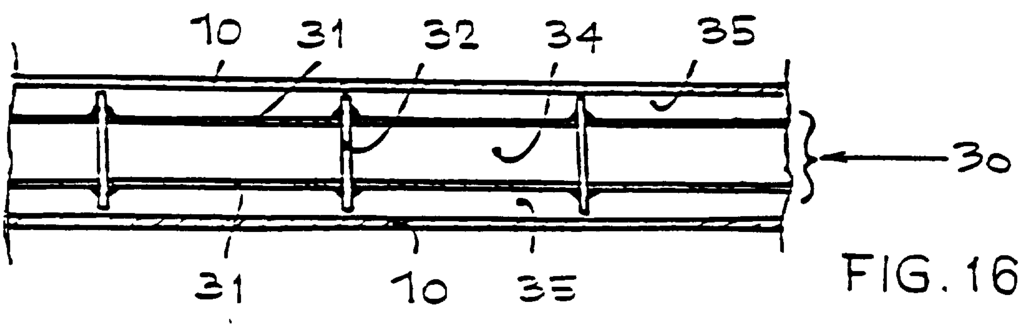


FIG. 16

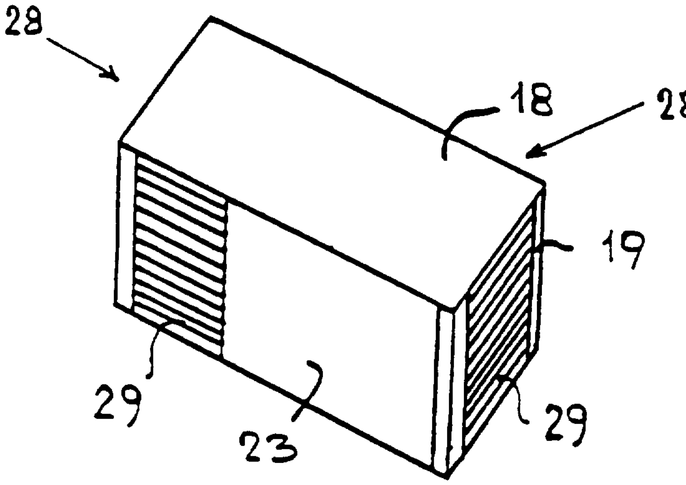


FIG. 17

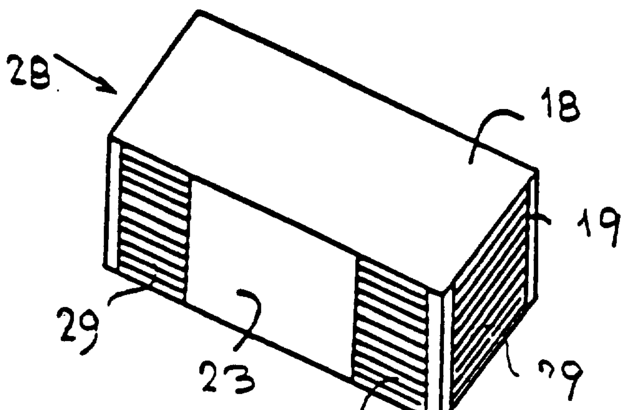


FIG. 18

INTERNATIONAL SEARCH REPORT

Int nal Application No
PCT/CZ 95/00030

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F28F3/08 F28F9/007

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 F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 043 113 (GTE PROD CORP) 6 January 1982 see the whole document ---	1-4
X	GB,A,2 147 095 (GTE PROD CORP) 1 May 1985 see the whole document ---	1-4
A	GB,A,217 593 (GEROUILLE DE BEAUVAIS) 11 June 1924 see page 2, line 11 - line 26 see page 2, line 48 - line 95; figures 1-4 ---	5
A	WO,A,83 03663 (NORTH ATLANTIC TECH) 27 October 1983 cited in the application see abstract; figure 8 -----	9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 April 1996	22.04.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Zaegel, B

INTERNATIONAL SEARCH REPORT

Information on patent family members

I[illegible]nal Application No
PCT/CZ 95/00030

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