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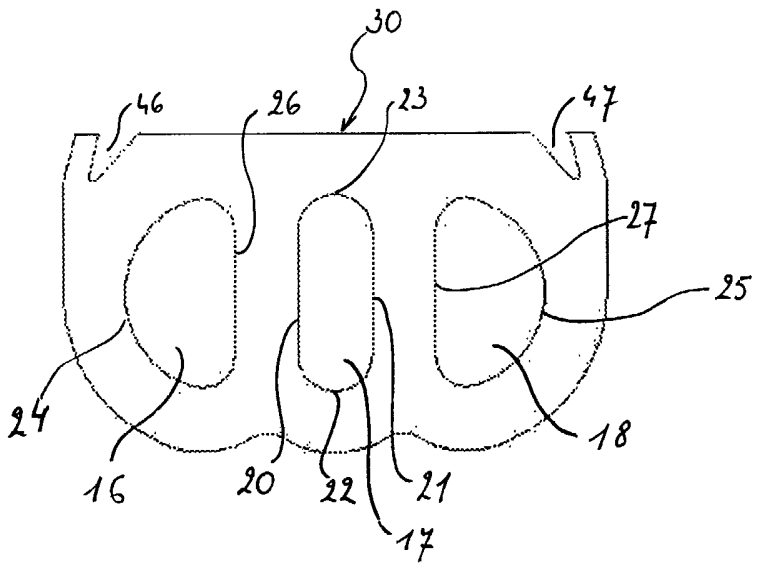
(54) Title: HIGH PRESSURE MANIFOLD



(57) Abstract: A heat exchanger comprising a plurality of flat tubes for heat exchange between a first fluidum flowing inside said tubes and a second fluidum flowing outside of said tubes, a pair of manifolds conected to the end of the flat tubes and provided with an inlet and na outlet for introducing the first fluidum into the flat tubes and for discharging therefrom, each manifold being provided with at least two parallel channels, at least part of the walls of the channel having a curved surface. The partition wall between any of two adjacent channels is provided with two parallel substantially flat surfaces facing the channels, thereby enabing the free flow of the heat exchanging fluid through the manifold and the tubes.

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High Pressure Manifold

The invention relates to a heat exchanger comprising a plurality of flat tubes for heat exchange between a first fluidum flowing inside said tubes and a second fluidum flowing outside of said tubes, a pair of manifolds connected to the end of the flat tubes and provider with an inlet and an outlet for introducing the first fluidum into the flat tubes and for discharging therefrom, each manifold being provided with at least two parallel channels, at least part of the walls of the channel having a curved surface.

Such a heat exchanger is known from WO-A-9851983.

In this known heat exchanger the manifolds are composed of a number of parallel tubes with circular cross-sections, each pair of adjacent tubes having a common wall portion, in such a way that the tubes of each manifold constitute a flat array of tubes. The circular cross-section of the tubes is selected because the high pressure inside the tubes, such as is common in modern heat exchangers used in cars and based upon CO2. It is common then to use a pressure well above 100 bar and the use of round cross-section channels avoid that stresses are built up in the walls of the manifold. Using round cross-section allows the inner wall to be thinner thereby saving weight and increasing heat transfer.

Otherwise a flat tube has to be inserted through holes, in one flat side of the manifold in order to have communication between the tubes and the manifolds. In order to have the least possible flow restriction it is preferred to insert the end portion of the flat tubes up to half way into the diameter of the channels in the manifold, as in this way the part of the end face of the flat tubes blocked by the partition walls in the manifold is minimal. However, in this way half of each channels in the manifold is blocked causing flow restriction in that part of the heat exchanger. As a compromise the end part of the flat tubes is not inserted up to half the diameter of the channels, but to about one third of the diameter. In this way the blockage in the channels of the manifold is substantially reduced, whereas the blockage of the end face of the flat tubes is only slightly increased and kept within acceptable limits.

However the disturbance of the fluid flow inside the heat exchanger, and especially inside the manifold channel is still highly disturbed by the inserted end portion of the flat tubes, which especially in high pressure systems can cause substantial pressure drops.

It is therefor an object of the invention to provide a heat exchanger in which this problem is substantially reduced.

This object is achieved in that the partition wall between any of two adjacent channels is provided with two parallel substantially flat surfaces facing the channels.

In this way it becomes possible to make channels having elongaed cross-section, which is only blocked to a minor extent by the inserted flat tubes. The use of flat surfaces in the partition walls is possible without causing exaggerated stresses in the walls, because both surfaces of the wall are subjected to the same, be it high pressure, thereby balancing the forces.

Fig. 1 is schematic view of a heat exchanger according to the invention,

Fig. 2 is a cross-section according to the line II-II of the manifold, shown in Fig. 1,

Fig. 3 is a cross-section according to the line III-III of the manifold, shown in Fig. 1,

Fig. 4 is a front view of the manifold used in the heat exchanger of Fig. 1,

Fig. 5 is a perspective view of a part of the manifold of Fig. 3 and

Referring to Fig. 1, the illustrated heat exchanger includes a plurality of flat heat transfer tubes 1 stacked in parallel and corrugated fins 2 sandwiched between the flat tubes 1. The ends 1a of the tubes 1 are connected to mainfolds 3 and 4. Each heat transfer tube may be made of extruded aluminium, having a flat configuration. Alternatively, the flat tubes can be multi-bored flat tubes, commonly called multiport tubes or else, electrically seamed tubes can be used. Multiport tubes may be made by extrusion, but otherwise it is possible to make such tubes by rolling from clad sheet, folding and brazing. Furthermore, it is possible to use a welded tube with an inserted baffle.

In the embodiment shown each corrugated fin 2 has a width approximately similar to that of the flat tube 1 but other widths may be used as well. The fins 2 and the flat tubes 1 are brazed to each other. The manifolds 3,4 are made up of aluminium tubes with holes 5 of the same shape as the cross-section of the heat transfer tubes 1 so as to accept the tube ends 1a. The holes 5 can also be tailor made, e.g. conical, so as to allow easier access for the flat tubes.

The inserted tube ends 1a are brazed in the holes 5. As shown in Fig. 1, manifolds 3 and 4 are connected to an inlet manifold 6 and an outlet manifold 7, respectively. The inlet manifold 6 allows a heat exchanging fluid to enter the manifold 3, and the outlet manifold 7 allows the heat exchanging fluid to discharge. The manifolds 3 and 4 are closed with caps or plugs 8 and 9, respectively. The reference numerals 13 and 14 denote side plates attached to the outermost corrugated fins 2.

The manifold 3 has its inner space divided by a baffle 10 into two sections, and the manifold 4 is divided into two sections by a baffle 11. In this way a medium path is provider starting from manifold 3, passing through a first set of tubes 1, through part of the manifold 4, passing through a second set of tubes 1 to manifold 3 and passing through a third set of tubes 1 to manifold 4 and to leave the heat exchanger unit through outlet 7. It is clear that these manifolds without baffles are also possible and otherwise manifolds with more than one baffle per manifold can be applied as well.

The heat exchanging fluid flows in zigzag patterns throughout the heat exchanger unit

The manifolds 3 and 4 are basicly identical and in the figures 2 - 4 an example of a manifold 3 is shown in more detail. The manifold 3 consists in fact of a multiple port extruded tube and in the example shown three channels 16, 17 and 18 are present. It is however clear that any number of channels may be present. As clearly shown in Fig. 2 the central channel 17 has a oval cross-section, i.e. it has two parrallel side walls 20, 21 and two semi-circular end walls 22, 23. In case the manifold has more than three channels each intermediate channel will have that type of shape. Otherwise the two outer channels 16 and 18 have identical cross-ssections and are composed of a substantially semi-circular side-wall 24 and 25 respectively and a flat side wall 26 and 27 respectively facing the respective flat side walls of the channel 17.

The outer surface of the manifold is formed by walls which are substantially parallel to the inner walls of the channels 16, 17 and 18 facing the outer outer wall, except for on side wall 30 which is perpendicular to the the side walls 26, 20, 21 and 27 and which is made flat. By shaping the manifold in this way it is possible to withstand high internal pressures without generating excessive stresses in the walls of the manifold 3. In fact the pressure in channel 17 on the flat side wall 20 and 21 compensated by the pressure acting on the flat side walls 26 and 27. Furthermore the remaining side walls are all curved thereby avoiding the building up of excessive stresses and making the manifold suitable for high pressure applications.

Moreove the cross-section of the manifold 3 can easily adapted for different applications without having to increase the width of the manifold, by simply adjusting the length of the flat sidewalls 26, 20, 21 and 27, whereby the volume of the channels is adjusted accordingly.

As shown in Fig. 3 the flat outer wall 30 is provided with a number of longitudinal holes 35 extending perpendicular to the longitudinal direction of the manifold. Each hole is made in the following way, as clearly shown in Fig. 3. Up till the line 36-37 there is made a groove with rectangular cross-section and a width equal to the width of the flat tube to be inserted in the hole, i.e. the smallest dimension of the flat tube 1. This groove can be made by sawing, or the like. Subsequently the hole is further shaped by punching, using a die with the right shape, whereby the groove is connected to the channels 16, 17 and 18. The punch die is shaped in such a way that both longitudinal sides of the hole 35 are provided with an edge 38 serving as a stop for the insertion of the flat tube in the hole. Furthermore the wall portion 26-20 and 21-27 between the channels 16, 17 and 17, 18 respectively are pushed back to some extent below the edge 38, as seen in Fig. 3, thereby forming two substantially semi-circular top walls 41 and 42, so that after insertion of a flat tube up till the edge 38, an open connection is present between the channels 16, 17 and 18, enabling a cross-flow of the medium in the manifold. In this way a manifold is obtained which makes an easy mounting of the flat tubes possible. Because of the shape of the channels, the end portions of the flat tubes will only slightly penentrate in the flow section of the channels and thereby only influence to a minor degree the flow of medium through the channels 16, 17 and 18. Because of the lower position of the separation walls between the channels 16, 17 and 18 at the place of the flat tubes, the flow of medium from the manifold to the tubes or reverse will not be hindered by the separation walls, as there is sufficient space between the walls 41 and 42 and e the and face of the inserted flat tube which will reach up till the line 38..

As shown in Fig.4 an additional opening 40 is present between two openings 35, which opening can be used for the insertion of a baffle 10 or 11 as explained above. The only difference with the holes for the flat tubes is that there is no edge 38 and the wall portions 41 and 42 shown in Fig. 3 are removed up till halfway the height of the channels 16 and 17

The flat wall 30 of the manifold 3 is provided with two longitudinal grooves 46 and 47. These grooves can be used to clamp a brazing sheet on top of the manifold 3. After placing a brazing sheet on the surface 30, and folding the edges of that sheet into the grooves 46 and 47, the grooves can deformed in such a way that the longitudinal edges of the brazing sheet are

clamped to the manifold. After insertion of the flat tubes into the manifold and insertion of the baffles 11, the whole manifold can be heated, e.g. by means of a brazing oven, and during this process the brazing sheet ensures that a reliable connection is obtained between the flat tubes and the manifold.

It is clear that the invention is not restricted to the embodiment described above, but that modifications can be applied without departing from the scope of the invention. More especially it is possible to use other systems for connecting the tubes to the manifold.

Claims

1. A heat exchanger comprising a plurality of flat tubes for heat exchange between a first fluidum flowing inside said tubes and a second fluidum flowing outside of said tubes, a pair of manifolds connected to the end of the flat tubes and provided with an inlet and an outlet for introducing the first fluidum into the flat tubes and for discharging therefrom, each manifold being provided with at least two parallel channels, at least part of the walls of the channel having a curved surface, characterized in that the partition wall between any of two adjacent channels is provided with two parallel substantially flat surfaces facing the channels.

2. A heat exchanger according to claim 1, characterized in that the dimensions of the channel in the direction parallel to its flat wall is bigger than in the direction perpendicular thereto.

3. A heat exchanger according to claim 1 or 2 , characterized in that each manifold is provided with a flat outer surface which is provided with holes for connecting the flat tubes to the manifold.

4. A heat exchanger according to claim 3, characterized in that the partition wall between two adjacent channels is partially removes as an extension of the holes.

5. A heat exchanger according to claim 4, in which the holes have a circumference corresponding ot the circumference of the flat tube, characterized in that parallel to the flat outer surface each hole is provided with at least one shoulder as a stop for the flat tube end.

6. A heat exchanger according to claim 4 or 5, characterized in that the end face of each partition wall opposite the holes is curved.

7. A heat exchanger according to any one of claims 3-6, characterized in that the flat outer surface of at least one manifold is provided with one additional hole for accomodating a baffle separating the fluid flow inside the manifold.

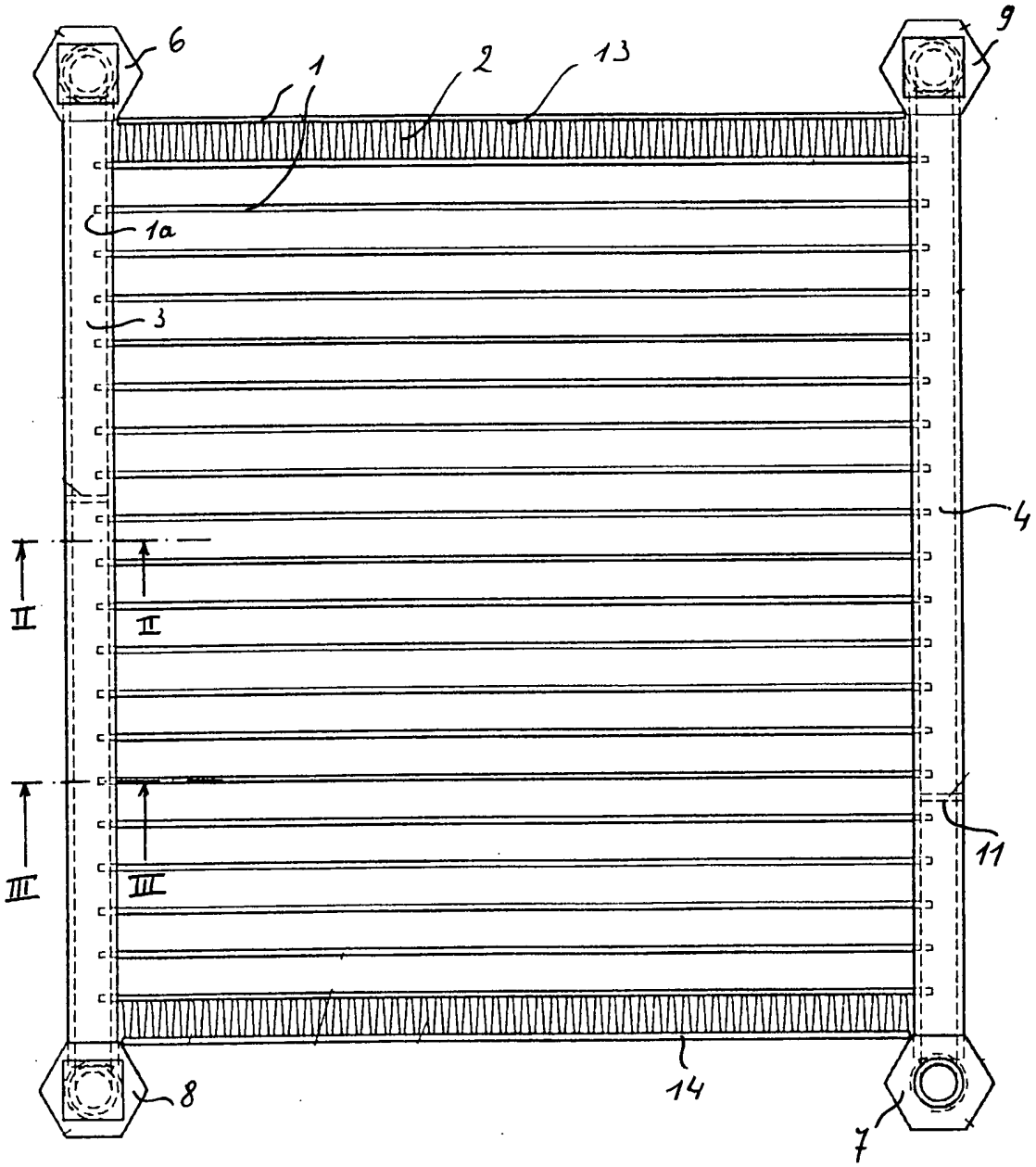

Fig. 1

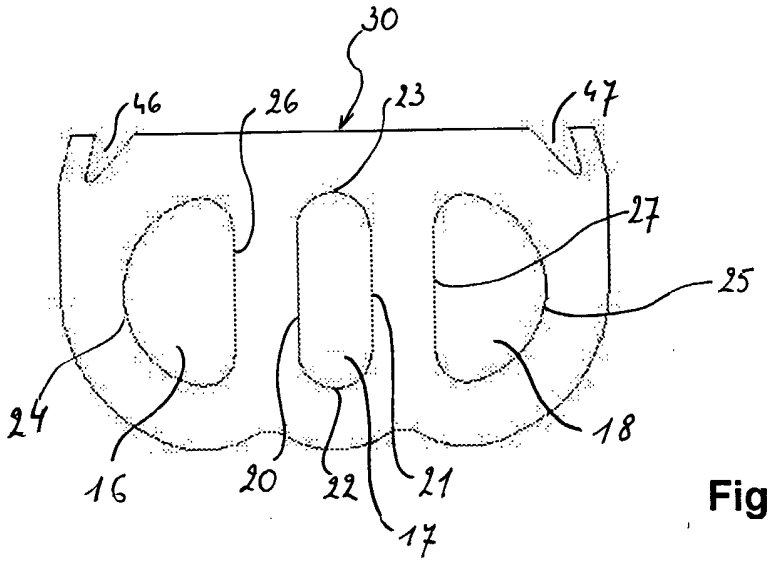

Fig. 2

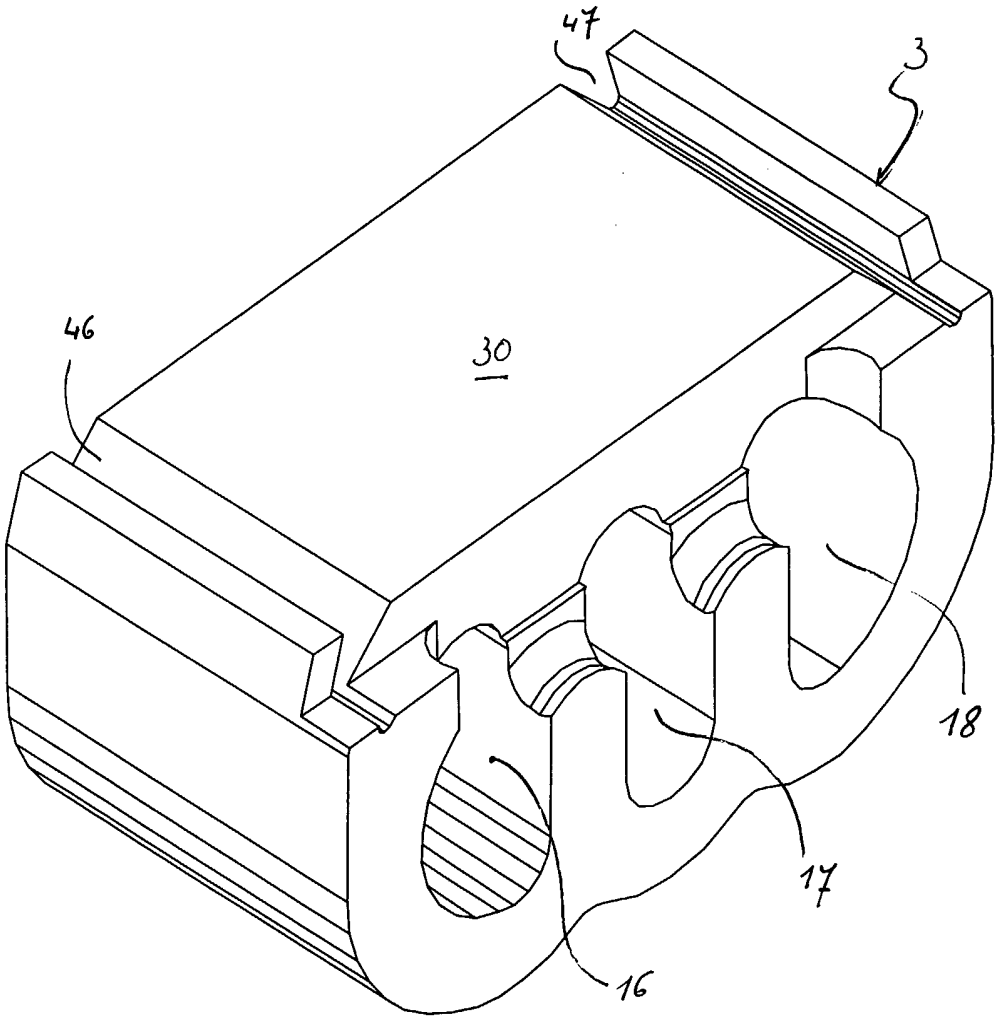

Fig. 5

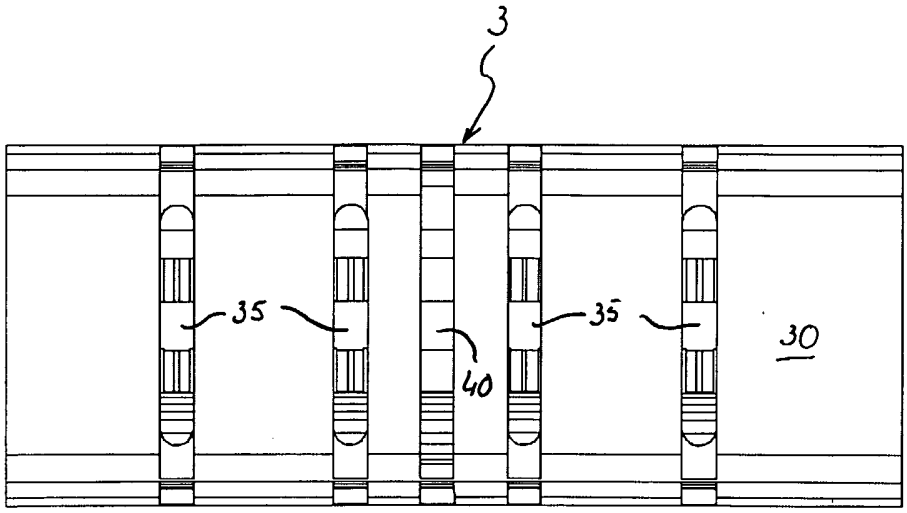

Fig. 4

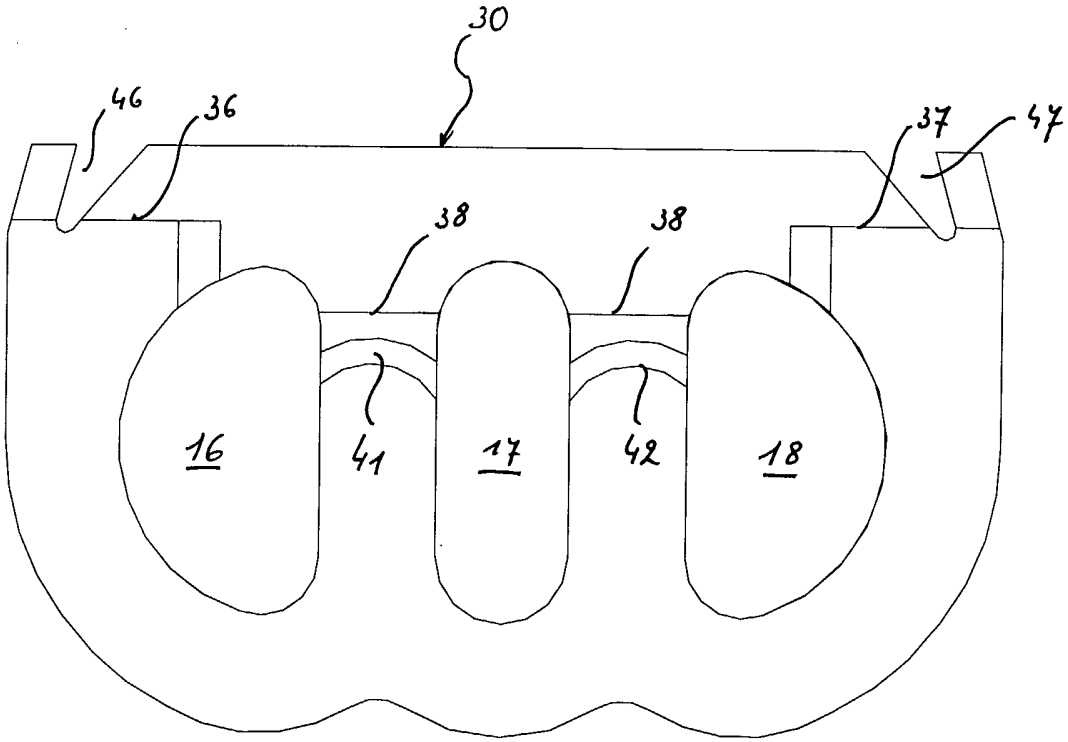

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F28F 9/02
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)

IPC7: F28F

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 practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	DE 19826881 A1 (BEHR GMBH & CO), 23 December 1999 (23.12.99), figures 1,3	1,3,7
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
12 March 2002	05. 04. 2002
Name and mailing address of the International Searching Authority 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	Authorized officer Annette Riedel / MRo Telephone No.

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International application No.
PCT/EP 01/09142

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

28/01/02

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PCT/EP 01/09142

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