

(19)



(11)

EP 2 096 399 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.09.2009 Bulletin 2009/36

(51) Int Cl.:
F28F 9/02 (2006.01)

(21) Application number: **09150708.7**

(22) Date of filing: **16.01.2009**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
 HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL
 PT RO SE SI SK TR**
 Designated Extension States:
AL BA RS

(71) Applicant: **XChange S.r.L.**
33030 Flumignano di Talmassons (UD) (IT)

(72) Inventor: **Stolfo, Daniele**
33100 Udine (IT)

(30) Priority: **29.02.2008 IT PN20080018**

(74) Representative: **Petrucelli, Davide et al**
Propria S.r.l.
Via della Colonna 35
33170 Pordenone (IT)

(54) Heat exchanger with modular headers

(57) The present invention refers to a heat exchanger provided with modular headers.

A heat exchanger, in particular of the finned-pack type, made according to the present invention comprises a plurality of tubes (1) that extend between a plurality of hollow interspaces (2); at least a header (4) comprising a support (5) provided with a plurality of first apertures

(6) adapted to accommodate an extremity region (7, 8) of the tubes (1); and a cover (9) associated to said support (5). The heat exchanger is **characterized in that** each one of said support (5) and said cover (9) comprises a plurality of modular members (10, 18) that are removably associated to each other by means of conjugate surfaces (11a, 11b; 19a, 19b).

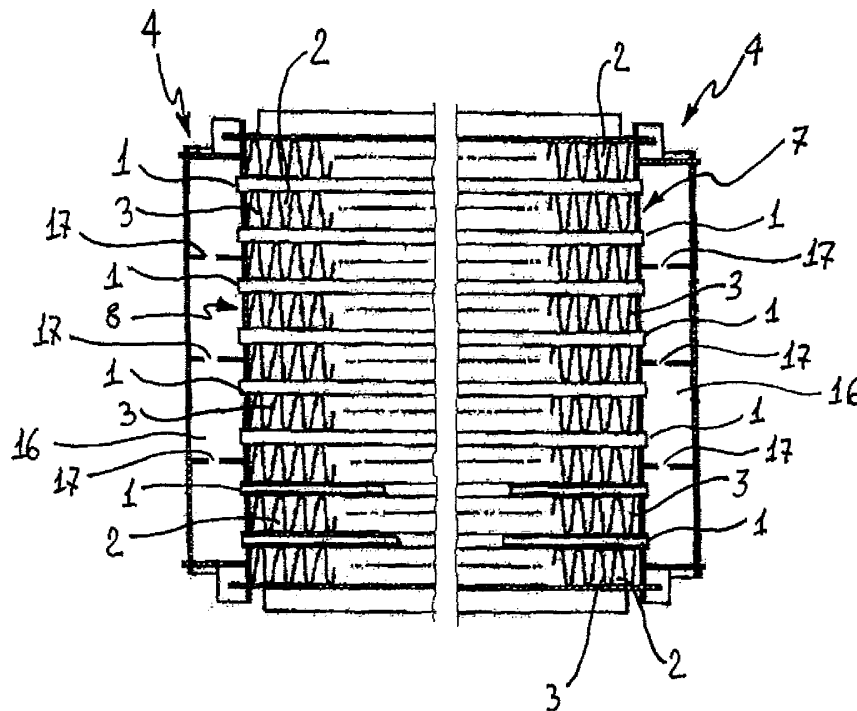


FIG. 1

EP 2 096 399 A1

Description

[0001] The present invention refers to a heat exchanger provided with modular headers.

[0002] Heat exchangers, in particular those of the finned-pack type used in the production of water-cooled heat-exchange banks, evaporators and condensers, are widely known in the art to be generally comprised of a plurality of tubes, through which a liquid medium is caused to circulate, and which are arranged in a pattern of parallel rows, or ranks, that are running transversally relative to the flow direction of the air. At the extremities thereof, the rows of tubes are connected to each other by a pair of manifolds, or headers, comprising at least one conduit for letting the liquid medium into the heat exchanger and at least one outlet conduit for the liquid medium to be able to exit the heat exchanger. Equally well-known in the art is the fact that, in view of increasing the efficiency of the heat exchanger, the tubes of the various rows or ranks must be fluidly connected to each other in such manner as to enable the liquid medium to repeatedly flow across the flow of air while moving to and from the headers of the heat exchanger. For such repeated passages of the liquid fluid across the air flow to be ensured, the tubes of the various rows, or ranks, are connected two-by-two via U-shaped pipe unions, or connection elbows, associated to the tubes by means of welding or brazing. Typically, heat exchangers of this kind are known to have some drawbacks, as set forth hereinbelow.

[0003] A first drawback lies in the fact that manufacturing time requirements are markedly dependant on the number of tubes which the heat exchanger is comprised of, since such number substantially determines the number of weldings or brazings that have to be done for the various rows or ranks of the heat exchanger to be fluidly connected to each other.

[0004] A second drawback derives from the need for all of the thus completed weldings or brazings to then undergo rigorous and laborious tests to check them for perfect execution. Among other things, these checks include a test of strength and leak-resistance of the tubes under internal pressurization conditions, which is carried out by insufflating dry air into the tubes while the heat exchanger is submerged in a water bath. It can be most readily appreciated that such tests strongly contribute to an extension of the time needed to complete the heat-exchanger manufacturing process, further to obviously implying the use of specially designed equipment and skilled personnel.

[0005] A further drawback, connected with the use of the above-mentioned U-shaped pipe unions, or connection elbows, derives from the need for a material to be used - both for the tubes and the related unions - that is able to be easily welded, or brazed, at low costs. Usually, such requirements are met by materials such as copper, which, on the other hand, has a specific weight and a purchase price that are definitely higher than those of

other materials, such as for instance aluminium. The use of aluminium tubes instead of copper ones only constitutes a partial solution to the afore-noted problems in that it inherently involves a number of other construction-related problems connected to the difficulties typically found and the high costs to be sustained in making the required welded or brazed joints between pipe unions and tubes.

[0006] Fully apparent is also the fact that, in the case of heat exchangers of the above-described type, maintenance and cleaning operations involving the conduits of the same heat exchangers turn out as being particularly complicated to be performed, since they generally require the heat exchanger to be at most completely disassembled.

[0007] For cooling down internal combustion engines and heating up the driver and passenger compartment, known in the automotive industry is the use of finned-pack heat exchangers made of aluminium and in a size ranging from 50 to 150 mm as far as the thickness is concerned, and from 500 to 700 mm as far as height and width are concerned. Mass-produced heat exchangers for this kind of application generally comprise a plurality of tubes extending between a plurality of hollow interspaces and a pair of headers provided at the extremities of the tubes. These headers are comprised of box-like bodies, each one of which comprises a support provided with a plurality of apertures adapted to receive and accommodate the extremities of the tubes, and a cover associated to such tube support. The internal cavity of the headers is subdivided into sections by a plurality of partitions, so that the liquid medium circulating in the tubes can be caused to pass several times to and from a header and the other one in view of enhancing the heat-exchange effect and, as a result, the efficiency of the whole heat exchanger. An example of heat exchangers of this kind is described in the European Patent specification EP 1 046 876.

[0008] The structure of the heat exchangers of the above-described kind has however a drawback in that is hardly adaptable to a production of the heat exchanger in various sizes and capacities thereof in any reasonably easy and low-cost manner. In fact, the headers are specially and rigidly sized in accordance with the size of the heat exchanger which they are intended for, and are not adaptable to heat exchangers having sizes differing from the design ones. As a result, in heat exchangers of such prior-art kind the need disadvantageously arises for headers of a pre-defined size to be used, which must therefore be each time produced to exactly comply with the particular size of the heat exchanger which they have to be associated to, actually. This introduces poor flexibility in the manufacturing process, along with an overall increase in the tools needed to cope with generally wide-ranging production requirements.

[0009] A further drawback of heat exchangers of the kind disclosed in EP 1 046 876 lies in the tightness, i.e. liquid leakage problems, as well as problems connected

with the ability of the headers to work correctly when attempts are made to apply them to heat exchangers having any higher number of ranks than a single one, such as for instance a number situated between 3 and 5. This is basically due to the increased flow rates of liquid medium that the heat exchanger is due to handle and the pressures which the headers are subject to.

[0010] At the light of the above-noted drawbacks, the use of the heat exchangers of the kind described in EP 1 046 867 has therefore been confined to the automotive industry, since they had generally not been considered as being reasonably reliable for application to other uses, such as in air-conditioning equipment for large-sized rooms and buildings.

[0011] It is an object of the present invention to therefore provide a heat exchanger, in particular of the finned-pack kind, which is effective in doing away with the drawbacks and disadvantages of prior-art heat exchangers. Within this general object, it is a purpose of the present invention to provide a heat exchanger that is easily disassembled to allow for convenient periodical maintenance and cleaning thereof.

[0012] Another purpose of the present invention is to provide a heat exchanger that, further to being reliable, requires shorter manufacturing times than prior-art heat exchangers in general.

[0013] Yet another purpose of the present invention is to provide a heat exchanger that can be easily produced in a wide range of sizes and capacities through simple and quick adaptations of the modular headers thereof.

[0014] A further, equally important purpose of the present invention is to provide a heat exchanger, in which the number of the ranks of the heat exchanger can be varied in a simple manner according to actual needs, substantially without this implying any alteration in production times.

[0015] Still a further purpose of the present invention is to provide a heat exchanger that can be equally well manufactured using materials of a different nature, such as copper, aluminium and steel.

[0016] According to the present invention, the above-stated object and aims are reached in a heat exchanger that incorporates the features and characteristics as defined and recited in claim 1 appended hereto. Features and advantages of the present invention will anyway be more readily understood from the detailed description that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematic, cutaway front view of a heat exchanger according to the present invention;
- Figure 2 is a perspective view of a header of the heat exchanger illustrated in Figure 1.

[0017] Although reference is made to a heat exchanger of the finned-pack kind both in the illustrations appearing in the accompanying drawings and the following descrip-

tion, it will be readily appreciated that - as this is fully apparent from what is set forth below - the invention may be equally applied to any other kind of heat exchanger provided with tubes, which requires the use of a header for letting a fluid into such tubes.

[0018] A heat exchanger according to the present invention is comprised of a plurality of tubes 1 that have a cross-section in a round or oval shape and are arranged into one or several ranks, preferably in a number situated between 3 and 5, which extend between a plurality of hollow interspaces 2 defined by finned surfaces 3 interposed between two contiguous ranks of tubes 1. The finned surfaces 3 are preferably comprised of corrugated sheets associated to the tubes. The heat exchanger further comprises a pair of headers 4 located at the end portions, i.e. extremity regions 7, 8 of the tubes 1. These headers 4 are intended to convey a liquid medium in a first pressure and temperature condition into the heat exchanger to let such liquid fluid out of the same heat exchanger in a second pressure and temperature condition different from the first condition. The change in the pressure and the temperature of the liquid medium is induced by the heat-exchange process taking place between the same liquid medium and the air flowing into and through the hollow interspaces due to the forced convection effect brought about by the action of one or several fans (not shown in the Figures). For reasons of greater illustrative simplicity and convenience, the liquid-medium inlet and outlet orifices have been intentionally omitted in the representation of the headers; it will however be readily appreciated that these may be provided on each header 4 in any of a number of generally known manners.

[0019] Figure 2 shows a perspective view of one of the headers 4 of the heat exchanger. The header 4 includes a support 5 provided with a plurality of first apertures 6 adapted to receive and accommodate the extremity regions 7, 8 of the tubes 1. A cover 9 is removably associated to the support 5 with the aid of means largely known as such in the art, such as for instance screw means, press-fit couplings, and the like. The cover 9 is provided to be comprised of a plurality of first modular members 10 that are associated with each other - in a removable manner - by means of first conjugate surfaces 11a, 11 b. Preferably, the modular members 10 of the cover 9 consists of dome-shaped elements, and the conjugate joining surfaces 11a, 11 b are provided with a set of teeth 12 intended to prevent the members from displacing relative to each other in a first transverse direction relative to the longitudinal direction of the members 10, while at the same time enabling them to displace in a second transverse direction that is orthogonal to both the first transverse direction and the longitudinal direction of the modular members 10, i.e. the direction coinciding with the prevailing or major dimension of each modular member 10. For an adequate liquid-tightness of the modular members 10 in the assembled state thereof, in which they form the cover 9, to be effectively ensured, these modular members 10 are arranged so as to at least par-

tially overlap each other, as this is shown in Figure 2.

[0020] The inner surface 13 of each such modular member 10 making up the cover 9, i.e. the surface that lies facing the support 5 when the cover 9 and the support 5 are assembled, is provided with a plurality of accommodations 14 adapted to receive one or several partitions 15. Each partition 15 is used to separate, i.e. subdivide the compartments 16 (Figure 1) that are created by assembling the cover 9 onto the support 5 into two or more sections. In this way, the liquid medium circulating in the tubes 1 can be conveyed from a header 4 to the other one following a flow path that is determined by the particular arrangement selected for such sections. By way of example, in Figure 2 the compartments 16 of each header 4 are shown to be subdivided into four sections. To this purpose, the partitions 15 can be substantially embodied in two basic forms thereof. A first embodiment calls for the partition 15 to be made up by a simple wall capable of enabling the compartments 16 to be subdivided into liquid-tight sections, i.e. sections that are effective in preventing the liquid medium from flowing or leaking into and from two contiguous sections of a same header 4. Obviously, when the compartments 16 of the headers 4 are subdivided into sections by means of partitions 15 made in accordance with this first embodiment, such partitions 15 must be located in the headers 4 according to a staggered arrangement, i.e. in such positions as to ensure that the tubes 1 that receive liquid medium from a section of a first header 4 will then discharge said liquid medium into two or more sections of the second header 4 of the heat exchanger.

[0021] In a second embodiment of these partitions 15, these are made in the form of a wall provided with one or more apertures 17 (Figure 1), which enable the liquid medium that happens to be in contiguous sections of the same compartment 16 of a header 4 to flow to and from such sections. When the compartments 16 of the headers 4 are subdivided into sections by means of partitions 15 made in accordance with this second embodiment thereof, the possibility will arise for sections to be obtained, which have substantially the same volume, as this is shown in Figure 1, while anyway enabling the liquid medium circulating in the tubes 1 to repeatedly displace from a header 4 to the other one by flowing through the entire heat exchanger.

[0022] In both embodiments thereof, the partitions 15 are provided with one or more recesses adapted to receive and accommodate at least a portion of the tubes 1.

[0023] The support 5 includes a plurality of second modular members 18, as well, which are again associated to each other in a removable manner by means of conjugate surfaces 19a, 19b. In the same way as this has already been described afore in connection with the first modular members 10 of the cover 9, also the conjugate surfaces 19a, 19b of the modular members 18 of the support 5 are provided with a set of teeth 24 intended to prevent the members from displacing relative to each other in a first transverse direction relative to the longi-

tudinal direction of the same members 18. While only two modular members 18 are shown to make up the support 5 in Figure 2 for reasons of greater illustrative simplicity, it will be appreciated that the actual number thereof is such as to enable the same members to cover the entire length of the cover 9, which the support 5 is due to be removably associated to.

[0024] According to a preferred embodiment, the modular members forming the support 5 and the cover 9 of each header 4 are made of a polymeric material, thereby reducing the overall weight of the heat exchanger.

[0025] For adequate liquid tightness to be ensured at the interface between the extremity regions 7, 8 of the tubes 1 and the support 5, there are provided sealing means 20, such as for instance gaskets, placed around said extremity regions 7, 8. Preferably, the sealing means 20 are arranged between the cover 9 and the support 5 and comprise in turn a plurality of modular portions 21, each one of which has a length that is greater than or equal to the length of each of said modular members 10, 18 forming the cover 9 and the support 5, respectively, of the header 4. In this way, the position of the interface between two contiguous portions 21 of the sealing means 20 is staggered relative to, i.e. does not coincide with the position of the interface between two modular members 10, 18, thereby improving the overall liquid-tightness of the header 4 as a whole.

[0026] In view of ensuring an adequate structural strength and rigidity of the header 4, particularly during the heat-exchanger fabrication and assembly steps, a thin strengthening plate 22 may be associated to the support 5. To this purpose, such thin strengthening plate 22, which is preferably made of metal, comprises a plurality of apertures 23 located in positions corresponding to those of the apertures 6 of the support 5, so that the extremity regions 7, 8 of the tubes 1 can be accommodated in and supported by both the support 5 and the plate 22. Depending on the actual manufacturing needs, the thin strengthening plate 22 may be provided as shown in Figure 2 between the support 5 and the cover 9 or, if preferred, may be arranged at the base of the support 5, i.e. in a position lying opposite to the side of the support 5 onto which the cover 9 is joined.

[0027] Although the preceding description particularly refers to a heat exchanger of the finned-pack kind, it will be readily appreciated that the invention may be equally applied to any other kind of heat exchanger provided with tubes, which requires the use of at least one header for letting the liquid medium into and/or receiving the outflow of liquid medium from such tubes, through which the same liquid medium is circulating. In this connection, the illustration in Figure 2, in which there are represented two headers 4, is to be considered as a preferred, although not sole exemplary embodiment of the present invention, which can therefore be modified to include heat exchangers provided with a single header 4. In particular, a heat exchanger according to the present invention can be effectively applied in fluid-carrying circuits of air-con-

ditioning equipment for large rooms or buildings, in which the radiating pack of the heat exchanger, in a plan view thereof, has a height and a length situated anywhere between 1,500 and 2,200 mm.

[0028] Fully apparent from the above description is therefore the ability of the present invention to effectively reach the aims and advantages cited afore by in fact providing a highly versatile heat exchanger, in particular of the finned-pack kind, which - owing to the assembly modularity of the headers thereof - can be manufactured in a wide-ranging variety of sizes through quite simple adaptations of the manufacturing process, the process itself being such as to anyway require a shorter working time than traditional manufacturing processes. A heat exchanger according to the present invention can advantageously be produced according to a "just-in-time" working practice, i.e. within a relatively short delay from the receipt of the order. Fully apparent is further the ability of a heat exchanger according to the present invention to enable fluid, i.e. pipe connections between tubes of different ranks to be changed according to a multiplicity of varying schemes, not only at the factory, when the heat exchanger is being manufactured, but also when the same heat exchanger is being installed or even during later maintenance steps. Maintenance itself turns out as being surprisingly simplified thanks to the rapidity with which the various component parts of the heat exchanger can be disassembled and re-assembled, actually.

[0029] The particular contrivances adopted in the construction of a heat exchanger according to the present invention are such as to make it possible for tubes and pipes made of a variety of different materials to be used with the same effectiveness from a manufacturing point of view, thereby enabling both the manufacturer and the user to each time select the kind of heat exchanger that best suits the actual application by ideally meeting the needs of the particular installation, which the heat exchanger is due to be fitted in, without incurring disadvantageous oversizing or undersizing problems.

Claims

1. Heat exchanger, in particular of the finned-pack type, comprising:

- a plurality of tubes (1) that extend between a plurality of hollow interspaces (2);
- at least a header (4) comprising a support (5) provided with a plurality of first apertures (6) adapted to accommodate an extremity region (7, 8) of the tubes (1), and a cover (9) associated to said support (5),

characterized in that each one of said support (5) and said cover (9) comprises a plurality of modular members (10, 18) that are removably associated to each other by means of conjugate surfaces (11a, 11

b; 19a, 19b).

2. Heat exchanger according to claim 1, wherein said conjugate surfaces (11a, 11b; 19a, 19b) are provided with a set of teeth (12, 24).
3. Heat exchanger according to any of the preceding claims, wherein the modular members (10) of said cover (9) consist of dome-shaped elements arranged so as to at least partially overlap each other.
4. Heat exchanger according to any of the preceding claims, wherein the modular members (10) of said cover (9) are provided with a plurality of accommodations (14) adapted to receive one or more partitions (15).
5. Heat exchanger according to claim 4, wherein said partitions (15) comprise one or more recesses adapted to accommodate at least a portion of said tubes (1).
6. Heat exchanger according to claim 4 or 5, wherein said partitions (15) comprise at least a second aperture (17).
7. Heat exchanger according to any of the preceding claims, wherein the modular members (10, 18) are made of a polymeric material.
8. Heat exchanger according to any of the preceding claims, wherein the modular members (10) of said cover (9) are removably associated to the modular members (18) of said support (5).
9. Heat exchanger according to any of the preceding claims, wherein sealing means (20) are applied around said extremity region (7, 8) of the tubes.
10. Heat exchanger according to claim 9, wherein said sealing means (20) are interposed between said support (5) and said cover (9) and comprise a plurality of modular portions (21) having a length that is greater than or equal to the length of said modular members (10, 18).
11. Heat exchanger according to any of the preceding claims, wherein a thin strengthening plate (22) is associated to said support (5), said thin strengthening plate (22) being provided with a plurality of third apertures (23) located in positions corresponding to those of said first apertures (6).
12. Heat exchanger according to claim 11, wherein said thin strengthening plate (22) is made of metal.
13. Heat exchanger according to claim 11 or 12, wherein said thin strengthening plate (22) is interposed be-

tween said support (5) and said cover (9).

14. Heat exchanger according to claim 11 or 12, wherein said thin strengthening plate (22) is associated to said support (5) on the opposite side relative to said cover (9). 5
15. Heat exchanger according to any of the preceding claims, wherein said tubes (1) have a cross-section in a round or oval shape and are arranged into a number of ranks comprised between 3 and 5. 10

15

20

25

30

35

40

45

50

55

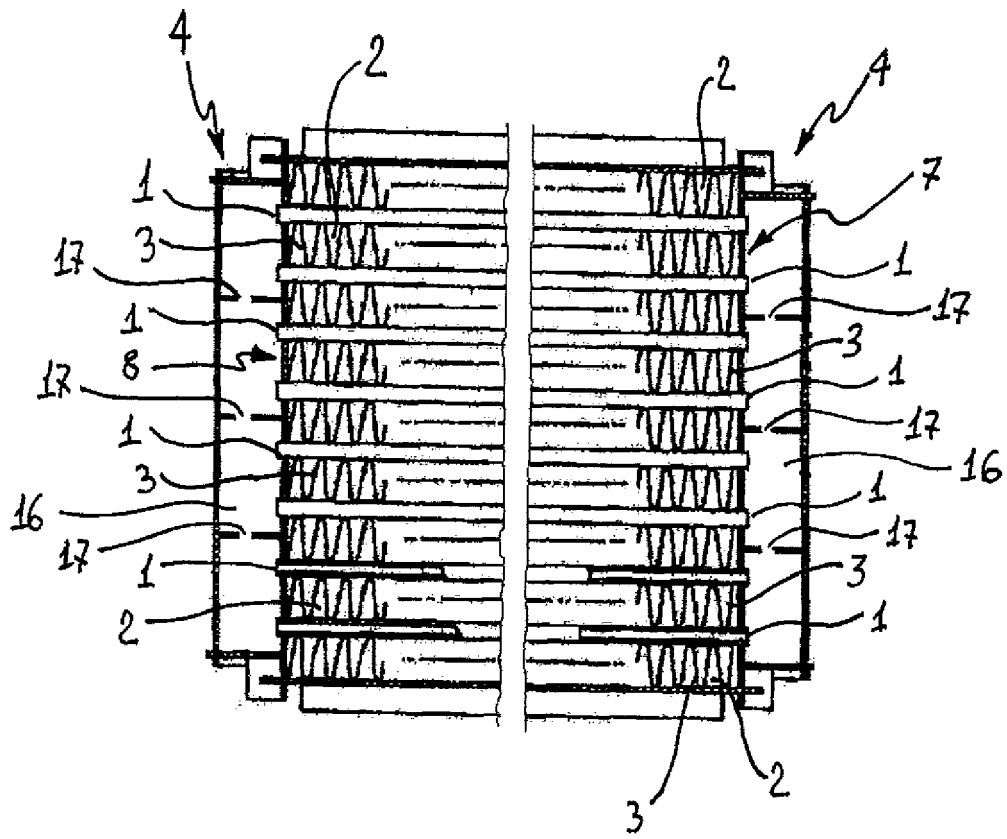


FIG. 1

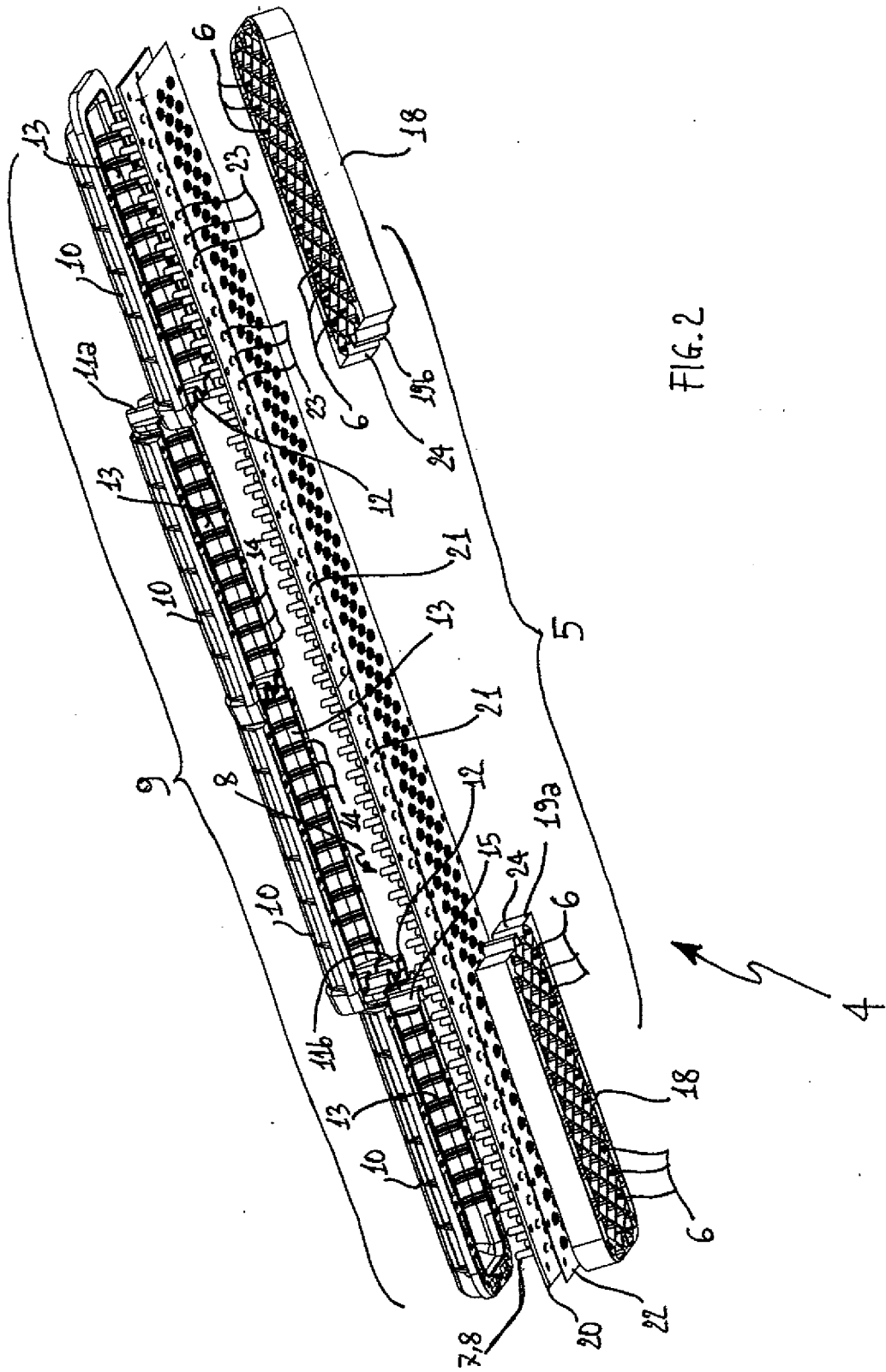


FIG.2



EUROPEAN SEARCH REPORT

Application Number
EP 09 15 0708

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/192681 A1 (YAMAUCHI YOSHIYUKI [JP] ET AL) 16 October 2003 (2003-10-16)	1,3,8,15	INV. F28F9/02
Y	* figure 2 *	7,11-14	
X	FR 2 214 875 A (SUEDEDEUTSCHE KUEHLER BEHR [DE]) 19 August 1974 (1974-08-19) * page 2, line 18 - line 20 * * page 4, line 22 - page 5, line 8 *	1,4-6,9,10	
X	US 2005/235691 A1 (KATOH YOSHIKI [JP] ET AL) 27 October 2005 (2005-10-27) * figure 2 * * figure 5a *	1,2	
Y	US 5 123 482 A (ABRAHAM ANTHONY W [US]) 23 June 1992 (1992-06-23) * column 2, lines 23-26; figure 5 *	11-14	
Y	JP 04 268199 A (NIPPON DENSO CO) 24 September 1992 (1992-09-24) * the whole document *	7	
A	DE 100 57 190 A1 (MODINE MFG CO [US]) 23 May 2002 (2002-05-23) * the whole document *	1	
A	EP 0 284 463 A (VALEO CHAUSSON THERMIQUE [FR]) 28 September 1988 (1988-09-28) * the whole document *	1	F28F F28D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 April 2009	Examiner Vassoille, Bruno
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

2
EPO FORM 1503 03.82 (P/4C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 09 15 0708

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-04-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003192681 A1	16-10-2003	DE 10317323 A1 FR 2838509 A1 JP 3812487 B2 JP 2003307397 A	30-10-2003 17-10-2003 23-08-2006 31-10-2003
FR 2214875 A	19-08-1974	DE 2302770 A1	01-08-1974
US 2005235691 A1	27-10-2005	DE 102005015799 A1 JP 4120611 B2 JP 2005299981 A	24-05-2006 16-07-2008 27-10-2005
US 5123482 A	23-06-1992	NONE	
JP 4268199 A	24-09-1992	NONE	
DE 10057190 A1	23-05-2002	NONE	
EP 0284463 A	28-09-1988	FR 2611881 A1	09-09-1988

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1046876 A [0007] [0009]
- EP 1046867 A [0010]