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(54) Heat exchanger

(57) Heat exchanger (10), in particular for an automotive vehicle, comprising an inlet header tank (12), a return header tank (14) and an outlet header tank (13), theinlet header tank (12) comprising an inlet port (24) for receiving refrigerant from a refrigeration circuit and the outlet header tank (13) comprising an outlet port (26) for returning refrigerant to the refrigeration circuit. The heat exchanger (10) further comprises a plurality of flat tubes (16, 16') extending between the inlet and outlet header tanks (12, 13) and the return header tank (14) and being in fluid connection therewith, for leading refrigerant from the inlet header tank (12) to the outlet header tank (13) via the return header tank (14). According to an important aspect of the invention, a partition wall (34) is arranged in the return header tank (14), the partition wall (34) dividing the return header tank (14) into a first chamber (30) and a second chamber (32), the partition wall (34) comprising openings (38) therein for fluidly connecting the first chamber (30) to the second chamber (32).

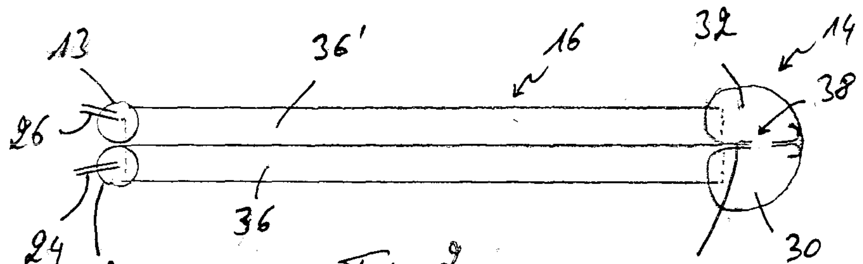

Fig. 2

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Description

Introduction

[0001] The present invention relates to a heat exchanger, in particular a heat exchanger for an automotive vehicle.

[0002] Such heat exchangers generally comprise two hollow header tanks with a plurality of flat tubes arranged therebetween. A refrigerant inlet is connected to the first header tank and a refrigerant outlet is either connected to the first or second header tank, depending on the refrigerant flow configuration of the heat exchanger. The header tanks comprise slots for receiving the ends of the flat tubes therein, such that refrigerant can flow from one header tank to the other.

[0003] In conventional heat exchangers, the header tank consists of a tube with generally circular cross-section. This design proves to be very satisfactory with traditional pressures of commonly used refrigerants, such as e.g. R134a. In such refrigeration systems, a pressure between 2.5 and 6 bar has been used at the low-pressure side, whereas a pressure between 15 and 30 bar has been used at the high-pressure side. In recent years, there has been a tendency to use the more environmentally friendly CO_2 as refrigerant. In high-pressure systems, as e.g. CO_2 systems, the low pressure is between 35 and 80 bar and the high pressure is between 80 and 170 bar. In order for the header tanks to withstand these significantly higher pressures, the wall thickness of the header tanks has been increased. This however results in an increase in size and weight of the heat exchanger, which is considered a disadvantage in the automotive industry.

[0004] Instead of increasing the wall thickness of the header tanks, EP-A-0 608 439 proposes a heat exchanger comprising a number of heat exchange modules, each module comprising a first and second header tank of generally circular cross-section and a plurality of flat tubes therebetween. The first header tanks are in fluid communication with an inlet manifold for receiving refrigerant from the refrigeration circuit and for delivering the refrigerant to the individual first header tanks. The second header tanks are in fluid communication with an outlet manifold for collecting refrigerant received from the individual second header tanks and for returning the refrigerant to the refrigeration circuit. Due to the smaller diameter of the header tanks, the latter are able to allow much higher refrigerant pressures. However, a disadvantage of this design is that a number of parallel flow paths are created through the first header tanks, the flat tubes and the second header tanks. Due to the effects of a pressure drop, the flow rates in the different available flow paths can be different. This leads to a loss of performance of the heat exchanger. Furthermore, it will be appreciated that the manufacture of a heat exchanger consisting of a number of smaller heat exchangers is rather costly.

[0005] A similar design is proposed in US-6,155,340, wherein the header tank is formed by an extruded element comprising a number of parallel tubes of generally circular cross-section. Slots are arranged in the extruded element so as to receive the flat tubes therein. The slots are arranged such that, when the flat tubes are arranged in the slots, a communication passage exists between neighbouring parallel tubes constituting the header tank for balancing the refrigerant flow between them. This design allows a more regular flow pattern of the refrigerant through the heat exchanger and hence better performance. A major disadvantage of this design, however, is the fact that the slots for receiving the flat tubes are not easily formed. Consequently, the manufacture of these heat exchangers is rather expensive.

Object of the invention

[0006] The object of the present invention is to provide an improved heat exchanger, which does not have the above-mentioned disadvantages. This object is achieved by a heat exchanger as claimed in claim 1.

General description of the invention

[0007] The present invention proposes a heat exchanger, in particular for an automotive vehicle, comprising an inlet header tank, a return header tank and an outlet header tank, the inlet header tank comprising an inlet port for receiving refrigerant from a refrigeration circuit and the outlet header tank comprising an outlet port for returning refrigerant to the refrigeration circuit. The heat exchanger further comprises a plurality of flat tubes extending between the inlet and outlet header tanks and the return header tank and being in fluid connection therewith, for leading refrigerant from the inlet header tank to the outlet header tank via the return header tank. According to an important aspect of the invention, a partition wall is arranged in the return header tank, the partition wall dividing the return header tank into a first chamber and a second chamber, the partition wall comprising openings therein for fluidly connecting the first chamber to the second chamber.

[0008] The above partition wall is an easy and effective means for reinforcing the return header tank, while allowing refrigerant to flow from one chamber to the other. The reinforcement of the return header tank is of particular interest when the refrigerant used in the refrigeration circuit is at high pressure, as is e.g. the case in CO_2 systems.

[0009] Preferably, the partition wall in the return header tank extends longitudinally therethrough, such that the first and second chambers are arranged side-by-side in a longitudinal direction of the return header tank. Refrigerant in the heat exchanger flows through the flat tubes from the inlet header tank to the first chamber of the return header tank in a first plane. In the return header tank, the refrigerant then passes through the openings in the partition wall from the first chamber to the second chamber. Refrigerant finally flows through the flat tubes from the second chamber of the return header tank to the outlet header tank in a second plane. The first and second planes are parallel to each other. A face-U flow configuration is achieved, in which air blown through the heat exchanger first encounters one plane of refrigerant and then the other plane of refrigerant. The heat transfer between the refrigerant in the heat exchanger and the air passing inbetween the flat tubes is improved, whereby, in turn, the efficiency of the heat exchanger is improved.

[0010] The return header tank is preferably folded from one sheet of metal having two parallel longitudinal edges, wherein the partition wall is formed by at least one of the longitudinal edges extending into the return header tank. Such a folded header tank can be very easily produced. The manufacture of such folded header tanks is significantly cheaper than extruded header tanks. The end of the longitudinal edge extends to the inner wall of the folded header tank and is preferably brazed thereto. For further strength, both longitudinal edges can extend into the return header tank.

[0011] It should also be noted that the formation of the openings in the partition wall can be very easily achieved. Preferably, these openings are e.g. punched into the sheet of metal before the latter is folded into a folded return header tank.

[0012] Alternatively, the partition wall is inserted between walls of the return header tank.

[0013] The inlet and outlet header tanks are preferably two separate tubes, a first tube defining the inlet header tank and a second tube defining the outlet header tank. Alternatively the inlet and outlet header tanks can be formed by a single tube with a divider therein for dividing the single tube into the inlet header tank and the outlet header tank. It will however be appreciated that, when two separate tubes are used, heat transfer between refrigerant in the inlet header tank and refrigerant in the outlet header tank is kept to a minimum, thereby improving the efficiency of the heat exchanger.

[0014] One set of flat tubes can be arranged between the inlet and outlet header tanks and the return header tank, each flat tube comprising at least two flow channels, wherein a first flow channel is in fluid connection with the inlet header tank and with the first chamber of the return header tank; and a second flow channel is in fluid connection with the second chamber of the return header tank and with the outlet header tank. The flat tubes can e.g. be folded tubes formed from a metal sheet, wherein longitudinal edges of the sheet are folded inwards so as to separate the interior of the formed tube into two separate flow channels, such as e.g. B-tubes. Preferably however, especially if high pressure refrigerant is to be used, the flat tubes are extruded tubes.

[0015] Two sets of flat tubes can be arranged between the inlet and outlet header tanks and the return header tank, wherein a first set of flat tubes is in fluid connection with the inlet header tank and with the first chamber of the return header tank; and a second set of flat tubes is in fluid connection with the second chamber of the return header tank and with the outlet header tank. By using a separate set of tubes for the two flow channels between the inlet and outlet header tanks and the return header tank, heat transfer between refrigerant in the first flow channel and refrigerant in the second flow channel is kept to a minimum, thereby improving on the efficiency of the heat exchanger.

Detailed description with respect to the figures

[0016] The present invention will be more apparent from the following description of some not limiting embodiments with reference to the attached drawings, wherein:

Fig.1 shows a perspective view of a heat exchanger according to a first embodiment of the invention;

Fig.2 shows a section view through a heat exchanger according to a second embodiment of the invention;

Fig.3 shows a perspective view of a header tank of the heat exchanger of Fig.2;

Fig.4 shows a section view through a heat exchanger according to a third embodiment of the invention; and

Fig.5 shows a section view through the heat exchanger of Fig. 1.

[0017] Fig. 1 shows a heat exchanger 10 with face-U flow configuration comprising an inlet header tank 12, an outlet header tank 13 and a return header tank 14. A plurality of flat tubes 16 are arranged between the inlet and outlet header tanks 12, 13 and the return header tank 14 for leading refrigerant from the inlet header tank 12 to the return header tank 14 and from there to the outlet header tank 13. The ends of the flat tubes 16 are connected to the header tanks 12, 13, 14 through slots in the respective header tanks. Corrugated fins 18 are arranged between individual flat tubes 16 in order to improve the heat transfer between the refrigerant in the flat tubes 16 and the air passing through the heat exchanger 10. As shown in Fig.1, the inlet and outlet header tanks 12, 13 are formed by a single tube with a divider 28 therein for dividing the single tube into the inlet and outlet header tanks 12, 13. The inlet header tank 12 comprises an inlet port 24 for receiving refrigerant from a refrigeration circuit (not shown) and the outlet header tank 13 comprises an outlet port 26 for returning refrigerant to the refrigeration circuit. The return header tank

14 is divided into a first chamber 30 and a second chamber 32 by means of a partition wall 34.

[0018] The flow of refrigerant through the heat exchanger 10 is better explained by referring to Fig.2, which is a section view through a heat exchanger according to a second embodiment of the invention. Refrigerant from the refrigeration circuit enters the inlet header tank 12 via the inlet port 24. In the inlet header tank 12, the refrigerant is distributed over the whole length of the inlet header tank 12 and supplied to first flow channels 36 of the flat tubes 16, which lead the refrigerant to the return header tank 14. In the return header tank 14, the refrigerant passes from the first chamber 30 to the second chamber 32 through openings 38 arranged in the partition wall 34. From the second chamber 32 of the return header tank 14, the refrigerant is led to the outlet header tank 13 via second flow channels 36' of the flat tubes 16. The refrigerant coming from the individual flat tubes 16 is collected in the outlet header tank 13 and returned to the refrigeration circuit via the outlet port 26. Each flat tube 16 comprises at least two separate flow channels 36, 36' therein, one for leading the refrigerant in one direction and one for leading the refrigerant in the opposite direction. The flat tubes 16 can be extruded tubes or folded tubes such as e.g. B-tubes.

[0019] A perspective view of the return header tank 14 of Fig.2 is shown in Fig.3. This return header tank 14 is formed from a folded sheet of metal, wherein one of the longitudinal edges of the sheet has been folded inwards to form the partition wall 34 within the folded header tank. The partition wall 34 separates the interior of the folded header tank into the first chamber 30 and a second chamber 32. In order to allow refrigerant to flow from the first chamber 30 to the second chamber 32, a plurality of openings 38 is arranged in the partition wall 34. It will be appreciated that the openings 38 can very easily be arranged in the edge portion of the sheet of metal before folding. Fig.3 also shows the slots 40 arranged in the wall of the return header tank 14 for receiving the flat tubes 16 therein. The cross-section of the slots 40 corresponds to the cross-section of the flat tubes 16.

[0020] In Fig.4, the inlet and outlet header tanks 12, 13 are connected to the return header tank via two sets of flat tubes 16, 16'. The first set of flat tubes 16 leads the refrigerant in one direction out of the inlet header tank 12. The second set of flat tubes 16' leads the refrigerant in the opposite direction, i.e. into the outlet header tank 13. It will be appreciated that the heat exchanger shown in Figs 2 and 4 comprises separate inlet and outlet header tanks 12, 13. By designing the heat exchanger in this way, the heat transfer between refrigerant in the inlet header tank 12 and refrigerant in the outlet header tank 13 is kept to a minimum and efficiency is improved.

[0021] In Fig.5, the return header tank 14 is divided into first and second chambers 30, 32 by means of a partition wall 34 arranged therein. The partition wall 34 comprises openings 38 to allow refrigerant to flow from the first chamber 30 into the second chamber 32. The partition wall 34 of Fig.5 is configured as a separate element that can be inserted into the return header tank 14 and then secured therein.

Reference signs

[0022]

10	heat exchanger
12	inlet header tank
13	outlet header tank
14	return header tank
16	flat tubes
18	corrugated fins
24	inlet port
26	outlet port
28	divider
30	first chamber
32	second chamber
34	partition wall
36 36'	flow channels
38	openings
40	slots

Claims

1. Heat exchanger, in particular for an automotive vehicle, comprising:

an inlet header tank, a return header tank and an outlet header tank; said inlet header tank comprising an inlet port for receiving refrigerant from a refrigeration circuit and said outlet header tank comprising an outlet port for returning refrigerant to said refrigeration circuit; and

a plurality of flat tubes extending between said inlet and outlet header tanks and said return header tank and being in fluid connection therewith, for leading refrigerant from said inlet header tank to said outlet header tank via said return header tank,

characterised by
a partition wall arranged in said return header tank, said partition wall dividing said return header tank into a first chamber and a second chamber, said partition wall comprising openings therein for fluidly connecting said first chamber to said second chamber.

2. Heat exchanger according to claim 1, wherein said partition wall in said return header tank extends longitudinally therethrough, such that said first and second chambers are arranged side-by-side in a longitudinal direction of said return header tank.

3. Heat exchanger according to claim 2, wherein said return header tank is folded from one sheet of metal having two parallel longitudinal edges, wherein said partition wall is formed by at least one of said longitud inal edges extending into said return header tank.

4. Heat exchanger according to claim 3, wherein said partition wall is formed by both of said longitudinal edges extending into said return header tank.

5. Heat exchanger according to claim 1 or 2, wherein said partition wall is inserted between walls of said return header tank.

6. Heat exchanger according to any of claims 1 to 5, wherein said inlet header tank and said outlet header tank are formed by a single tube with a divider therein for dividing said single tube into said inlet header tank and said outlet header tank.

7. Heat exchanger according to any of claims 1 to 6, wherein one set of flat tubes is arranged between said inlet and outlet header tanks and said return header tank, each flat tube comprising at least two flow channels, wherein
a first flow channel is in fluid connection with said inlet header tank and with said first chamber of said return header tank; and
a second flow channel is in fluid connection with said second chamber of said return header tank and with said outlet header tank.

8. Heat exchanger according to any of claims 1 to 6, wherein two sets of flat tubes are arranged between said inlet and outlet header tanks and said return header tank, wherein
a first set of flat tubes is in fluid connection with said inlet header tank and with said first chamber of said return header tank; and
a second set of flat tubes is in fluid connection with said second chamber of said return header tank and with said outlet header tank.

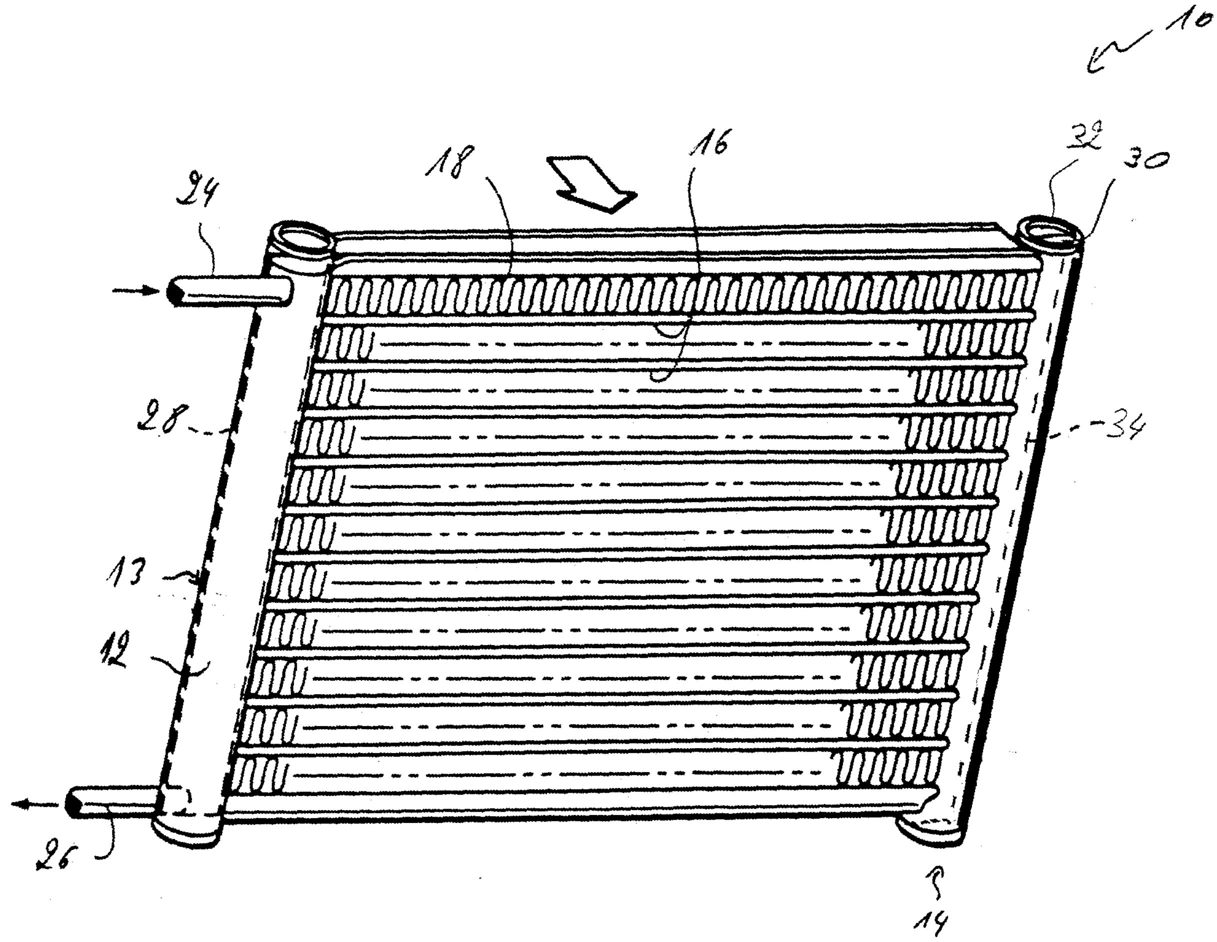

Fig. 1

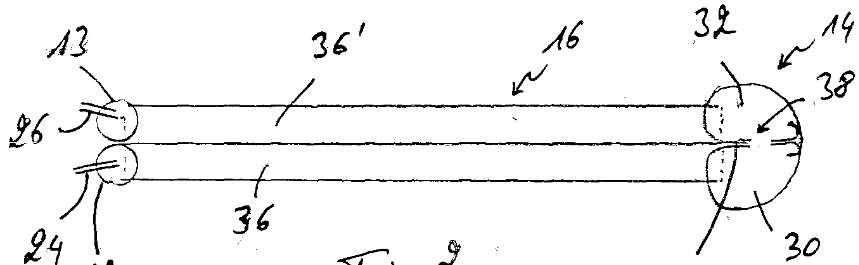

Fig. 2

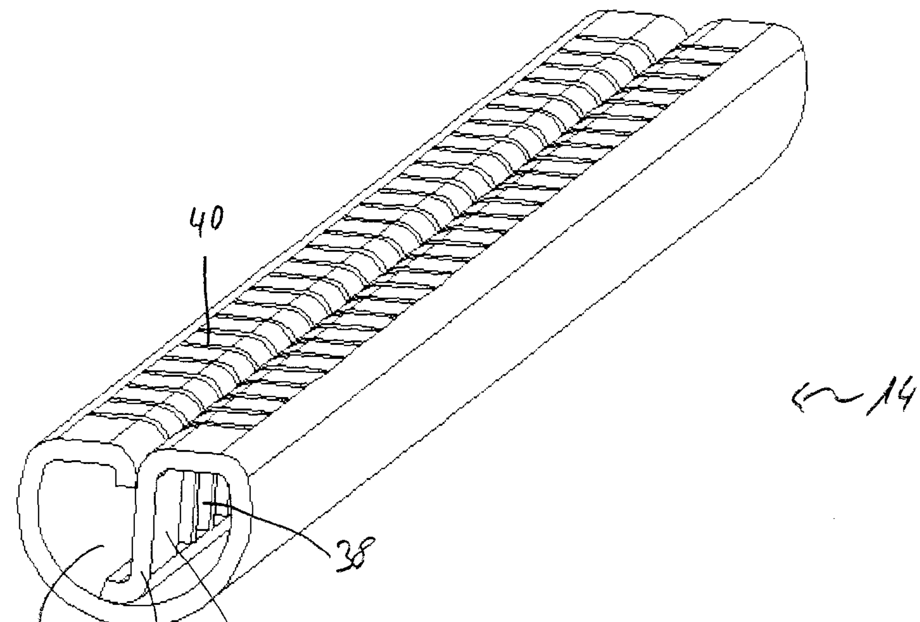

Fig. 3

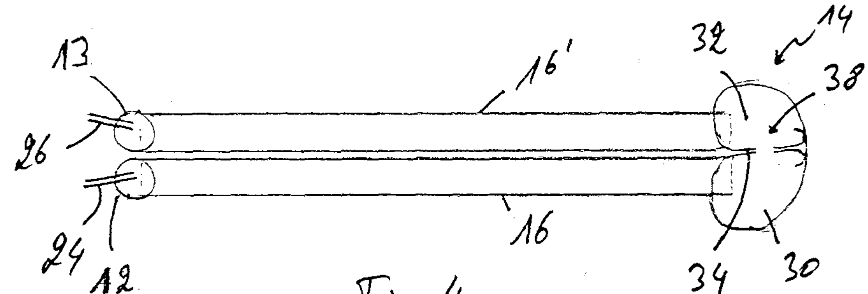

Fig. 4

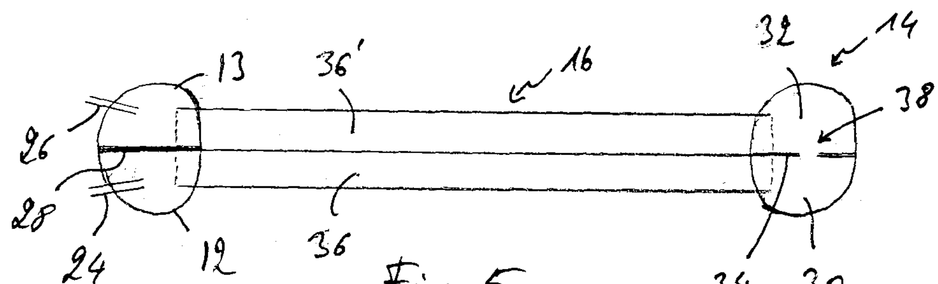

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 03 10 0286

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 198 26 881 A (BEHR GMBH & CO) 23 December 1999 (1999-12-23) * column 3 - column 4, line 45; figures 1-4 *	1-4,6,8	F28F9/02 F28D1/053
X	WO 02 103263 A (HORIUCHI HIROFUMI ;HOSHINO RYOICHI (JP); SHOWA DENDO K K (JP); TAM) 27 December 2002 (2002-12-27) * page 40, line 7 - page 41, line 6 * * page 42, line 13 - line 20 * * page 45, line 14 - page 47, line 1 * * page 51, line 7 - line 16 * * page 54, line 12 - line 18 * * page 55, line 24 - page 58, line 21 * * figures *	1,2,5-8	
Y		3,4	
Y	WO 02 079708 A (HORIUCHI HIROHUMI ;HOSHINO RYOICHI (JP); KAWAMATA YASUJI (JP); SHO) 10 October 2002 (2002-10-10) * abstract; figures *	3,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
X	US 2002/066553 A1 (FISCHER EWALD ET AL) 6 June 2002 (2002-06-06) * page 2, paragraph 27 - page 4, paragraph 35; figures 1-3 *	1-4,6	F28D F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 July 2003	Van Dooren, M

CATEGORY OF CITED DOCUMENTS

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09-07-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19826881 A	23-12-1999	DE 19826881 A1	23-12-1999
WO 02103263 A	27-12-2002	WO 02103263 A1	27-12-2002
		JP 2003075024 A	12-03-2003
WO 02079708 A	10-10-2002	WO 02079708 A2	10-10-2002
		JP 2002357395 A	13-12-2002
US 2002066553 A1	06-06-2002	DE 10056074 A1	08-05-2002

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