(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 111 322 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
27.06.2001 Bulletin 2001/26

(21) Application number: **99940503.8**

(22) Date of filing: **26.08.1999**

(51) Int Cl.[7]: **F28F 1/02**, F28F 1/40, F28D 1/047

(86) International application number:
PCT/JP99/04617

(87) International publication number:
WO 00/12950 (09.03.2000 Gazette 2000/10)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **27.08.1998 JP 24129798**

(71) Applicant: **Zexel Valeo Climate Control Corporation**
Saitama 360-0193 (JP)

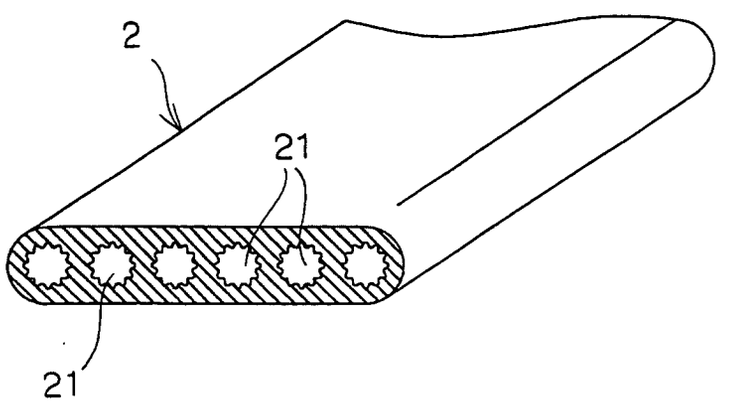
(72) Inventor: **KATO, Soichi,**
Zexel Corporation Kohnan Plant
Osato-gun, Saitama 360-0100 (JP)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) HEAT EXCHANGER

(57) A heat exchanger (1) having a heat-exchange tube (2) including medium passages and a pair of headers (4), (5) disposed at ends of the heat-exchange tube to receive and supply a medium, and having the medium to perform a heat exchange by heat which is conducted to the heat-exchange tube, wherein the medium passages (21) in the heat-exchange tube (2) have a substantially circular cross section and an uneven inner surface. And, the medium is a non-condensation medium, and the heat-exchange tube (2) is made of an aluminum alloy.

FIG. 2



EP 1 111 322 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger in which a medium exchanges heat by conducting heat to a heat-exchange tube.

BACKGROUND ART

[0002] A conventionally known heat exchanger is comprised of a heat-exchange tube for performing a heat exchange of a medium and a pair of headers for receiving and supplying the medium, which are connected to be communicative.

[0003] Specifically, the medium taken in from one of the headers is flown through the medium passages in the heat-exchange tube and discharged from the other header, and the heat exchange of the medium is performed by heat conducted to the heat-exchange tube.

[0004] The heat-exchange tube used for such a heat exchanger of the type as described above is produced by extruding or the like of an aluminum alloy. It is formed to have a flat appearance and provided with a plurality of small medium passages so to improve the efficiency of heat exchange.

[0005] For example, one disclosed in Japanese Patent Application Laid-Open Publication No. 5-215482 has a plurality of medium passages with a circular cross section in order to reduce a pressure loss. Thus, when the medium passages have a circular cross section, a pressure resistance to the medium can be improved as compared with those having a triangle or square cross section.

[0006] As described above, the heat-exchange tube having the plurality of medium passages with the circular cross section has the pressure resistance of the medium passages improved as compared with those having the triangle or square-shaped medium passages, but has a drawback that the passages has a small inner surface area to a flow rate of the medium.

[0007] In other words, a contact area between the medium and the heat-exchange tube becomes relatively small, so that there is a disadvantage that a heat-exchange rate is lowered.

[0008] Particularly, when the heat-exchange tube made of an aluminum alloy is used for a gas cooler or the like in which the medium is not condensed and which therefore needs a remarkable pressure resistance, there are drawbacks that the heat-exchange tube has a thick wall and results in a considerably lowered heat-exchange rate as compared with those made of titanium or copper.

[0009] Therefore, in view of the drawbacks described above, the present invention provides a heat exchanger which can improve the pressure resistance and heat-exchange rate of the heat-exchange tube.

DISCLOSURE OF THE INVENTION

[0010] The invention described in claim 1 is a heat exchanger comprising a heat-exchange tube having medium passages and a pair of headers disposed at ends of the heat-exchange tube to receive and supply a medium, and having the medium to perform heat exchange by heat which is conducted to the heat-exchange tube, wherein the medium passages in the heat-exchange tube have a substantially circular cross section and an uneven inner surface.

[0011] Thus, according to the heat exchanger of the present invention, the medium passages in the heat-exchange tube have a substantially circular cross section and an uneven inner surface, so that the heat-exchange tube is improved its performance as its pressure resistance and heat-exchange rate are improved.

[0012] More specifically, when the heat-exchange tube having the medium passages in the circular shape, their pressure resistance is improved as compared with those having a triangle or square shape, but a contact area between the medium and the heat-exchange tube becomes relatively small, resulting in a degradation of the heat-exchange rate. But, the present invention solves such a drawback by having the uneven inner surface in the passages so to secure a large contact area between the medium and the heat-exchange tube.

[0013] The invention described in claim 2 is the heat exchanger according to the invention of claim 1, wherein the medium is a non-condensation medium, and the heat-exchange tube is made of an aluminum alloy.

[0014] Thus, according to the heat exchanger of the present invention, the medium is a non-condensation medium, and the heat-exchange tube is made of an aluminum alloy, so that the heat-exchange tube is produced lightweight at a low cost.

[0015] Specifically, when the heat-exchange tube of an aluminum alloy is used for a gas cooler or the like for which the medium is not condensed, an excellent pressure resistance is required, and there are drawbacks that the heat-exchange tube has a thick wall and a considerably lowered heat-exchange rate as compared with those made of titanium or copper. But, the present invention forms the medium passages with an uneven-shaped inner surface, so that the heat-exchange tube made of a relatively lightweight and inexpensive aluminum alloy can secure sufficient performance.

[0016] The invention described in claim 3 is the heat exchanger according to the invention of claim 1 or 2, wherein the heat-exchange tube is formed by bending an extruded member.

[0017] Thus, according to the heat exchanger of the present invention, the heat-exchange tube is formed by bending the extruded member, so that the uneven shape is formed readily on the inner surface of the passages.

[0018] Especially, when the extruded member is bent, the medium passages can be prevented from becoming

narrow, and the bent portions of the tube can be prevented from having a high passage resistance. This is because the uneven inner surface of the passages reinforces a resistance against an extra thickness or a crease involved in such bending.

[0019] The invention described in claim 4 is the heat exchanger according to the invention of claim 3, wherein the medium passages in the heat-exchange tube are formed to protrude on a center line which divides a cross section of the tube into two in a direction of width thereof.

[0020] Thus, according to the heat exchanger of the present invention, the medium passages in the heat-exchange tube are protruded on the center line which divides the cross section of the tube into two in the direction of width thereof, so that the inner surfaces of the passages are efficiently prevented from contacting mutually when the extruded member is bent.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is an external diagram showing a heat exchanger according to an embodiment of the present invention;

Fig. 2 is an external diagram showing a heat-exchange tube according to the embodiment of the present invention;

Fig. 3 is a cross sectional diagram showing the heat-exchange tube according to the embodiment of the present invention; and

Fig. 4 is a cross sectional diagram showing a heat exchange tube according to an embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] An embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0023] Fig. 1 is an external diagram showing a heat exchanger 1 of this embodiment. This heat exchanger 1 is a gas cooler comprising a heat-exchange tube 2 which is provided with fins 3, 3 and formed into a meandered shape and a pair of headers 4, 5 which are disposed at ends of the heat-exchange tube 2, wherein carbon dioxide (CO_2), which is a non-condensation medium, is used as the medium.

[0024] The respective headers 4, 5 are provided with an inlet joint 41 for connecting a pipe for supplying the medium or an outlet joint 51 for connecting a pipe for discharging the medium, so that the medium supplied through the header 4 flows through the heat-exchange tube 2 and discharged from the header 5.

[0025] In the aforesaid structure, the heat exchange of the medium is performed by heat conducted to the heat exchange tube. And, the heat exchange is promoted by the fins 3, 3 fitted to the heat-exchange tube 2.

[0026] Respective points of the tube 2, the fins 3, 3 and the pair of headers 4, 5 are connected by brazing.

[0027] The heat-exchange tube 2 of this embodiment is formed to have a flat shape and provided with a plurality of medium passages 21, 21 therein as shown in Fig. 2 and Fig. 3.

[0028] The plurality of passages 21, 21 are arranged in parallel along a center line A which divides the tube into two in a direction of width.

[0029] The medium passages 21, 21 are substantially circular in cross section and have an uneven inner surface. The heat-exchange tube 2 is improved its pressure resistance and heat-exchange rate by virtue of the structure of the medium passages 21, 21.

[0030] Specifically, the shape of the respective medium passages 21, 21 based on a circular shape in order to improve the pressure resistance is gathered or corrugated in its cross section to secure a wide contact area between the medium and the heat-exchange tube 2.

[0031] And, the heat-exchange tube 2 is produced by bending the extruded member of an aluminum alloy into a predetermined shape.

[0032] Here, the plurality of medium passages 21, 21 of this embodiment are formed to protrude on the center line A, so that the inner surfaces of the respective medium passages 21, 21 are efficiently prevented from contacting each other when the extruded member is bent.

[0033] Thus, to prevent the mutual contact of the inner surfaces of the respective medium passages 21, 21, the gathering or corrugating intervals on the center line A may be increased as shown in Fig. 4.

[0034] As described above, according to the heat exchanger of this embodiment, the heat-exchange tube has a flat shape and the plurality of medium passages have a substantially circular shape in cross section and an uneven inner surface, so that the heat-exchange tube can be improved its pressure resistance and heat-exchange rate, and its performance can be improved.

[0035] More specifically, in the heat-exchange tube having the plurality of medium passages, when the medium passages are circular, the heat-exchange tube has an improved pressure resistance as compared with one having the medium passages in a triangle or square shape but has a drawback that its heat-exchange rate is lowered because a contact area between the medium and the heat-exchange tube is relatively small. But, because the inner surface of each passage is formed to have an uneven shape in this embodiment, a large contact area between the medium and the heat-exchange tube can be secured, so that such a drawback can be solved.

[0036] According to the heat exchanger of this embodiment, the medium is a non-condensation medium, and the heat-exchange tube is made of an aluminum alloy, so that the heat-exchange tube can be produced lightweight at a low cost.

[0037] More specifically, when the heat-exchange

tube of an aluminum alloy is used for a gas cooler or the like for which the medium is not condensed and requires an excellent pressure resistance, there are drawbacks that the heat-exchange tube has a thick wall and a considerably lowered heat-exchange rate as compared with those made of titanium or copper. But, the present embodiment forms the plurality of medium passages with an uneven-shaped inner surface, so that the heat-exchange tube made of a relatively lightweight and inexpensive aluminum alloy can secure sufficient performance.

[0038] According to the heat exchanger of this embodiment, the heat-exchange tube is formed by bending the extruded member, so that the uneven-shaped inner surface of the passage can be formed readily.

[0039] Especially, when the extruded member is bent, the medium passages can be prevented from becoming narrow, and the bent portions of the tube can be prevented from having a high passage resistance. It is because the uneven-shaped inner surface of the passage reinforces a resistance against an excess thickness or a crease involved in such bending.

[0040] According to the heat exchanger of this embodiment, the plurality of medium passages of the heat-exchange tube are protruded on the center line which divides the cross section of the tube into two in a direction of width, so that the inner surfaces of the passages can be efficiently prevented from contacting mutually when the extruded member is bent.

INDUSTRIAL APPLICABILITY

[0041] The heat exchanger according to the present invention is a heat exchanger having a heat-exchange tube with an improved pressure resistance and heat-exchange rate and also a next-generation heat exchanger suitable for a high-pressure medium such as carbon dioxide which will take the place of a conventional heat-exchange medium, and is particularly suitable for a refrigerating cycle for automobiles and consumer products.

Claims

1. A heat exchanger comprising a heat-exchange tube having medium passages and a pair of headers disposed at ends of the heat-exchange tube to receive and supply a medium, and having the medium to perform a heat exchange by heat which is conducted to the heat-exchange tube, wherein:
   the medium passages in the heat-exchange tube have a substantially circular cross section and an uneven inner surface.

2. The heat exchanger according to claim 1, wherein the medium is a non-condensation medium and the heat-exchange tube is made of an aluminum alloy.

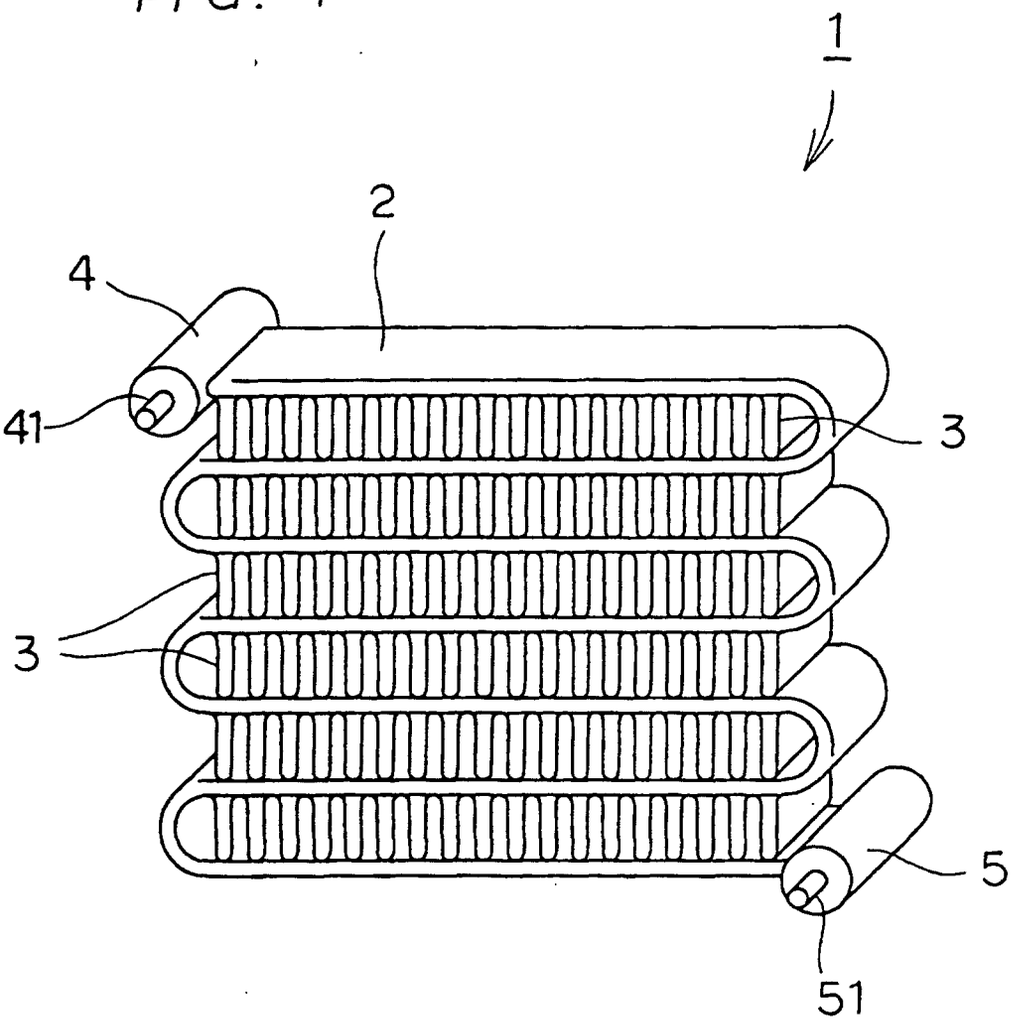
3. The heat exchanger according to claim 1 or 2, wherein the heat-exchange tube is formed by bending an extruded member.

4. The heat exchanger according to claim 3, wherein the heat-exchange tube has a plurality of medium passages, and the medium passages in the heat-exchange tube are formed to protrude on a center line which divides a cross section of the tube into two in a direction of width.

Amended claims under Art. 19.1 PCT

1. A heat exchanger comprising a heat-exchange tube having medium passages and a pair of headers disposed at ends of the heat-exchange tube to receive and supply a medium, and having the medium to perform a heat exchange by heat which is conducted to the heat-exchange tube, wherein:
   the heat-exchange tube is formed by bending an extruded member having a plurality of medium passages;
   the medium passages in the heat-exchange tube have a substantially circular cross section and an uneven inner surface, and the medium passages are formed to protrude on a center line which divides a cross section of the tube into two in a direction of width; and
   the medium is a non-condensation medium, and the heat-exchange tube is made of an aluminum alloy.

FIG. 1



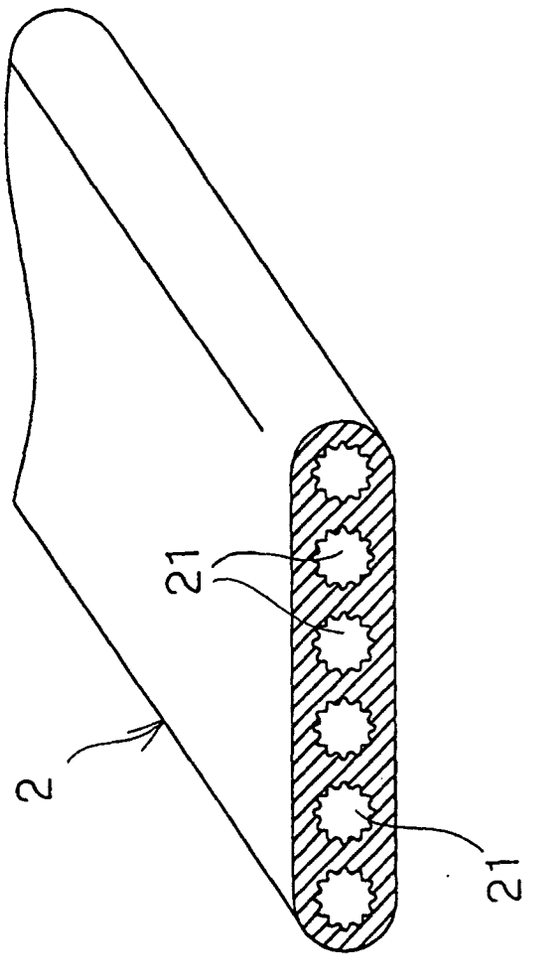


FIG. 2

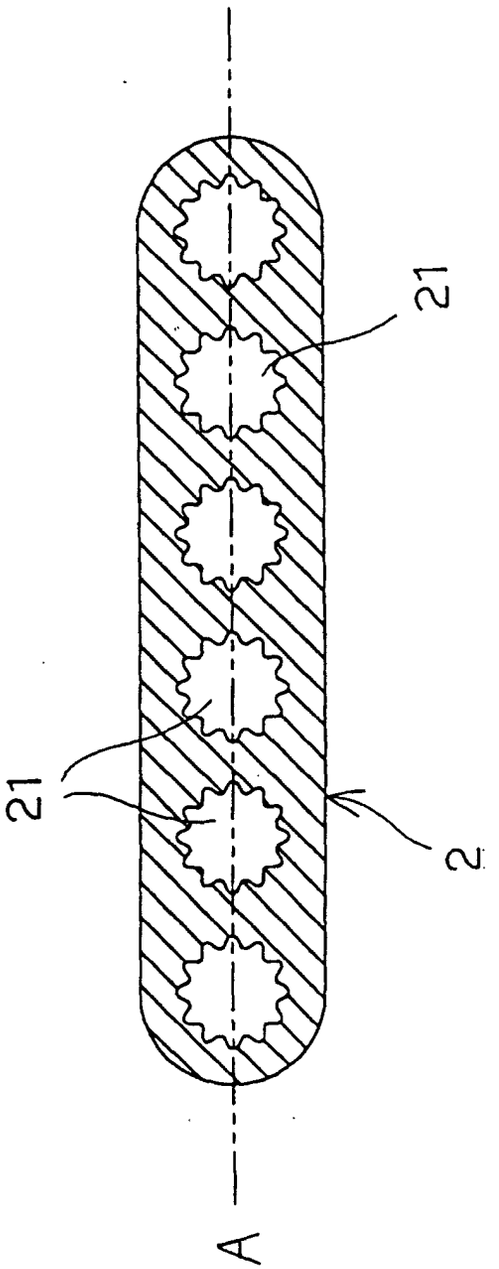


FIG. 3

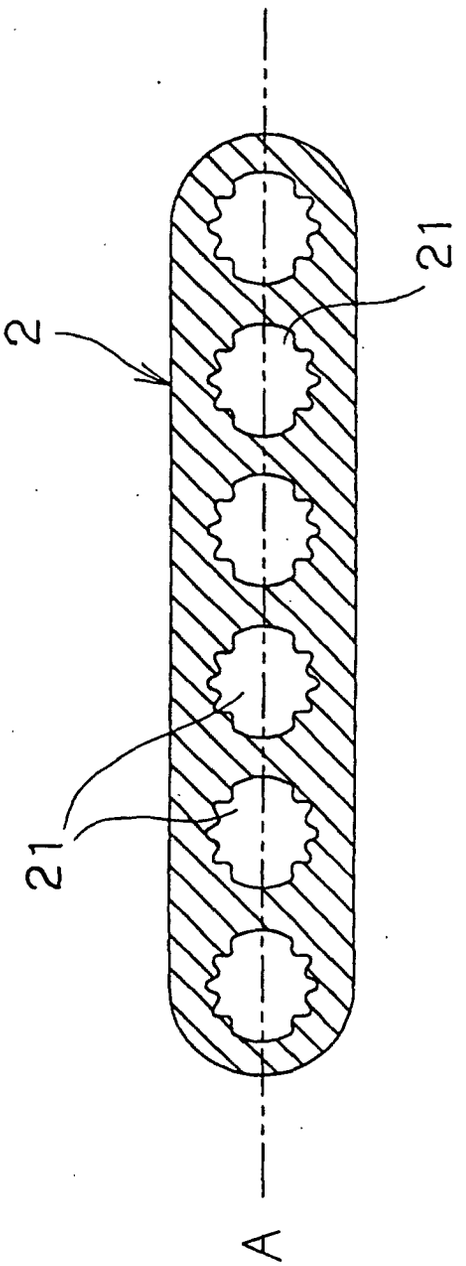


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/04617

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl[6] F28F1/02, F28F1/40, F28D1/047

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)
Int. Cl[6] F28F1/02 F28F1/40 F28D1/047

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1999 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1999

Electronic data base consulted during the international search (name of data base and, where practicable, 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 Y	JP, 3-45034, Y2 (Mitsubishi Heavy Industries, Ltd.), 24 September, 1991 (24.09.91), page 2, left column, line 4 to right column, line 5 (Family: none)	1,2,3 4
X Y	JP,10-166034, A (Hitachi Cable, Ltd.), 23 June, 1998 (23.06.98), page 3, left column, lines 1 to 30 (Family: none)	1,3 2,4
Y	JP, CD-ROM of the specification and drawings annexed to the request of the Japan Utility Model Application No. 14298/1991 (Laid-open No. 108163/1992) (Toyo Radiator K.K.), 18 September, 1992 (18.09.92), Page 4, lines 2-20 (Family: none)	1,2,3,4
EX EY	JP, 11-44498, A (Showa Aluminum Corporation), 16 February, 1998 (16.02.98), Page 2, right column, lines 33 to 40; page 6, right column, lines 41 to 44; page 8, left column, line 4 to page 9, left column, line 19 & EP, 881448, A2 & AU, 6980198, A1	1 2,3,4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November, 1999 (11.11.99)	24 November, 1999 (24.11.99)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)