

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
23 February 2006 (23.02.2006)

PCT

(10) International Publication Number
WO 2006/018746 A1

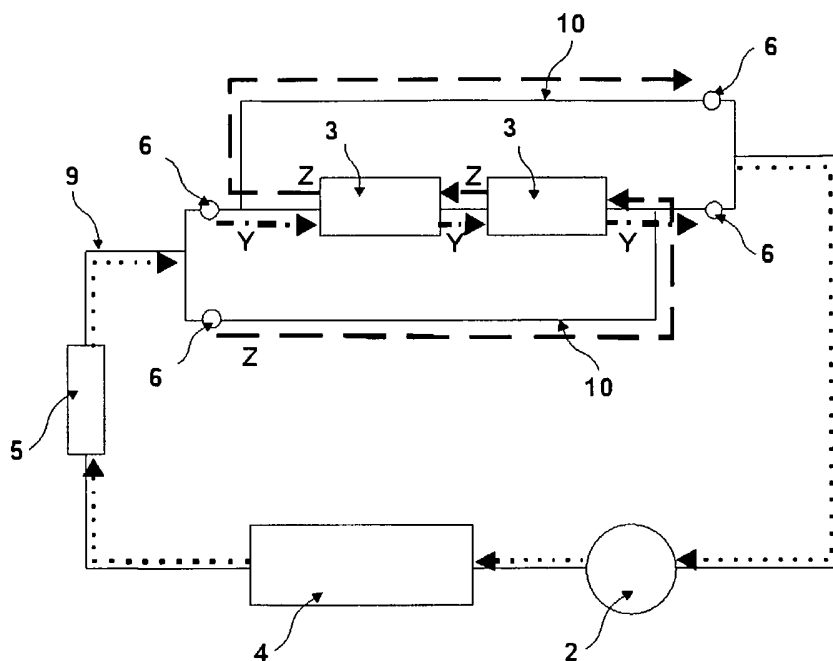
- (51) International Patent Classification:
F25B 5/04 (2006.01) *F25D 11/02* (2006.01)
F25B 41/04 (2006.01)
- (21) International Application Number:
PCT/IB2005/052405
- (22) International Filing Date: 19 July 2005 (19.07.2005)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
2004/02055 18 August 2004 (18.08.2004) TR
- (71) Applicant (for all designated States except US): **ARCELİK ANONİM ŞİRKETİ** [TR/TR]; E5 Ankara Asfaltı Uzeri, Tuzla, 34950 Istanbul (TR).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **GULDALI, Yalcin** [TR/TR]; Arcelik Anonim Sirketi, E5 Ankara Asfaltı Uzeri, Tuzla, 34950 Istanbul (TR). **CAGLAR, Talip** [TR/TR]; Arcelik Anonim Sirketi, E5 Ankara Asfaltı Uzeri, Tuzla, 34950 Istanbul (TR).

- (74) Agent: **ANKARA PATENT BUREAU**; Bestekar Sokak No.10, Kavaklıdere, 06680 Ankara (TR).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A COOLING DEVICE



(57) Abstract: This invention relates to a cooling device (1), the cooling performance of which is improved by controlling the cycle of the refrigerant.

WO 2006/018746 A1

Description

A COOLING DEVICE

- [001] This invention relates to a cooling device, the cooling performance of which is improved by controlling the cycle of the refrigerant.
- [002] In cooling devices, the circulation of the refrigeration fluid through units such as compressor, condenser, capillary tubes and evaporator constitutes the cooling cycle. Especially in refrigerators comprising cooling and freezing compartments, wherein evaporators connected in series, one for each compartment, are utilized, refrigeration fluid circulates through the evaporators following their connection order in the cooling cycle. As a result of this, controlling the cooling temperatures and efficiencies of the evaporators becomes problematic.
- [003] For example, in cooling systems with serially connected evaporators, when there is an instantaneous heat load in a compartment, the system can not respond quickly if the evaporator of this compartment is in the last position in the connection order of the cooling cycle.
- [004] Moreover, in cooling systems with serially connected evaporators, since the circulation of the refrigerant is in one direction, compartment temperatures can not be controlled independently. In such a system, for example, as the compressor starts operating, refrigeration fluid circulates through the freezing compartment evaporator first. However, the refrigerant, which was heated up in the stand-by phase fills the freezing compartment evaporator following the activation of the compressor. In this transient regime, which starts as the compressor starts operating and ends as the temperature of the refrigerant reaches to a level suitable for cooling, the temperature of the refrigerant entering the freezing compartment evaporator is too high to be used in cooling, so that it may even create a heat load in the compartment.
- [005] The object of the present invention is the realization of a cooling device, the cooling performance of which is improved by controlling the cycle of the refrigerant.
- [006] The cooling device designed to fulfill the object of this invention is illustrated in the attached figures, where:
- [007] Figure 1- is a schematic view of a cooling device.
- [008] Figure 2- is a schematic view of a cooling cycle of the prior art.
- [009] Figure 3- is a schematic view of a cooling cycle.
- [010] Figure 4- is a schematic view of an alternative cooling cycle.
- [011] Figure 5- is a schematic view of an alternative cooling cycle.
- [012] Elements shown in figures are numbered as follows:
1. Cooling device
 2. Compressor

3. Evaporator
4. Condenser
5. Capillary tube
6. Valve
7. Compartment
8. Control unit
9. Circulation line
10. By-pass line

[013] The cooling device (1), preferably the refrigerator, comprises one or more than one compartment (7), a compressor (2) which activates the refrigeration cycle, more than one evaporators (3), at least two of them being serially-connected, absorbing the thermal energy in the medium to be cooled, a condenser (4) transferring the thermal energy to the outer medium, a capillary tube (5) enabling the expansion of the refrigerant that leaves the condenser (4) and transferring it to the evaporator, a circulation line (9) connecting the compressor (2), the evaporator (3), the condenser (4) and the capillary tube (5), more than one valves (6) on the circulation line (9), provided at the inlets or at the outlets of the evaporators (3) designating the direction and the order in which refrigeration fluid circulates through the evaporators (3), controlling the circulation during cooling cycle, one or more than one by-pass line (10) connected to at least one valve (6) and connecting to at least one evaporator (3) directly or by the circulation line (9), enabling the refrigeration fluid directed by the valve to enter the desired evaporator (3) from the desired direction.

[014] In one embodiment of the present invention, a one way valve (6) is utilized on the cooling cycle (Figure 3).

[015] In another embodiment of the present invention, two way solenoid valves (6) are utilized in the cooling cycle (Figure 4).

[016] In another embodiment of the present invention, one way and two way valves (6) are utilized in the cooling cycle (Figure 5).

[017] In yet another embodiment of the present invention, a valve (6) controlling more than one inlets and outlets is utilized in the cooling cycle.

[018] In yet another embodiment of the present invention, the cooling device (1) comprises a control unit (8) controlling the operation of the valves (6).

[019] In the preferred embodiment of the present invention, the cooling device (1) comprises two separate compartments (7), e.g. a cooling and a freezing compartment, two serially connected evaporators (3), one in each compartment (7) for cooling the compartments (7), e.g. a cooling compartment evaporator (3) and a freezing compartment evaporator (3), a two way valve (6) positioned at the inlet of the freezing compartment evaporator (3) which is the first in the cooling cycle, e.g. a freezing valve

(6), a by-pass line (10) connecting the freezing compartment valve (6) to the cooling compartment evaporator (3) which is positioned after the freezing compartment evaporator (6) in the circulation direction, e.g. a freezing by-pass line (10), a two way valve (6) which is positioned after the connection of the by pass line (10) and the cooling compartment evaporator (3), e.g. a cooling valve (6), and another by-pass line (10) connecting the cooling valve (6) to the inlet of the freezing compartment evaporator (3), e.g. a cooling by-pass line (10). In this embodiment, when the refrigeration fluid is desired to circulate through the freezing compartment evaporator (3) and the cooling compartment evaporator (3) respectively, e.g. primary circulation (Y), the freezing valve (6) opens the circulation line (9) as it blocks the freezing by-pass line (10) and the cooling valve (6) opens the circulation line (9) as it blocks the cooling by-pass line (10). Thus, refrigeration fluid enters and leaves the freezing compartment evaporator (3) and the cooling compartment evaporator (3) respectively and continues its circulation through the circulation line (9). When the refrigeration fluid is desired to circulate through the cooling compartment evaporator (3) and the freezing compartment evaporator (3) respectively, e.g. secondary circulation (Z), freezing valve (6) blocks the circulation line (9) as it opens the freezing by-pass line (10) and cooling valve (6) blocks the circulation line (9) as it opens the cooling by-pass line (10). Thus, refrigeration fluid enters and leaves the freezing by-pass line (10), the cooling compartment evaporator (3), the freezing compartment evaporator (3) and the cooling by-pass line (10) respectively and continues its circulation through the circulation line (9) (Figure 4).

[020] With the embodiment of the present invention, in a cooling cycle comprising serially connected evaporators (3), employment of the secondary circulation (Z) before the primary circulation (Y) starts a transient regime and as the necessary working conditions are provided, system switches to a steady-state regime, wherein the secondary circulation (Z) is employed after the primary circulation (Y).

[021] As a result of the required positioning of the valves (6), the cooling compartment (7) evaporator (3) is given the first position and the freezing compartment (7) evaporator (3) is given the second position in the cooling cycle, thus freezing compartment (7) evaporator (3) is filled comparatively later as the compressor (2) starts operating which in turn provides a suitable cooling during the transient regime.

[022] With the embodiment which is the object of the present invention, the evaporator (3) of the compartment (7) having a temperature higher than the ideal level is taken to the first position in the cooling cycle and thus, a better control over the compartment (7) temperatures is achieved.

[023] Since switching between the primary circulation (Y) and the secondary circulation (Z) in the transient regime, which is achieved by the embodiment of the present

invention enables the cooling compartment (7) to be cooled at a relatively higher pressure level, thermodynamic efficiency of the cooling process is improved. At the end of the transient regime, the refrigeration fluid enters the freezing compartment (7) evaporator (3) first and this results in an improvement in the efficiency.

[024] Thus, independent of the operation of the compressor, the evaporator (3) of the compartment (7) the heat load of which is increased, is provided to be the first in the cooling cycle by suitable positioning of the valves (6) and thus, is fed with a more suitable refrigerant.

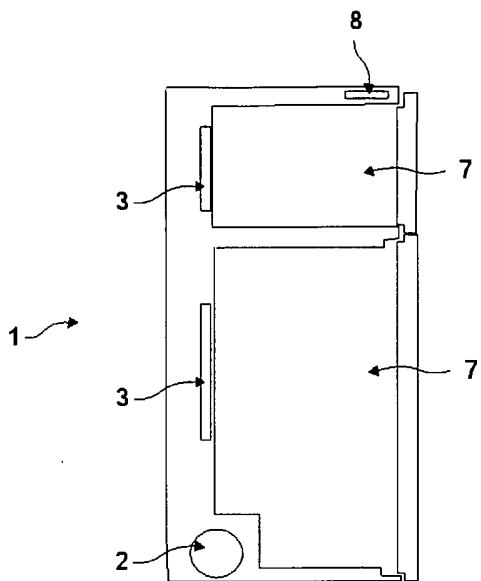
[025] Moreover, evaporator (3) of the compartment (7) with an instantaneous heat load may be taken to the first position in the cooling cycle. As a result of the fact that the first evaporator (3) in the cooling cycle has a better performance, the evaporators (3) of the compartments (7) can cool in different activities and the temperatures of the compartments (7) may be controlled as required.

Claims

- [001] A cooling device (1) comprising one or more than one compartments (7), a compressor (2) activating the cooling cycle, more than one evaporators (3) preferably in different compartments (7), absorbing the thermal energy available in de medium to be cooled and a circulation line (9) connecting units constituting the cooling cycle such as a compressor (2), evaporator (3) etc., and characterized by more than one valves (6) positioned on the circulation line (9) at the inlets or outlets of the evaporators (3), for controlling the direction and order in which refrigeration fluid circulates through the evaporators (3), thus controlling the circulation during cooling cycle and one or more than one by-pass lines (10) connected to at least one valve (6) and connecting to at least one evaporator (3) directly or by the circulation line (9), enabling the refrigeration fluid directed by the valve (6) to enter the desired evaporator (3) from the desired direction.
- [002] A cooling device (1) as in Claim 1, characterized by a control unit (8) for controlling the operation of the valves (6).
- [003] A cooling device (1) as in Claim 1, characterized by a one way valve (6) utilized in the cooling cycle.
- [004] A cooling device (1) as in Claim 1, characterized by a two way valve (6) utilized in the cooling cycle.
- [005] A cooling device as in Claim 4, comprising two separate compartments (7), e.g. a cooling compartment (7) and a freezing compartment (7), two serially connected evaporators (3), each located in a compartment (7) for cooling the compartments, e.g. a freezing compartment evaporator (3) and cooling compartment evaporator (3), a two way valve (6) positioned at the inlet of the freezing compartment evaporator (3) which is the first in the cooling cycle, e.g. a freezing valve (6), a by-pass line (10) connecting the freezing valve (6) to the outlet of the cooling compartment evaporator (3) which is positioned after the freezing compartment evaporator (3) in the cooling cycle, e.g. a freezing by-pass line (10), another two way valve (6) positioned at a location after the connection between the cooling compartment evaporator (3) and the by-pass line (10), e.g. cooling valve (6), another by-pass line (10) connecting before the cooling valve (6) and the freezing compartment evaporator (3), e.g. cooling by-pass line (10), and characterized with cycles such that, when the refrigeration fluid is desired to circulate through the freezing compartment evaporator (3) and the cooling compartment evaporator (3) respectively, e.g. primary circulation (Y), the freezing valve (6) opens the circulation line (9) as it blocks the freezing by-pass line (10) and the cooling valve (6) opens the circulation line (9) as it blocks the cooling by-pass

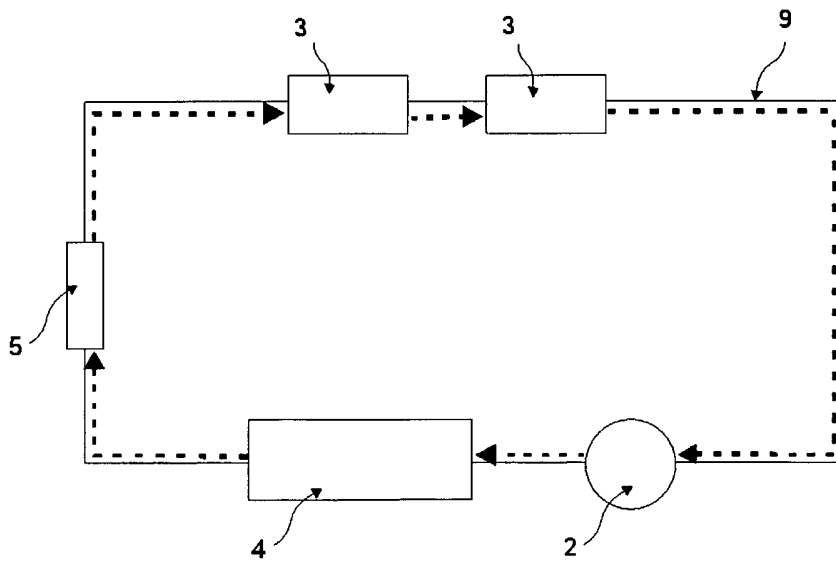
line (10), thus, refrigeration fluid enters and leaves the freezing compartment evaporator (3) and the cooling compartment evaporator (3) respectively and continues its circulation through the circulation line (9), when the refrigeration fluid is desired to circulate through the cooling compartment evaporator (3) and the freezing compartment evaporator (3) respectively, e.g. secondary circulation (Z), freezing valve (6) blocks the circulation line (9) as it opens the freezing by-pass line (10) and cooling valve (6) blocks the circulation line (9) as it opens the cooling by-pass line (10), thus, refrigeration fluid enters and leaves the freezing by-pass line (10), the cooling compartment evaporator (3), the freezing compartment evaporator (3) and the cooling by-pass line (10) respectively and continues its circulation through the circulation line (9).

[Fig. 001]

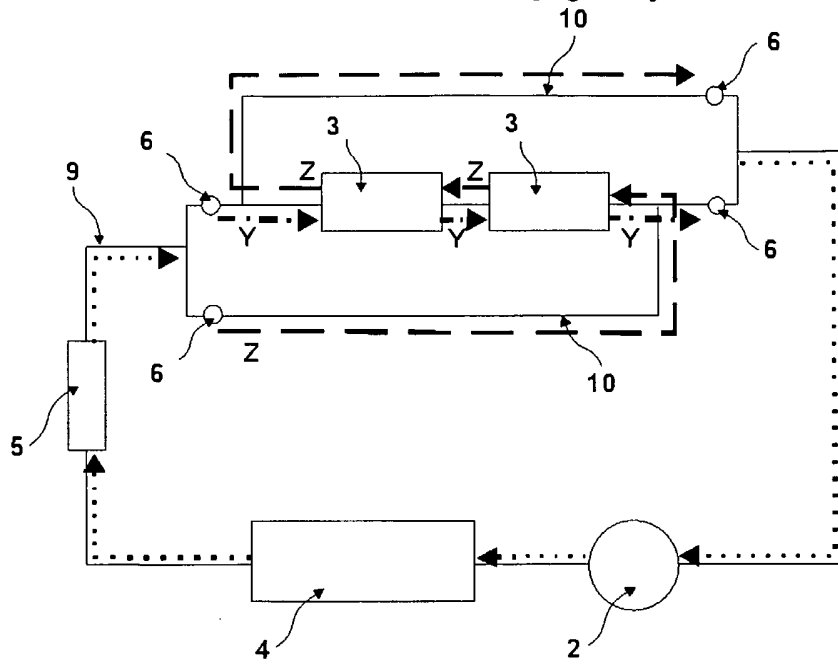


[Fig. 002]

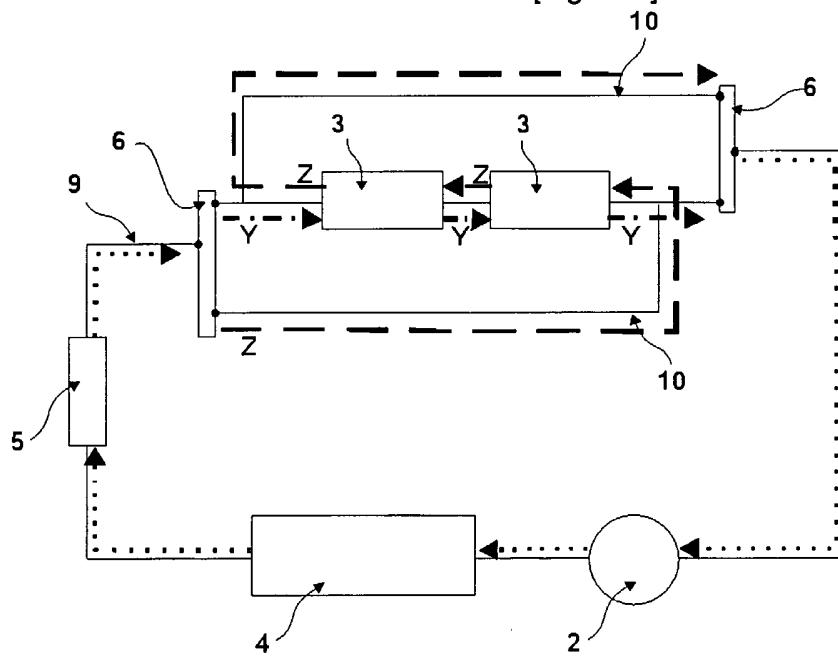
PRIOR ART



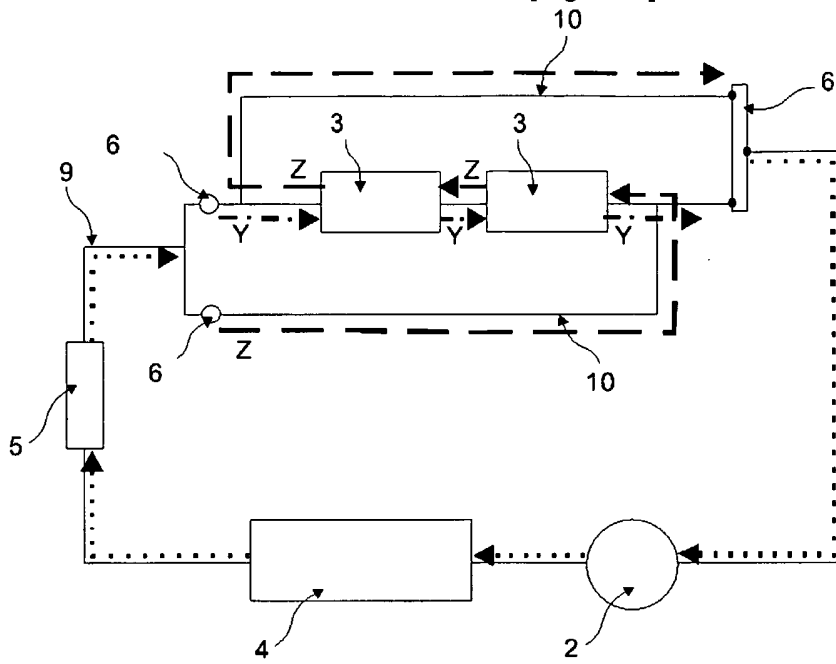
[Fig. 003]



[Fig. 004]



[Fig. 005]



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2005/052405

A. CLASSIFICATION OF SUBJECT MATTER
 F25B5/04 F25B41/04 F25D11/02

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)
 F25B F25D

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/067160 A (DAIKIN INDUSTRIES, LTD; YABU, TOMOHIRO; XI, GUANNAN) 14 August 2003 (2003-08-14) page 57, line 18 - page 58, line 22; page 60, line 1 - page 61, line 10; figures 15,16	1,2
A	----- US 6 167 712 B1 (LIM JAE-HOON ET AL) 2 January 2001 (2001-01-02) column 3, line 1 - column 6, line 54; figures 1-4	1,2
A	----- US 2003/061822 A1 (RAFALOVICH ALEXANDER P) 3 April 2003 (2003-04-03) paragraph '0026! - paragraph '0041!; figures 1-5	1,2,4

Further documents are listed in the continuation of box C.
 Patent family members are listed in annex.

* Special categories of cited documents :

<p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*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)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p>	<p>*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</p> <p>*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</p> <p>*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.</p> <p>*Z* document member of the same patent family</p>
--	--

Date of the actual completion of the international search 18 November 2005	Date of mailing of the international search report 29/11/2005
--	---

Name and mailing address of the ISA 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 Szilagyi, B
--	--

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No PCT/IB2005/052405
--

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
WO 03067160	A	14-08-2003	AU	2003244345 A1	02-09-2003
			CN	1628230 A	15-06-2005
			JP	3695417 B2	14-09-2005
			JP	2003294268 A	15-10-2003
			US	2005150237 A1	14-07-2005
US 6167712	B1	02-01-2001	CN	1262420 A	09-08-2000
			JP	3167697 B2	21-05-2001
			JP	2000230769 A	22-08-2000
			KR	2000055341 A	05-09-2000
US 2003061822	A1	03-04-2003	NONE		