(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 February 2008 (21.02.2008)

PCT

(10) International Publication Number
WO 2008/019440 A1

(51) International Patent Classification:
B65D 1/28 (2006.01) *B65D 23/02* (2006.01)
B65D 1/40 (2006.01) *B65D 85/72* (2006.01)

(21) International Application Number: PCT/AU2007/001157

(22) International Filing Date: 15 August 2007 (15.08.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2006904522 15 August 2006 (15.08.2006) AU

(71) Applicant *(for all designated States except US)*: AMCOR LIMITED [AU/AU]; 679 Victoria Street, Abbotsford, Victoria 3067 (AU).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: CAREW, David [AU/AU]; 5 Currunghi Court, St Albans, Victoria 3021 (AU).

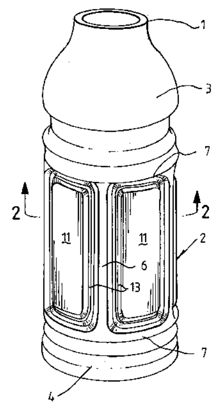
(74) Agent: GRIFFITH HACK; 509 St Kilda Road, Melbourne, Victoria 3004 (AU).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, 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, MT, 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*

(54) Title: A CONTAINER



(57) Abstract: A rigid beverage container for cold fill applications is disclosed. The container is made from a polymer with a moisture vapour transmission rate of greater than 100 g/m2.day at a 25um wall thickness. The container includes one or more than one panel that is responsive to vacuum conditions generated in the container and can accommodate in a controlled way any vacuum contraction caused by the loss of liquid from the container when the container has been cold filled with a liquid, such as a beverage, and closed.

WO 2008/019440 A1

A CONTAINER

The present invention relates to containers formed from polymeric materials.

The present invention relates particularly, although by no means exclusively, to containers for beverages.

It is well known in the art to produce rigid containers, such as bottles, from polymers such as polyethylene terephthalate (PET). These bottles are used to contain a large variety of liquid products, such as beverages, such as carbonated soft drinks, juices, milk drinks, water and flavoured waters, sports drinks, isotonic drinks, cordials etc. PET bottles are popular because of their low weight, low cost, easy manufacturability, clear walls and design flexibility. One disadvantage of PET is that it is not readily biodegradable, although PET bottles can be recycled.

It is known to use more biodegradable polymers for producing rigid containers. These polymers are often made from non-petroleum sources and can break down in waste treatment processes, including landfill and composting, to carbon dioxide and water.

A suitable known biodegradable polymer is polylactic acid (also known as polylactide resin), described by Wikpedia[1] as follows:

"Polylactic acid or Polylactide (PLA) is a biodegradable, thermoplastic, aliphatic polyester derived from lactic acid. It can be easily produced in a high

---

[1] As copied from Wikpedia, under the terms of their copyright policy, on 10 August 2006.

molecular weight form through ring-opening polymerization using a stannous octoate catalyst, but for laboratory demonstrations tin(II) chloride is often employed.

Due to the chiral nature of lactic acid several distinct forms of polylactide exist: poly-L-lactide (PLLA) is the product resulting from polymerization of lactic acid in the L form. PLLA has a crystallinity around 37%, a glass transition temperature between 50-80° C and a melting temperature between 173-178° C. The polymerization of a mixture of both L and D forms of lactic acid leads to the synthesis of poly-DL-lactide (PDLLA) which is not crystalline but amorphous. Polylactic acid can be processed like most thermoplastics into fiber (for example using conventional melt-spinning processes) and film. PLA is currently used in a number of biomedical applications, such as sutures, dialysis media and drug delivery devices, but it is also evaluated as a material for tissue engineering. Being biodegradable it can also be employed in the preparation of bioplastic, useful for producing loose-fill packaging, compost bags, food packaging and disposable tableware. In form of fibers and non-woven textiles PLA also has many potential uses, for example as upholstery, disposable garments, awnings, feminine hygiene products and nappies.

PLA is particularly attractive as a sustainable alternative to petrochemical-derived products, since the lactate from which it is ultimately produced can be derived from the fermentation of agricultural by-products such as corn starch or other starch-rich substances like maize, sugar or wheat. PLA is more expensive than many petroleum-derived commodity plastics, but its price has been falling as more production comes online. The degree to which the price will fall, and the degree to which PLA will be able to compete with non-sustainable petroleum-derived polymers, is uncertain."

Despite the above stated advantages, PLA and other biodegradable polymers have only recently been produced for beverage containers. This is due to these polymers having different material properties to PET, and the various process issues in high volume manufacturing when the properties of the raw material are altered.

There is another issue which has restricted the use of PLA for rigid beverage containers. Specifically, 25 um PLA film has a moisture vapour transmission rate (MVTR) of around 325 g/m2.day, which compares to around 16 g/m2.day for PET. In practice, this means that a PLA bottle filled with a beverage will lose a greater amount of liquid over time than PET. Given enough time, i.e. the normal storage of filled containers for consumer products, the loss of liquid can lead to "panelling", i.e. uncontrolled distortion, of the bottles.

In this patent specification MVTR is measured at 38°C and 90% relative humidity using the methodology described in ASTM F1249. It is noted that the MVTR of a polymer of thickness differing from 25 um will need to be corrected to an equivalent MVTR for the same polymer at 25 um.

It is also noted, and will be understood by those skilled in the art, that the figure of 25um in this patent specification does not imply a container with this wall thickness. 25um is selected by persons in the art to specify intrinsic material properties, and the containers of the present invention, such as rigid bottles, will have wall thicknesses more typically around 300um.

The higher MVTR of a PLA bottle compared to a PET bottle is explained by the chemistry and molecular structure of the polymers. Although both are polyesters, PLA comprises proportionately more polar ester groups, compared to the non-polar chains between the ester groups, compared to PET. Further, the density of PLA is lower, and the free volume higher, than PET. Further, the crystallinity of PLA is typically lower then PET after the forming process.

Permeability of a polymer is the product of solubility and diffusion. Because of the more polar nature of PLA, solubility of water is higher than PET. Because the material has higher free volume, and lower crystallinity, diffusion rates are greater. Together, this dramatically increases intrinsic permeability.

The same technical issue of high MTVR applies to other more polar, lower density, lower crystallinity polymers than PET and is not confined to PLA.

A specific example of such a polymer is a biodegradable starch based polymer disclosed in International application PCT/AU99/01101 (publication no.WO0036006) in the name of Food and Packaging Centre Management Limited. In fact, many biodegradable or degradable polymers are likely to be more polar than more conventional packaging resins such as PET, as a degree of polarity is required for the polymer breakdown reactions during the degradation of the polymer, which will include reactions between the polymer chains and water molecules. For this reason many biodegradable or degradable polymers are likely to have a MVTR significantly greater than the MVTR of PET and other traditional, non-biodegradable packaging polymers.

The phenomenon of panelling is caused by the loss of liquid creating a partial vacuum in a bottle. This vacuum in turn leads to uncontrolled mechanical distortion of the bottle. This often manifests in a random region of the bottle flexing toward the vertical axis of the body of the bottle.

Panelling is also a recognised phenomenon in another type of polymeric rigid container. Hot filled bottles are also known in the art to be prone to panelling.

The term "hot filled" is understood herein to mean filling containers with liquid products at temperatures of at least 60°C, typically at least 80°C.

An important requirement for hot fill containers formed from polymeric materials, such as bottles containing liquid products such as non-carbonated "sports" drinks, fruit juices and water, is that the containers be able to accommodate volume contraction that occurs within the containers as the contents of the containers cool from a hot fill temperature to an ambient temperature. Such volume contraction causes vacuum conditions within the containers that can cause uncontrolled and undesirable distortion of the containers.

It is known to accommodate volume contraction by forming hot fill containers, such as bottles, with panels that can deform inwardly in response to vacuum conditions created as the contents of hot-filled containers cool from a hot fill temperature to an ambient temperature. Generally but not always, the panels are located in the body sections of the containers. To a lesser extent hot fill panels are also found in the base and shoulder of the bottle.

Examples of panels for hot fill bottles are found in Australian patent 720439 in the name of the applicant, Australian patent application 2004203314 in the name of ACI Operations Pty Ltd, and Australian patent 652052 in the name of Continental PET Technologies, Inc. Australian patent application 2001270286 in the name of the applicant protects the concept of a base of a bottle that is designed to flex inwardly to absorb vacuum contraction due to hot filling and subsequent cooling to an ambient temperature.

This above list of prior art for hot fill bottles is far from extensive. However, all of this prior art shares a common feature, namely that it is specifically aimed at hot fill applications. As far as the applicant is aware, the use of vacuum contraction panels for other applications has not been considered.

As far as the applicant is aware, all of the very limited number of commercially available PLA bottles have been produced without vacuum panels as they all have been used for cold fill applications (filling at less than 80°C) and cold filled bottles do not come with the added and unnecessary expense of vacuum panels.

The present invention is based on a realisation that the use of one or more than one panel that is responsive to vacuum conditions generated in PLA (and other high MTVR) bottles that are cold filled makes it possible to avoid altogether or at least substantially minimise panelling of the bottles.

In general terms, according to the present invention there is provided a rigid container, such as a bottle, for liquid products for cold fill applications made from a polymer with a MVTR of greater than 100 g/m2.day at a 25um wall thickness that includes one or more than one panel that is responsive to vacuum conditions generated in the container and can accommodate in a controlled way any vacuum contraction caused by the loss of liquid from the container when the container has been cold filled with a liquid product, such as a beverage, and closed.

The term "cold filled" is understood herein to mean filling containers with liquids at less than 80°C.

The reference to accommodating vacuum contraction in a "controlled way" is understood herein to mean that the contraction does not result in panelling, as discussed above.

Preferably the cold fill applications are applications in which the container is cold filled with liquid products at less than 60°C.

Most preferably, the cold fill applications are ones in which the container is cold filled with liquid product at a temperature no more than 10°C above ambient temperature at the time and geographical location where the product is filled.

The present invention applies to containers made from polymers with a MVTR of greater than 100 g/m2.day at a 25um wall thickness. The applicant has found that the present invention is particularly important for containers made from polymers with a MVTR of greater than 200 g/m2.day at a 25um wall thickness.

The polymer may be any polymer that is biodegradable in landfill or compost conditions and has a MVTR of greater than 100 g/m2.day at a 25um wall thickness.

Preferably the polymer is a polylactic acid based polymer.

The polymer may be a co-polymer of the polylactic acid based polymer and another polymer or polymers.

Preferably the polylactic acid based polymer is a major constituent, i.e. more than 50% by weight, of the co-polymer.

Other high MTVR polymers other than polylactic acid based polymers include the biodegradable polymer disclosed in International application PCT/AU99/01101 mentioned above.

Another type of high MTVR polymer, which is not biodegradable, is the family of polyamides (nylons).

The container may include one or more than one of the materials provided in the art as colorants, processing aids, light absorbers, property enhancers or other additives, to provide further desirable properties to the finished container

Examples of the vacuum panels include, by way of example only, vacuum panels in a body of the rigid container, vacuum panels in a base of the container, and vacuum panels in a shoulder of the rigid container.

The vacuum panel may be selected from the large range of vacuum panels that are used and are available for hot fill beverage containers, such as bottles, but which have not been previously used for cold fill applications for high MVTR polymer bottles.

Preferably the container includes a barrier layer or a coating that reduces the overall MTVR of the container.

According to the present invention there is provided the above-described container when cold filled with a liquid product, such as a beverage, and closed.

Preferably the rigid container is cold filled with the liquid product at a liquid temperature of less than 80°C

More preferably the rigid container is cold filled with the liquid product at a liquid temperature of less than 60°C.

More preferably the rigid container is cold filled with the liquid product at a temperature not more than 10°C above ambient as defined above.

Preferably the container includes a barrier layer or a coating that reduces the overall MTVR of the container.

An example of a cold fill rigid container in accordance with the present invention is shown in the accompanying drawings, of which:

Figure 1 is a perspective view of the cold fill rigid container in the form of a bottle; and

Figure 2 is a cross-section along the line 2-2 of Figure 1.

The bottle shown in Figures 1 and 2 is a bottle that is disclosed in Australian patent 720439 by the applicant. The Australian patent relates to bottles for hot fill applications and the bottle shown in Figures 1 and 2 is described in this context in the Australian patent.

The bottle shown in Figures 1 and 2 comprises an opening 1, a generally cylindrical body 2, a shoulder 3, and a base 4.

The body 2 comprises land areas 6 and 7 and vacuum contraction panels 11 defined by the land areas. The vacuum panels 11 are surrounded by an indentation 13.

The bottle shown in Figures 1 and 2 is made from polymers, such as PLA, that have considerably higher MVTRs, i.e. MVTRs greater than 100 g/m2.day at a 25um wall thickness, than known materials, such as PET, that are used for bottles for hot fill applications.

The bottle shown in Figures 1 and 2 is suitable for use in cold fill applications. In such applications, vacuum contraction as a consequence of making the bottle from higher MVTR polymers, such as PLA, is accommodated by the vacuum panels 11.

The vacuum panels 11 are formed to be movable inwardly and outwardly in response to pressure differences between the interior and the exterior of the bottle after the bottle has been filled and sealed with a liquid product, such as a beverage. Specifically, in use, after the bottle has been cold filled and closed, a vacuum starts to develop in the sealed bottle as liquid is lost from the bottle via transmission through the PLA wall of the bottle. Under such a vacuum, the vacuum panels 11 move inwards in a controlled way and hence the bottle is not subject to the above-mentioned panelling problem.

The present invention is based on experimental work carried out by the applicant.

Cylindrical wall bottles of 355mL nominal capacity traditionally manufactured from PET were manufactured from PLA. These bottles were filled with water and capped with closures suited to the bottle finish, the bottle finish being the Alcoa 1810 standard understood in the art.

The sample bottles were stored in a controlled environment of 23+/- 0.1°C and 50+/- 1% relative humidity for 2 weeks. Loss of moisture was measured by weight change. PLA bottles lost 1.5g per week of water, compared to less than 0.1g per week for PET bottles.

Samples were prepared to show the effect of loss of moisture over time as follows. Bottles were filled to brimful, then calculated weights of water were removed. For example, to show the effect of 10 weeks storage, 1.5X10=15 g of water was removed. Bottles were then squeezed until the water reached the top, and capped. Bottles filled in this way showed the panelling effect expected for cylindrical bottles.

The same effect has been observed in commercially filled PET water bottles. However, the necessary water loss occurs over time periods well in excess of normal product shelf life.

Many modifications may be made to the embodiment of the present invention described above without departing from the spirit and scope of the invention.

By way of example, whilst the embodiment of a PLA bottle with vacuum panels in the body 2 is an effective option, the present invention is not so limited and extends to bottles in which the vacuum contraction panels are located in another section or sections of the bottle.

By way of further example, whilst the embodiment of a PLA bottle with vacuum panels includes vacuum panels of a particular structure and number, the present invention is not so limited and extends to any suitable structure, number and arrangement of vacuum panels.

By way of further example, whilst the above description is in the context of a 25um wall thickness, the present invention is not confined top bottles or other forms of containers having this wall thickness.

CLAIMS

1. A rigid container for liquid products for cold fill applications made from a polymer with a moisture vapour transmission rate ("MVTR") of greater than 100 g/m2.day at a 25um wall thickness that includes one or more than one panel that is responsive to vacuum conditions generated in the container and can accommodate in a controlled way any vacuum contraction caused by the loss of liquid from the container when the container has been cold filled with a liquid product, such as a beverage, and closed.

2. The container defined in claim 1 wherein the cold fill applications are applications in which the container is cold filled with products at less than 60°C.

3. The container defined in claim 1 or claim 2 wherein the cold fill applications are applications in which the container is cold filled with liquid product at a temperature no more than 10°C above ambient temperature at the time and the geographical location where the product is filled.

4. The container defined in any one of the preceding claims wherein the polymer has a MVTR of greater than 200 g/m2.day at a 25um wall thickness.

5. The container defined in any one of the preceding claims wherein the polymer is biodegradable in landfill or compost conditions.

6. The container defined in any one of the preceding claims wherein the polymer is a polylactic acid based polymer.

7. The container defined in any one of the preceding

claims wherein the polymer is a co-polymer of the polylactic acid based polymer and another polymer or polymers.

8. The container defined in claim 7 wherein the polylactic acid based polymer is a major constituent, i.e. more than 50% by weight, of the co-polymer.

9. The container defined in any one of the preceding claims wherein the vacuum panel is in a body of the container.

10. The container defined in any one of the preceding claims when cold filled with a liquid product, such as a beverage, and closed.

11. The container defined in claim 10 when cold filled with the liquid product at a liquid temperature of less than 80°C.

12. The container defined in claim 11 when cold filled with the liquid product at a liquid temperature of less than 60°C.

13. The container defined in any of claims 10 to 12 when cold filled with the liquid product at a temperature no more than 10°C above ambient temperature at time and the geographical location where the product is filled.

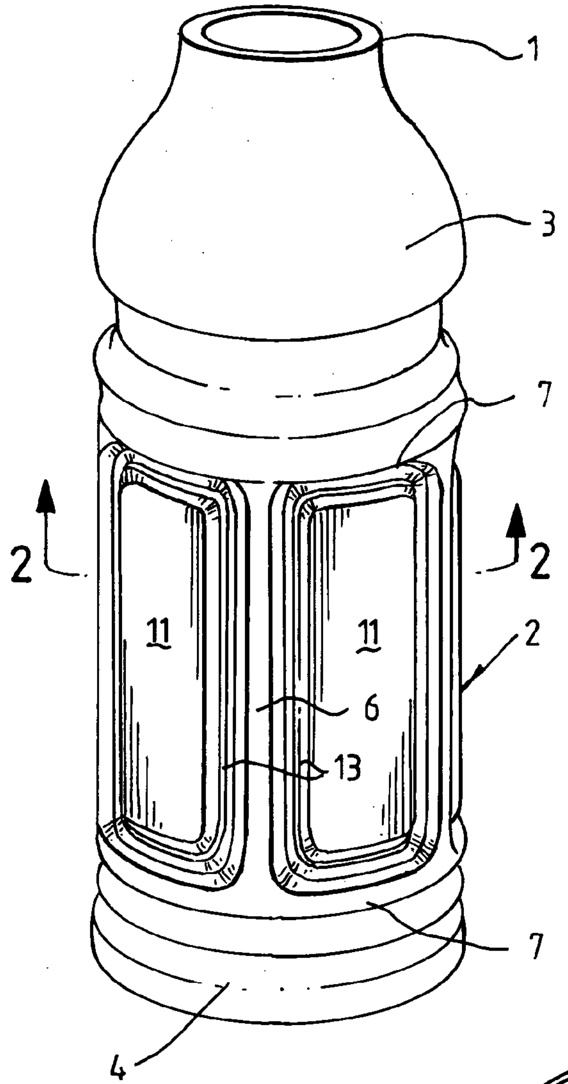


FIG. 1.

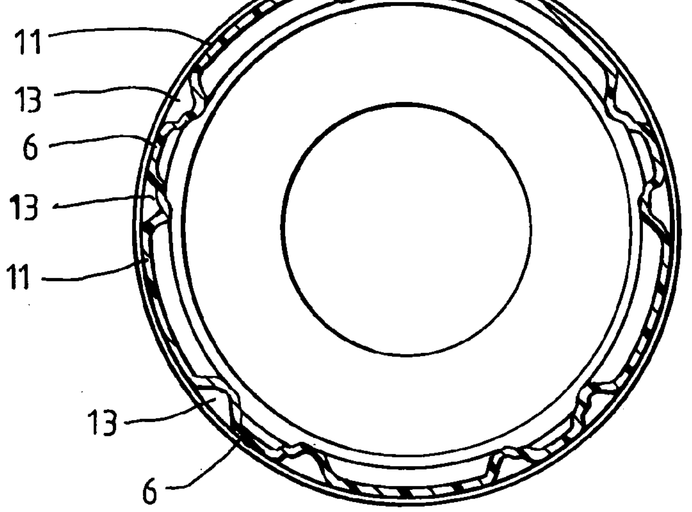


FIG. 2.

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2007/001157

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B65D 1/28 (2006.01) ***B65D 23/02*** (2006.01)
B65D 1/40 (2006.01) ***B65D 85/72*** (2006.01)

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)

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)
DWPI & IPC - B65D 01/-, B65D 23/-, B65D 85/-, B65D 81/-, B65D 65/46, B67C 3/-, B65B 3/- & Keywords (container, bottle, moisture, vapor, MVTR, vacuum, PLA, panel, cold, fill & similar terms)
Esp@ce & IPC B65D (container, vapor transmission)
USPTO (g/m2, MVTR, transmission, thick and similar words).

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6887385 B2 (TONKIN ET AL.) 3 May 2005 See whole document	1-13
Y	US 5853639 A (KAWAKAMI ET AL.) 29 December 1998 See whole document	1-13
Y	US 6001439 A (KAWAKAMI ET AL.) 14 December 1999 See whole document	1-13

[X] Further documents are listed in the continuation of Box C [X] 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 application or patent 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
13 September 2007	17 SEP 2007
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **Adrian Giacobetti** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 2579

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001157

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6159416 A (KAWAKAMI ET AL.) 12 December 2000 See whole document	1-13
Y	US 6905759 B2 (TOPOLKARAEV ET AL.) 14 June 2005 See whole document	1-13
Y	US 5303834 A (KRISHNAKUMAR ET AL.) 19 April 1994 See whole document	1-13
Y	US 4877141 A (HAYASHI ET AL.) 31 October 1989 See whole document	1-13
	<u>Note:</u> For the Y indications, documents one to seven can be combined together with relevance to claims 1-13.	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	6887385	AU	25775/99	CA	2319736	EP	1051354
		EP	1290930	EP	1291322	EP	1291588
		EP	1362833	EP	1614974	IL	137697
		KR	2006002194	US	6793824	US	7166224
		US	2002130078	US	2004099601	US	2004124145
		WO	9940031	ZA	9900933		
US	5853639	EP	0805175	JP	10060136		
US	6001439	EP	0806283	JP	10337772	US	6159416
US	6905759	AU	2002256087	GB	2391232	MX	PA03009612
		US	2003021973	WO	02085969		
US	5303834	AU	55121/94	CA	2115882	NZ	250854
		US	5178289	US	5279433		
US	4877141	AU	11913/88	EP	0279628	EP	0506065
		JP	63096022	JP	63203541	JP	63203542
		US	5064081				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX