



## Description

**[0001]** The invention relates to a pouring nozzle. Such pouring nozzle may be used for the transfer of a metal melt from one (upper) metallurgical vessel to a second (lower) metallurgical vessel, for example for the transfer of a steel melt from a ladle to a tundish.

**[0002]** Such pouring nozzles are made of at least one refractory material (to withstand the high melt temperatures) and comprise a tubular region, defining a first part of a pouring channel, and a plate like region with an orifice defining a second part of said (common) pouring channel. Said plate like region which usually is integral with said tubular region is arranged at one end of the tubular member. This leads to a T-like design of the total pouring nozzle.

**[0003]** Typically two of said pouring nozzles are arranged in the outflow area of a metallurgical melting vessel. One of said two nozzles being mostly arranged within the refractory lining of the vessel, e.g. within a well block. This so called inner nozzle is mounted with its tubular region at its upper end and the plate like region at its lower end.

**[0004]** By this instalment the plate like region may be used as one part of a sliding gate valve. For this purpose the plate like region has a flat surface at its free (lower) end, which flat surface running perpendicular to a longitudinal axis of the pouring channel, i. e. more or less horizontal in the mounted position of the pouring nozzle.

**[0005]** Correspondingly a second nozzle (often called outer nozzle or exchange nozzle) may be installed below said inner nozzle, e.g. mounted vice versa with its plate like part at its upper end and the tubular part at its lower end. This nozzle often may be moved after installation. Again the free surface of the plate like region should be flat so as it may be used as a sliding surface within a 2 or 3 plates sliding mechanism.

**[0006]** It is further known to encapsulate a least part of such a nozzle by a metallic envelope (metal casing). This casing stabilizes the nozzle and facilitates the exchange of the nozzle. The metallic can further provides the necessary geometrical accuracy for effective fit with a corresponding operational or exchange mechanism and mechanical support to the relatively brittle refractory ceramic nozzle components.

**[0007]** Due to a combination of thermo-mechanical forces established during preheat of the nozzle, exchange motion and/or cast operation stresses are created within the nozzle which may result in cracks through its wall, especially at the transition area where the plate and tubular portions meet.

**[0008]** The inventors have analyzed by computer simulation studies the origins of said crack formation. It was noted that for the lower (moving) element the highest stresses occur over the support mechanism for said nozzle and being greatest at the central transverse axis over the loading mechanism. In the classical "T" form of a pouring nozzle these support forces create a highly

stressed zone between the support surface and the pouring channel along which a crack may propagate from the exterior to the bore (pouring channel) of the tube section under the support flange (the plate like member).

**[0009]** It was further observed that under operating conditions differential expansion causes surface deflection. Whilst the surfaces of the pair of plates around the pouring channel remain in intimate contact with each other plate surfaces in the outer areas become separated as illustrated in figure 1.

**[0010]** It is an object of the invention to provide a pouring nozzle which may either be used as inner or outer nozzle which provides the necessary accuracy for effective fit within a corresponding holding or pushing mechanism while at the same time providing the necessary stability over the range of the temperatures encountered in assembly, preheat and operation.

**[0011]** It has been found by the inventors that the disadvantages of prior art devices may be overcome by the arrangement of at least one stiffening element within the refractory material of the plate like member or between said plate like member and the metallic envelope. A further alternative, which leads to similar results, is to make the stiffening element part of the metallic envelope such that the stiffening element then protrudes into the refractory material of said plate like member.

**[0012]** In its most general embodiment the invention relates to a pouring nozzle made of at least one refractory material and comprising a tubular member defining a first part of a pouring channel and a plate like member integral with said tubular member and projecting from the tubular member along its periphery at the one end, said plate like member having an orifice defining a second part of said pouring channel and a flat surface at its free end, which flat surface running perpendicular to a longitudinal axis of said pouring channel, at least part of the plate like member and/or of the tubular member being encapsulated by a metallic envelope, wherein at least one stiffening element is arranged within the refractory material of said plate like member, between said plate like member and the metallic envelope or protruding from said metallic envelope into the said plate like member.

**[0013]** The design configuration of the external encapsulation facilitates introduction of integral stiffening within the support can. The extra rigidity provided by such integral, internal stiffening elements introduces the potential to absorb the point loading forces from a corresponding support mechanism and distribute any such forces evenly across a wide area of the encapsulated refractory ceramic material and thereby onto the head and tubular regions of the nozzle.

**[0014]** Various design configurations of the integral stiffening elements are possible to provide maximum strength with minimum weight and maximum compatibility with the support mechanism of the nozzle change device.

**[0015]** According to one embodiment the pouring nozzle comprises two stiffening elements, arranged at op-

posite ends of said plate like member. Typically the plate like member is shaped as a parallelepiped, especially when used within a sliding gate arrangement. It then comprises two (of four) opposite support flanges against which the support mechanism acts.

**[0016]** The stiffening elements may have various shapes. They can be shaped as a rod, as a helical spring, as a bar or the like.

**[0017]** Along with pouring nozzles comprising a plate like member with a circular free surface area the plate like member may have the shape of a ring.

**[0018]** The stiffening element (reinforcement element) may be fully surrounded by refractory ceramic material (first alternative). It may also be arranged between the refractory ceramic material and the metallic envelope (alternative 2). In alternative 3 the reinforcement member is part of the metallic envelope and arranged like a flange along the inner wall of said envelope. All these three embodiments will be further disclosed by examples hereinafter.

**[0019]** The stiffening element may be arranged such that one of its surfaces forms part of the flat surface of the plate like member. It is then preferably arranged at the outer periphery of the flat surface of the plate like member. This minimizes the risk of any deflection in the outer peripheral region of the plate like member according to figure 1.

**[0020]** As principally disclosed in EP 1 133 373 B1 a shock absorbing interface zone may be arranged between the basic (inner) refractory material and the stiffening element(s) and/or the (outer) metallic envelope. Said shock absorbing interface zone may be made of a second refractory material which becomes deformable at temperatures experienced during use of said pouring nozzle in metal casting. For further details reference is made to EP 1 133 373 B1.

**[0021]** The inventive concept may be applied to pouring nozzles of a strong T-shape, i. e. nozzles comprising a plate like region the supporting surfaces of which running more or less parallel to the flat surface at their free end. The concept may as well be applied to nozzles according to figure 3 of EP 1 133 373 B1 (identical to nozzles according to EP 1 590 114 B1) comprising bearing surfaces (opposite the free flat surface) which bearing surfaces form an angle unequal 90° with the longitudinal axis of the pouring channel.

**[0022]** In the latter case part(s) of the stiffening element (s) form part of the chamfered surface sections (bearing surfaces).

**[0023]** The stiffening element(s) may be made of any material improving the manufacturing, use or exchange of a pouring nozzle for metal casting. One of the most favourite materials is metal but a ceramic of high modulus of rupture may be favourite as well.

**[0024]** Further features of the invention are disclosed in the sub claims and the other application documents.

**[0025]** The invention will now be described in more detail relating to the attached drawing, which schematically

shows:

Figure 1: A cross sectional view of a pouring nozzle according to prior art after use.

Figure 2: A cross sectional view of a pouring nozzle according to the invention (embodiment 2).

Figure 3: A cross sectional view of a pouring nozzle according to the invention (embodiment 3).

Figure 4: A cross sectional view of a pouring nozzle according to the invention (embodiment 1).

**[0026]** Figure 1 shows an inner nozzle 10 and an outer nozzle 12 of a generally T-shaped design with flanges of similar geometric design but both nozzles 10, 12 could as well be characterised by identical designs.

**[0027]** During use under operating conditions at elevated temperatures differential expansion causes surface deflection within said known nozzle. A contact between the respective flat surface sections 10s/12s is only maintained around a central pouring channel 14 while outer surface areas 12so separate and create unrestrained regions free to deflect under the pressure of closing forces (arrows C) creating a bending/tearing stress concentrated at the meeting point of the plate like part and the tubular element which may cause a crack "CS" from the exterior towards bore 14.

**[0028]** Nozzle 12 of figure 2 comprises a tubular region 12t defining a first part of pouring channel 14. Said tubular part 12t is made from a common refractory ceramic material and is integral with a plate like region 12p following upwardly. Said plate like region 12p is of larger cross sectional area than part 12t and comprises an inner part 12pi made of the same refractory material as tubular member 12t and two metallic parts 12pm running alongside two opposite sides of the inner part 12pi. While the inner surfaces of the metallic parts 12pm are touching the corresponding outer surface areas of the refractory part 12pi the outer surfaces of part 12m are in contact with an envelope 16, as described hereinafter.

**[0029]** Said plate like member 12p provides a flat upper surface 12s at its free end (opposite tubular part 12t) which surface 12s being defined by a combination of corresponding surfaces of the refractory part 12pi and said two metal reinforcement inserts 12pm, presenting stiffening elements. Following the outer (peripheral) design the said stiffening elements (metallic parts 12pm) are characterised by an upper vertical outer surface 12pmo, followed by an inclined surface portion 12pmi while the respective inner walls are running vertical from upper surface 12s to the respective lower ends.

**[0030]** A metallic can 16 encapsulates the plate like member 12p and the annexed area of tubular member 12t. The longitudinal axis of this nozzle 12 is marked as "L".

**[0031]** When nozzle 12 of figure 1 is replaced by one

incorporating the design shown in figure 2 with the integral stiffening members, the temperature conditions arising from service again generate a differential thermal deflection across the plate surface 12s. However the said stiffening elements 12pm bear the pressures from the closing mechanism and prevent them from establishing any bending stress moment across the refractory material of the nozzle 12.

**[0032]** Besides this important effect nozzle 12 according to figure 2 provides the further advantage that its chamfered bearing surfaces, provided by the can sections opposite surface sections 12pmi present increased mechanical stability because the stiffening elements 12pm are arranged directly behind this bearing surfaces.

**[0033]** A similar effect may be achieved by a pouring nozzle 12 according to figure 4 which differs from that of figure 2 just in the arrangement of said two stiffening elements 12pm.

**[0034]** Both stiffening elements 12pm are designed as rods (bars) and placed within the refractory ceramic material of plate like member 12p, i.e. they are fully surrounded by said refractory material.

**[0035]** The respective cross sectional area is adapted to the outer design of plate like member 12p. Especially said stiffening element 12pm provides inclined lower surface sections 12pmi running parallel to corresponding inclined bearing surfaces 16b of metal can 16.

**[0036]** Figure 3 represents a pouring nozzle 10 used as an inner nozzle according to inner nozzle 10 of figure 1.

**[0037]** Nozzle 10 again comprises a tubular part 10t followed (here: at its lower end) by a plate like part 10p. The transition area between tubular part 10t and plate like part 10p is marked as "T".

**[0038]** Figure 3 shows that tubular part 10t is - at its lower end - surrounded by a sleeve 18, made of a refractory material different to that of part 10t. This sleeve 18 continues around the plate like member 10p and in turn is encapsulated by an outer metallic envelope 16 which ends shortly before the free and flat surface area 10s at the lower end of nozzle 10.

**[0039]** A shock absorbing interface layer "S", made from a material which becomes deformable at the temperatures experienced during use of said pouring nozzle, may be introduced between the refractory pouring nozzle element 10p and the second surrounding refractory sleeve 18.

**[0040]** Following the shape of sleeve 18 can 16 is characterised by a cylindrical part at its upper end, followed by an inclined (outwardly extending) portion 16b and an outwardly extending horizontal part 16h followed by a final vertically running portion 16v.

**[0041]** That part of envelope 16 provided by horizontal part 16h and vertical portion 16v is mechanically reinforced by two stiffening elements 10pm, protruding from opposing inner wall of envelope 16. Both of said stiffening elements are designed as rods with a rectangular square section. They are replacing part of encapsulating material of sleeve 18.

**[0042]** The refractory material of tubular part 10t extends into the area of plate like member 10p and is characterised by an outwardly tapered portion 10pi providing the inner part of surface section 10s around the pouring channel 14.

**[0043]** The two metal bars 10pm again act as stiffening elements similar to stiffening elements in figures 2 and 4. According to the embodiment of figure 3 these stiffening elements 10pm are integral part of the outer metallic envelope 16.

**[0044]** The shape of the can and any adjacent stiffening means like 12pm or 10pm in any of the embodiments shown may have a profile suited to any specific mechanism configuration.

## Claims

1. Pouring nozzle made of at least one refractory material and comprising a tubular member (10t, 12t) defining a first part of a pouring channel (14) and a plate like member (10p, 12p), integral with said tubular member (10t, 12t) and projecting from the tubular member (10t, 12t) along its periphery at one end, said plate like member (10p, 12p) having an orifice defining a second part of said pouring channel (14) and a flat surface (10s, 12s) at its free end, which flat surface (10s, 12s) running perpendicular to a longitudinal axis (L) of said pouring channel (14), at least part of the plate like member (10p, 12p) and/or of the tubular member (10t, 12t) being encapsulated by a metallic envelope (16), wherein at least one stiffening element (10 pm, 12pm) is arranged between said plate like member (10p, 12p) and the metallic envelope (16) or part of said metallic envelope and arranged like a flange along the inner wall of said metallic envelope (16).
2. Pouring nozzle according to claim 1, comprising two stiffening elements (10pm, 12pm), arranged at opposite sides of said plate like member (10p, 12p).
3. Pouring nozzle according to claim 1, wherein the stiffening element has the shape of a rod.
4. Pouring nozzle according to claim 1, wherein the stiffening element has the shape of a helical spring.
5. Pouring nozzle according to claim 1, wherein the stiffening element has the shape of a ring.
6. Pouring nozzle according to claim 1, wherein the stiffening element (10pm) is part of the envelope (16), which stiffening element (10pm) protrudes from the inner wall of said envelope into said refractory material of said plate like member (10p).
7. Pouring nozzle according to claim 1, wherein the

stiffening element (12pm) is arranged such that one of its surfaces forms part of the flat surface (12s) of the plate like member (12p).

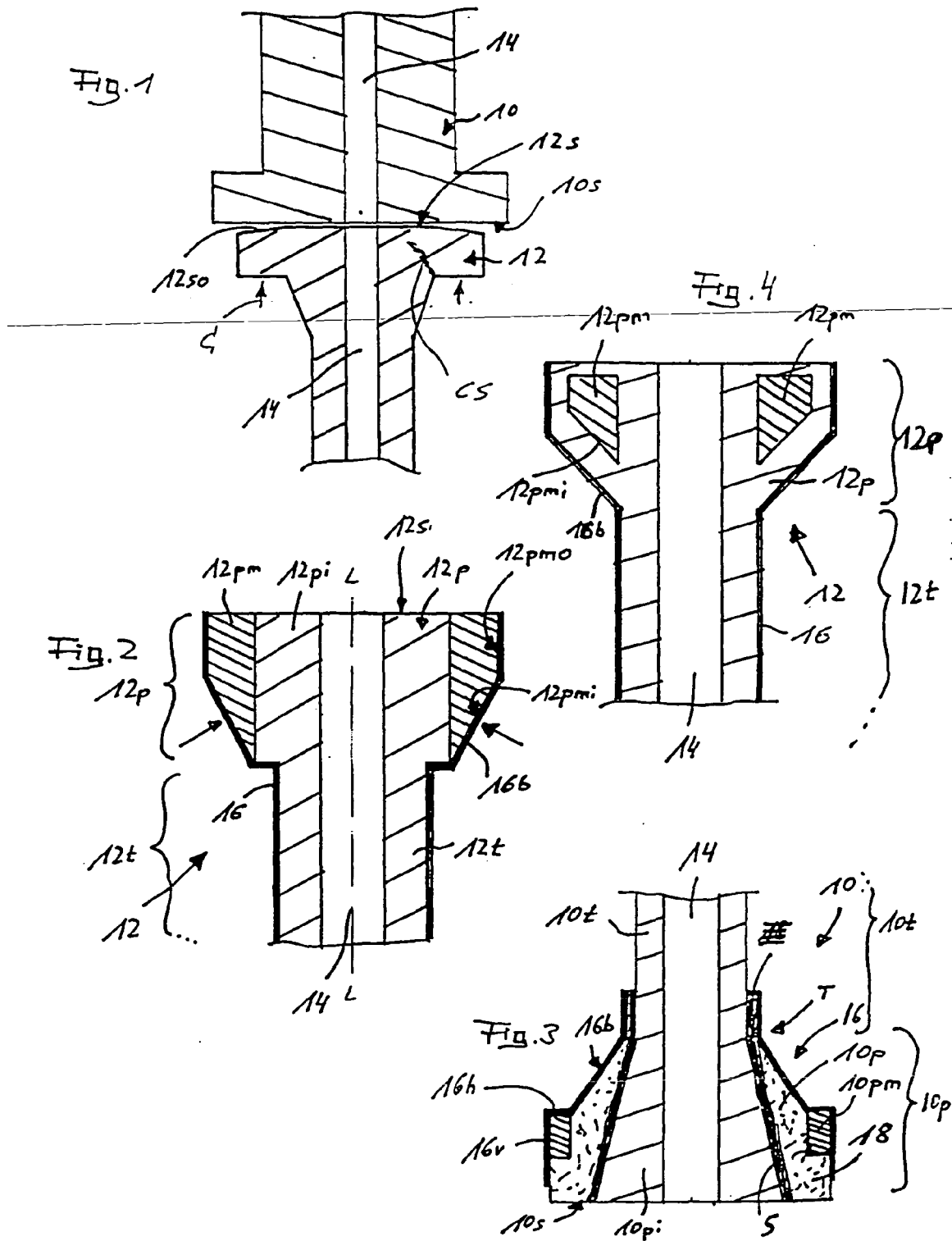
8. Pouring nozzle according to claim 7, wherein the stiffening element (12pm) is arranged at the outer periphery of the flat surface (12s) of the plate like member (12p). 5
9. Pouring nozzle according to claim 1, wherein chamfered surface sections of said plate like member opposite its flat surface form an angle  $\alpha$  between 20 and 85° with the longitudinal axis (L) of the pouring channel. 10
10. Pouring nozzle according to claim 9, wherein part(s) of the stiffening element(s) form part of the said chamfered surface sections (). 15
11. Pouring nozzle according to claim 1, comprising a second refractory zone (18) between the envelope (16), the stiffening element(s) (10pm) and the plate like member (10p). 20
12. Pouring nozzle according to claim 11, where a shock absorbing interface zone (S) is arranged between zone (18) and plate like member (10p) and made from a refractory material, which becomes deformable at temperatures experienced during use of said pouring nozzle. 25  
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13. Pouring nozzle according to claim 1, comprising at least one metallic stiffening element (10pm, 12pm).
14. Pouring nozzle according to claim 1, comprising at least one high density ceramic stiffening element (10pm, 12 pm). 35

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# EUROPEAN SEARCH REPORT

Application Number  
EP 06 01 4520

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | JP 62 124071 A (NIPPON STEEL CORP; TAIKO REFRACTORIES SHINNIPPON SEITETSU KK; TAIKO RE) 5 June 1987 (1987-06-05)<br>* abstract; figure 1 * | 1,2,4,6,11,13                    | INV.<br>B22D41/50                       |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 1 140 394 B1 (VESUVIUS CRUCIBLE CO [US]) 16 April 2003 (2003-04-16)<br>* claim 1 *                                                      | 1,6,13                           |                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | JP 11 104793 A (AKECHI CERAMICS KK) 20 April 1999 (1999-04-20)<br>* abstract; figures 1,3 *                                                | 1,3,5,13                         |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 1 149 649 A1 (AKECHI CERAMICS KK [JP]; TOKYO YOGYO KK [JP]) 31 October 2001 (2001-10-31)<br>* figures 2,3 *                             | 1-14                             |                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                            |                                  | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                            |                                  | B22D                                    |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                            | Date of completion of the search | Examiner                                |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                            | 5 December 2006                  | Baumgartner, Robin                      |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                            |                                  |                                         |

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EPO FORM 1503 03.82 (P04C01)

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

EP 06 01 4520

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  
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05-12-2006

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------------|
| JP 62124071                               | A  | 05-06-1987          | JP 1854663 C               | 07-07-1994          |
|                                           |    |                     | JP 5071347 B               | 07-10-1993          |
| -----                                     |    |                     |                            |                     |
| EP 1140394                                | B1 | 16-04-2003          | AT 237420 T                | 15-05-2003          |
|                                           |    |                     | AU 754513 B2               | 21-11-2002          |
|                                           |    |                     | AU 1368000 A               | 03-07-2000          |
|                                           |    |                     | BE 1013024 A3              | 07-08-2001          |
|                                           |    |                     | WO 0035614 A1              | 22-06-2000          |
|                                           |    |                     | CN 1330577 A               | 09-01-2002          |
|                                           |    |                     | DE 69907024 D1             | 22-05-2003          |
|                                           |    |                     | DE 69907024 T2             | 04-03-2004          |
|                                           |    |                     | EP 1140394 A1              | 10-10-2001          |
|                                           |    |                     | ES 2193787 T3              | 01-11-2003          |
|                                           |    |                     | JP 2002532252 T            | 02-10-2002          |
|                                           |    |                     | US 6533147 B1              | 18-03-2003          |
| -----                                     |    |                     |                            |                     |
| JP 11104793                               | A  | 20-04-1999          | NONE                       |                     |
| -----                                     |    |                     |                            |                     |
| EP 1149649                                | A1 | 31-10-2001          | AT 284767 T                | 15-01-2005          |
|                                           |    |                     | CA 2323348 A1              | 28-10-2001          |
|                                           |    |                     | DE 60016717 D1             | 20-01-2005          |
|                                           |    |                     | DE 60016717 T2             | 13-04-2006          |
|                                           |    |                     | JP 3506655 B2              | 15-03-2004          |
|                                           |    |                     | JP 2001314949 A            | 13-11-2001          |
|                                           |    |                     | US 2001035438 A1           | 01-11-2001          |
| -----                                     |    |                     |                            |                     |

**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 1133373 B1 [0020] [0020] [0021]
- EP 1590114 B1 [0021]