Title: IRRIGATION PIPE COMPRISING A MULTILAYERED PIPE WALL

Abstract: An irrigation pipe (12) with holes is provided. The pipe is, at least in the area of each hole, multilayered. At least top (152a) and bottom (152b) layers of the pipe (12) are made of a water-repellant material, and an inner layer (154) of the pipe (12) is made of a porous material. The hole is defined by a cut surface of the pipe wall. The cut surface comprises a seal, which covers at least the inner layer (154). Each layer (152a, 152b, 154) may be bonded to adjacent layers.
FIELD OF THE INVENTION

This invention relates to irrigation pipes, in particular to pipes for assembling branching irrigation networks.

BACKGROUND OF THE INVENTION

Modern irrigation typically employs large pipe networks, for example in drip irrigation systems or in flood systems. An irrigation network includes main water supply pipes and irrigation branches deployed and assembled on the field. The assembly of branches is made usually by specially designed lateral connectors and involves considerable labor costs but does not always prevent leakages.

For example, publications WO 02/066881 and JP08318177 disclose connectors for mounting lateral outlets of small diameter to the wall of a flexible,rollable and collapsible pipe of large diameter. These connectors comprise a tubular member with flaring end and external thread, and a matching nut. The pipe wall is punched in the field, in desired locations on its wall. The flaring end of the connector is then inserted in a wall opening which expands elastically and grips the connector above the flaring end. The connector is secured to the pipe by tightening the nut against the flaring end.

In this application, the term "rollable pipe" means a pipe that is flexible enough to be rolled in a reel for any purpose, e.g. packaging, transportation, storage, sale, etc. The term "collapsible pipe" means a pipe which tends to collapse when left empty, for example lay-flat pipe. A rollable pipe may be or may not be collapsible.
SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an irrigation pipe with holes. The pipe is, at least in the area of each hole, multilayered. At least top and bottom layers of the pipe are made of a water-repellant material, and an inner layer of the pipe is made of a porous material. The hole is defined by a cut surface of the pipe wall. The cut surface comprises a seal, which covers at least the inner layer. Each layer may be bonded to adjacent layers.

According to one embodiment, the pipe comprises a pipe connector having a circumferential notch around a sidewall thereof. The notch is formed so as to provide a tight fit of the portion of the irrigation pipe wall adjacent the hole within it. The pipe connector constitutes the seal. The pipe connector may be molded on the irrigation pipe.

According to another embodiment, the top and bottom layers are made from a meltalbe material. The hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal. The heated-punching may be carried out with a laser. The laser may have a power within the range of 10-200 W, a cutting speed within the range of 3-20 mm/s, a frequency within the range of 1-10 Hz. The hole may be formed by 1-30 cycles of the laser. Alternatively, the heated-punching may be carried by a hot-punch or an ultrasonic punch.

In accordance with another aspect of the present invention, there is provided a method for forming a hole in an irrigation pipe wall. The pipe wall is multilayered and having at least top and bottom layers made of a water-repellant material, and an inner layer being made of a porous material. The method comprises the steps of:

(a) forming the hole in the pipe Avail, the hole being defined by a cut surface of the pipe wall; and

(b) sealing said cut surface at least in the area of the inner layer.

Each layer is of the pipe wall may be bonded to adjacent layers.
According to one embodiment, the pipe comprises a pipe connector having a circumferential notch around a sidewall thereof. The notch is formed so as to provide a tight fit of the portion of the pipe wall adjacent the hole within it. The pipe connector constitutes the seal. The pipe connector may be molded on the pipe.

According to another embodiment, the top and bottom layers are made from a meltable material. The hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal. The heated-punching may be carried out with a laser. The laser may have a power within the range of 10-200 W, a cutting speed within the range of 3-20 mm/s, a frequency within the range of 1-10 Hz. The hole may be formed by 1-30 cycles of the laser. Alternatively, the heated-punching may be earned by a hot-punch or an ultrasonic punch.

**BRIEF DESCRIPTION OF THE DRAWINGS**

In order to understand the invention and to see how it may be carried out in practice, a number of embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

**Fig. 1** is a perspective view of an irrigation pipe of the present invention, with integral connector elements and branch connectors;

**Fig. 2** is an illustration of a collapsible irrigation pipe with integral connectors rolled on a reel;

**Fig. 3** is a sectional view of an internally fitted threaded connector element in an irrigation pipe, and a lateral branch connector;

**Fig. 4A** is a sectional view of an externally fitted threaded connector element;

**Fig. 4B** is a sectional view of a connector element fitting the irrigation pipe from both sides;

**Fig. 4C** is a sectional view of a threaded connector element with threaded enclosure;
Fig. 4D is a sectional view of a threaded connector element formed from the material of the irrigation pipe wall;

Fig. 5 is a sectional view of a connector element with external thread and a matching lateral connector with internal thread;

Fig. 6 is a sectional view of a connector element fitted to an irrigation pipe and adapted for assembly with a self-tapping lateral connector;

Fig. 7 is a sectional view of a connector element with tapering (cone) bore adapted for friction assembly with a matching tapered lateral connector;

Fig. 8 is a sectional view of an integral connector element and a lateral connector constituting a bayonet lock;

Fig. 9 is a sectional view of an internally fitted connector element initially closed by the pipe wall and a lateral connector with cutting teeth;

Fig. 10 is a sectional view of a connector element fitted between two layers of an irrigation pipe;

Fig. 11 is a sectional view of a connector element initially closed by an integral notched lid;

Fig. 12 is a sectional perspective view of an irrigation pipe of the present invention, with integral connector elements of a second type, prepared for boring;

Fig. 13 is a sectional perspective view of an integral connector element of the second type fitted in a longitudinal overlap seam of an irrigation pipe;

Fig. 14 is a perspective view of a spiral-welded irrigation pipe with a connector element of the second type fitted in a spiral seam;

Fig. 15 shows a production scheme of a reliable pipe with integral connectors;

Figs. 16A, 16B and 16C show a process of reliable pipe welding with protective tapes according to the invention;

Fig. 17 is a cross-sectional side view of a pipe wall;

Fig. 18 is a cross-sectional side view of the pipe wall illustrated in Fig. 17 at a location of cutting according to one embodiment of the present invention;
**Fig.** 19 is a cross-sectional side view of a connector according to one aspect of the present invention; and

**Fig.** 20 is a cross-sectional side view of a mold which may be used to produce the connector illustrated in Fig. 19.

**DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS**

With reference to Figs. 1, 2 and 3, an irrigation pipe 10 of the present invention comprises a pipe 12 and integral pipe connectors 14 fitted to the wall of the pipe during the manufacture. The pipe connectors 14 are adapted for assembly with lateral connectors 16 for branching pipes 18. The pipe 10 may be rolled on a reel 20, as in the example of a collapsible pipe (lay-flat pipe) shown in Fig. 2.

Figs. 3, 4A, 4B and 10 show integral connectors fitted in the following positions:

- adjacent to the internal surface of the pipe 12, connector 14 in Fig. 3;
- adjacent to the external surface of the pipe 12, connector 22 in Fig. 4A;
- embracing portions of the internal and the external surface of the pipe 12, connector 24 in Fig. 4B; and
- embedded in the wall of a pipe 28, between two layers 30 and 32 forming the pipe wall - connector 26 in Fig. 10.

As shown in Fig. 4D, an integral connector 36 may be formed from material of the pipe wall 38.

As seen in Figs. 3 to 8, the walls of the irrigation pipe 12 may be punched during the manufacture and left open, so that the pipe connectors are fitted open and ready for assembly with the lateral connectors. In this case, the pipe connectors 14, 22, 24, 36 may be provided with caps 40 for closing connectors that will not be used in the field. The caps preserve pipe's fluid tightness under operative pressure.

Alternatively, as shown in Figs. 9, 10 and 11, pipe connectors may have integral enclosures preserving pipe's fluid tightness under the operative pressure.
Such pipe connectors can be used for assembly after removal of the enclosure which may be material of the wall, of the connector, or both.

In particular, Figs. 9 and 10 show integral pipe connectors 42 and 26 respectively, closed by a portion 44 of the pipe wall 12. The portion 44 may be cut out before assembly by means of a suitable tool (see, for example, Fig. 12, where such tool is used with connectors of another kind). Alternatively, a lateral connector 46 may be formed with cutting teeth 48. In the latter case, the pipe connector 42 may need higher profile to accommodate safely the teeth 48 after the assembly.

Fig. 11 shows an integral pipe connector 50 made of a single piece of material with enclosure 52. The enclosure 52 may be made formed with means for facilitating its removal, for example, an annular notch 54 and a guiding recess 56 for supporting the tip of a rotary cutting tool.

Figs. 3 and 5 to 8 illustrate a few possible means for assembly of the integral pipe connectors to lateral connectors. Fig. 3 shows the pipe connector 14 with internal thread 58 and a lateral connector 16 with matching external thread 60. As shown in Fig. 5, a pipe connector 62 may be made with external thread 64 while a lateral connector 66 may have an internal thread 68. Fig. 6 shows a pipe connector 70 with smooth bore 72 made of relatively soft material while a lateral connector 74 is made with threaded nozzle 76 of relatively hard material such that the nozzle 76 can be self-tapped into the bore 72. Fig. 7 shows a pipe connector 78 with a tapered (conical) bore 80 and a matching lateral connector 82 with tapered nozzle 84. The angle of taper and the materials of the connectors are selected so as to provide reliable grip by friction after assembly. Fig. 8 shows an integral pipe connector 86 and a lateral connector 88 formed as matching parts of a bayonet lock with lugs 90 and L-shaped channels 92.

As illustrated in Fig. 17, the wall of the pipe 12 may comprises several layers. Top and bottom layers (which comprise, respectively, the exterior and interior surfaces of the pipe), indicated by 152a and 152b, are made from water-repellant materials. These may be polymers, such as PE, PP, PVC, and TPE,
elastomers, or copolymers. An inner layer 154 is provided, which is made from a porous material, such as a textile, woven on non-woven fabric, or bi-oriented or high-stiffness polymer. It will be appreciated that other layers may exist, and each layer may comprise sub-layers of similar or different materials.

In accordance with another aspect of the present invention, a hole is formed in the pipe illustrated in Fig. 17, such that the inner layer 154 is sealed. This is done to prevent water from being absorbed thereby. According to one embodiment, the material of the top and bottom layers 152a, 152b is meltable. The hole is formed by a heated-punching technique, such as hot-punching, ultrasonic-punching, or by use of a laser. By using one of these techniques, as seen in Fig. 18, some of the material of at least one of the top and bottom layers 152a, 152b will melt and cover the cut surface 156 of the pipe 12, at least in the area of the inner layer 154. The melted material sets, forming the seal 158.

When a laser is used, it should preferably have a power within the range of 10-200 W, a cutting speed within the range of 3-20 mm/s, and a frequency within the range of 1-10 Hz. Furthermore, 1-30 passes of the laser can be used to fully form the hole. Specifically, a hole as described above has been formed experimentally by using a laser having a power of 50 W, a speed of 10 mm/s, a frequency of 5 Hz, and using 2 passes of the laser.

According to another embodiment, the sealing is accomplished by using a connector 160 which seals the cut surface 156 of the pipe 12. Such a connector, illustrated in Fig. 19, comprises a circumferential notch 162 formed so that the pipe wall tightly fits within it. The connector itself, when the pipe wall adjacent the hole is fit therein, constitutes the seal. The connector may either be preformed and fitted with the pipe, or, as illustrated in Fig. 20, a mold, generally indicated at 164, may be used to form the connector 160 directly on the pipe.

In accordance with another aspect of the present invention illustrated in Figs. 12 to 14, an irrigation pipe 100 comprises a flexible pipe 102 and an extended connector element 104 which is integrally fitted to the pipe's wall during manufacture. The extended connector element 104 has sufficient size,
such that a plurality of bores 106 can be made and lateral connectors can be attached in desired locations after the manufacture. As seen in Fig. 13, a band 108 of suitable material can be fitted along the irrigation pipe 100 as a continuous integral pipe connector. Such band is especially suitable for fitting in an overlapping seam, for example in a spiral-welded pipe 110 as shown in Fig. 14, or in the straight-seam pipe 100 of Fig. 13.

The integral connector element 104 or 108 may be bored by a rotary tool, such as the tool 112 in Fig. 12, for assembly with a self-tapping lateral connector such as 74 in Fig. 6, or with a tapered lateral connector held by friction, such as 82 in Fig. 7.

With reference to Fig. 15, there is shown an exemplary production scheme of a rollable polymer pipe 10 with integral connectors 14, according to yet another aspect of the present invention. The production is performed on a conveyor line 111 including: feeding reel 113 for feeding raw strip material 114, strip accumulator 116, connectors fitting section 120, piping apparatus 121, puller 122, printing and monitoring station 124, pipe accumulator 126, and a receiving reel 20 for the pipe 10.

The connectors fitting section 120 includes connectors stock feeder 130, a drum magazine 132, a feeding plunger 134, a chute 136, welding equipment units 138, a pulling unit 140, and an optional punching device 142.

In the operation of the conveyor, the raw polymer sheet material is first cut into strips 114 of predetermined width, and is wound on feeding reels 113 (this process is done before the reel 113 is loaded to the line 111). The strip 114 is fed to the accumulator 116 and further to the connector fitting section 120.

In the connector fitting section 120, the connectors feeder 130 loads the drum magazine 132 with pipe connectors 14 arranging them in predetermined orientation. The drum magazine 132 rotates in steps, at predetermined intervals of time, and the feeding plunger 134 periodically pushes a connector 14 down the chute 136. The connector is directed to the welding units 138.
The raw strip 114 is also directed to the welding units 138, the connector 14 is positioned on the flat strip 114 and ultrasonic welding or RF (microwave) welding is performed. The strip 114 is pulled by the puller unit 140. The strip 114 may be optionally punched at the openings of the connectors in the punching device 142, before or after the welding, in dependence, for example, on the configuration of the connector.

The strip 114 with welded connectors 14 is then fed to the piping apparatus 121. There, the strip is bent (twisted) into a sleeve with juxtaposed edges or overlapping margins, and the edges or margins are welded by a watertight seam into a pipe with closed section. The connectors may remain either at the outer side of the pipe, or at the inside, as desired. The pipe 10 may be welded by the same method as the connectors, or by a different one.

The ready pipe 10 is pulled by the puller 122, checked and stamped in the printing and monitoring station 124 and, via the accumulator 126, is wound on the receiving reel 20.

With reference to Figs. 16A, 16B and 16C there is shown a process of rollable or collapsible pipe production with protective tapes, according to the present invention. Before feeding the polymer strip 114 (the same strip as above) into the piping apparatus 121, two narrow protective tapes 132 and 134 are welded to the margins of the strip (shown in cross section in Fig. 16A, welding zone 136 between either tape and the strip being exaggerated). In the piping apparatus 121, the strip is bent (twisted) into a sleeve with overlapping margins, as seen in Fig. 16B, and the sleeve is welded into a pipe (overlapping welding zone 140 also shown exaggerated). A tight seam 142 is formed, as shown in Fig. 16C, where cut edges 138 are tightly covered by the protective tapes 132 and 134.

The polymer strip 114 for making a pipe usually has layered structure, including polymer film or fabric and various laminating and coating layers. The function of the protective tapes is to prevent the irrigation water from penetrating
between these layers from the cut edge 138, and weakening the pipe. The protective tapes are preferably thin polymer tapes.

The welding of the tapes and the strip edges is done preferably by hot air, without using additional adhesives. It would be appreciated that the welding or bonding may be done by other known technologies like using adhesives, RF welding and others. As it is more important to protect the inner edge, the outer tape 132 may be omitted.

Although a description of specific embodiments and methods has been presented, it is contemplated that various changes could be made without deviating from the scope of the present invention. For example, the integral connectors may be arranged in two rows along the pipe, or may be fitted with tearable caps similar to ones in liquid bags. The fitting of the integral connectors may be performed by pressing, press-heating or other methods. The pipe may be punched before fitting the connectors, etc. The method of fitting to the strip before forming a closed pipe may be used for attaching other irrigation elements such as drip emitters or sprinklers (nozzles). The production scheme may include rolling of the strip with fitted irrigation elements into a reel on one production line (e.g. after the elements welding) as semi-finished product, and forming of the pipe in a piping apparatus on another production line.

Those skilled in the art to which this invention pertains will readily appreciate that numerous changes, variations and modifications can be made without departing from the scope of the invention mutatis mutandis.
CLAIMS:

1. An irrigation pipe with holes, the pipe being, at least in the area of each hole, multilayered, at least top and bottom layers thereof being made of a water-repellant material, and an inner layer thereof being made of a porous material, the hole being defined by a cut surface of the pipe wall, said cut surface of the pipe wall comprising a seal, covering at least the inner layer.

2. An irrigation pipe according to Claim 1, wherein each layer is bonded to adjacent layers.

3. An irrigation pipe according to Claim 1 or 2, comprising a pipe connector with a circumferential notch around a sidewall thereof, said notch being formed so as to provide a tight fit of the portion of the irrigation pipe wall adjacent the hole therein, the pipe connector constituting the seal.

4. An irrigation pipe according to Claim 3, wherein the pipe connector is molded on the irrigation pipe.

5. An irrigation pipe according to any one of Claims 1 to 4, said top and bottom layers being made from a meltable material, wherein the hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal.

6. An irrigation pipe according to Claim 5, wherein the heated-punching is carried out with a laser.

7. An irrigation pipe according to Claim 6, wherein the laser has a power within the range of 10-200 W, a cutting speed within the range of 3-20 mm/s, a frequency within the range of 1-10 Hz, and the hole is formed by 1-30 cycles of the laser.

8. An irrigation pipe according to any one of Claims 5 to 7, wherein the heated-punching is carried by a hot-punch or an ultrasonic punch.

9. A method for forming a hole in an irrigation pipe wall, the pipe wall being multilayered and having at least top and bottom layers being made of a
water-repellant material, and an inner layer thereof being made of a porous material, the method comprising the steps of:

(a) forming the hole in the pipe wall, the hole being defined by a cut surface of the pipe wall; and

(b) sealing said cut surface at least in the area of the inner layer.

10. A method according to Claim 9, wherein each layer is bonded to adjacent layers.

11. A method according to Claim 9 or 10, wherein the sealing is accomplished by providing a pipe connector with a circumferential notch around a sidewall thereof, said notch being formed so as to provide a tight fit of the portion of the pipe wall adjacent the hole therein, the pipe connector constituting the seal.

12. A method according to Claim 11, wherein the pipe connector is molded on the pipe.

13. A method according to any one of Claims 9 to 12, said top and bottom layers being made from a meltable material, wherein the hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal.

14. A method according to Claim 13, wherein the heated-punching is earned out with a laser.

15. A method according to Claim 14, wherein the laser has a power within the range of 10-200 W, a cutting speed within the range of 3-20 mm/s, a frequency within the range of 1-10 Hz, and the hole is formed by 1-30 cycles of the laser.

16. A method according to Claim 15, wherein the heated-punching is carried by a hot-punch or an ultrasonic punch.
AMENDED CLAIMS
[Received by the International Bureau on 29 January 2007 (29.01.2007)]

1. An irrigation pipe with holes, the pipe being, at least in the area of each hole, multilayered, at least one of top and bottom layers thereof being made of a water-repellant material, and an inner layer thereof being made of a porous material, the hole being defined by a cut surface of the pipe wall, said cut surface of the pipe wall comprising a seal, covering at least the inner layer.

2. An irrigation pipe according to Claim 1, wherein each layer is bonded to adjacent layers.

3. An irrigation pipe according to Claim 1 or 2, comprising a pipe connector with a circumferential notch around a sidewall thereof, said notch being formed so as to provide a tight fit of the portion of the irrigation pipe wall adjacent the hole therein, the pipe connector constituting the seal.

4. An irrigation pipe according to Claim 1 or 2, comprising a pipe connector with a bore formed therein along an axis, and a seat disposed adjacent the bore for seating the pipe wall; the seat comprising a lateral portion and an axial portion; the lateral portion having a first end proximal to the bore and a second end distal to the bore; the axial portion extending a predetermined length axially from the proximal end of the lateral portion; wherein the lateral portion engages a portion of the pipe wall adjacent said hole in the pipe and the axial portion extends into the hole and abuts the cut surface of the pipe.

5. An irrigation pipe according to Claim 4, wherein said cut surface of the pipe has an axial dimension and the predetermined length of the axial portion is at least substantially equal thereto.

6. An irrigation pipe according to any one of Claims 3 to 5, wherein the pipe connector is molded on the irrigation pipe.

7. An irrigation pipe according to any one of Claims 1 to 6, said top and bottom layers being made from a meltable material, wherein the hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal.

AMENDED SHEET (ARTICLE 19)
8. An irrigation pipe according to Claim 7, wherein the heated-punching is carried out with a laser.

9. An irrigation pipe according to Claim 8, wherein the laser has a power within the range of 0-200 W, a cutting speed within the range of 3-20 mm/s, a frequency within the range of 1-100 Hz, and the hole is formed by 1-30 cycles of the laser.

10. An irrigation pipe according to Claim 7, wherein the heated-punching is carried by a hot-punch or an ultrasonic punch.

11. A method for forming a hole in an irrigation pipe wall, the pipe wall being multilayered and having at least one of top and bottom layers being made of a water-repellant material, and an inner layer thereof being made of a porous material, the method comprising the steps of:
   (a) forming the hole in the pipe wall, the hole being defined by a cut surface of the pipe wall; and
   (b) sealing said cut surface at least in the area of the inner layer.

12. A method according to Claim 11, wherein each layer is bonded to adjacent layers,

13. A method according to Claim 11 or 12, wherein the sealing is accomplished by providing a pipe connector with a circumferential notch around a sidewall thereof, said notch being formed so as to provide a tight fit of the portion of the pipe wall adjacent the hole therein, the pipe connector constituting the seal.

14. A method according to Claim 11 or 12, wherein the pipe further comprises a pipe connector with a bore formed therein along an axis, and a seat disposed adjacent the bore for seating the pipe wall; the seat comprising a lateral portion and an axial portion; the lateral portion having a first end proximal to the bore and a second end distal to the bore; the axial portion extending a predetermined length axially from the proximal end of the lateral portion; wherein the lateral portion engages a portion of the pipe wall adjacent said hole.
ill the pipe and the axial portion extends into the hole and abuts the cut surface of the pipe.

15. A irrigation pipe according to Claim 14, wherein said cut surface of the pipe has an axial dimension and the predetermined length of the axial portion is at least substantially equal thereto.

16. A mellioid according to any one of Claims 13 to 15, wherein the pipe connector is molded on the pipe.

17. A method according to any one of Claims 11 to 16, said top and bottom layers being made from a meltable material, wherein the hole is formed by a heated-punching technique which results in some of the material of at least one of the top or bottom layers to form the seal.

18. A method according to Claim 17, wherein the heated-punching is carried out with a laser.

19. A method according to Claim 18, wherein the laser has a power within the range of 10-200 W, a cutting speed within the range of 3-20 m/s, a frequency within the range of 1-10 Hz, and the hole is formed by 1-30 cycles of the laser.

20. A method according to Claim 17, wherein the heated-punching is carried by a hot-punch or an ultrasonic punch.
INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2006/000992

A. CLASSIFICATION OF SUBJECT MATTER

INV. A01G25/02 B05B1/20

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)
AOIG B05B

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 2003/201345 A1 (JEONG IN SEON [KR]) 30 October 2003 (2003-10-30) paragraph [0052]; claims; figures</td>
<td>1, 9</td>
</tr>
<tr>
<td>A</td>
<td>WO 03/031164 A (KIM JIN-HO [KR]) 17 April 2003 (2003-04-17) the whole document</td>
<td>1, 9</td>
</tr>
</tbody>
</table>

D

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 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)

'C' document referring to an oral disclosure, use exhibition or other means

'S' 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: 21 November 2006


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: Thanbichler, Peter
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EP 1720401 A2</td>
<td>15-11-2006</td>
</tr>
<tr>
<td>US 2004046065 A1</td>
<td>11-03-2004</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 2003201345 A1</td>
<td>30-10-2003</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1471459 A</td>
<td>28-01-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2004521791 T</td>
<td>22-07-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 2003029177 A</td>
<td>14-04-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2004003857 A1</td>
<td>08-01-2004</td>
</tr>
</tbody>
</table>