



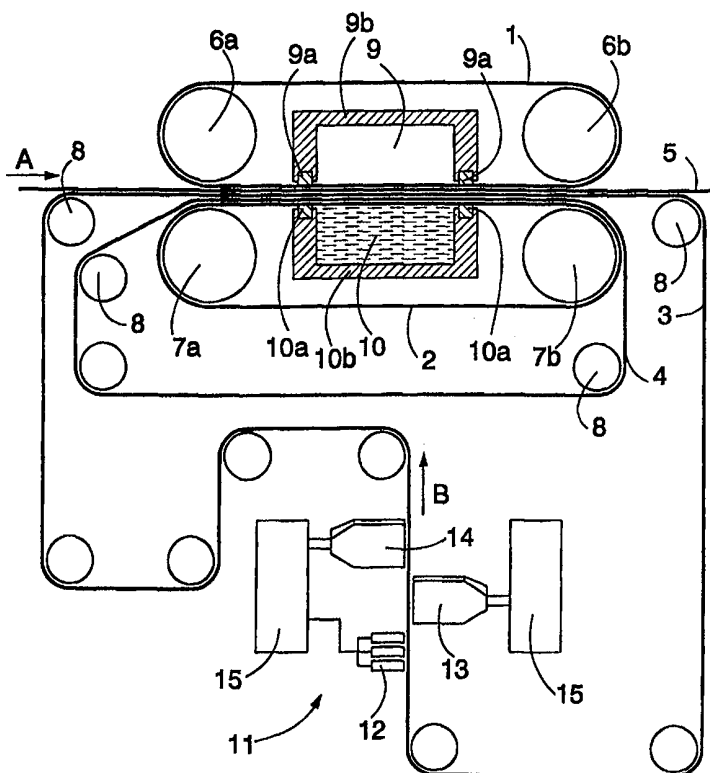
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(21) International Application Number: PCT/FI99/00251 (22) International Filing Date: 26 March 1999 (26.03.99) (30) Priority Data: 980726 31 March 1998 (31.03.98) FI (71) Applicant (for all designated States except US): VALMET CORPORATION [FI/FI]; Panuntie 6, FIN-00620 Helsinki (FI). (72) Inventors; and (75) Inventors/Applicants (for US only): ILOMÄKI, Jari [FI/FI]; Nivarinkatu 6 C 5, FIN-33610 Tampere (FI). MUSTONEN, Seppo [FI/FI]; Ahkionkuja 18 E 9, FIN-33580 Tampere (FI). OJALA, Timo [FI/FI]; Pitkäkallionkatu 16, FIN-33730 Tampere (FI). (74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).		(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published With international search report. With amended claims.

(54) Title: METHOD AND APPARATUS FOR DRYING A FIBER WEB

(57) Abstract

The invention relates to a method and apparatus of drying a fiber web (5) which is dried between two tight bands (1, 2) that move in parallel and turn around turning rolls (6a, 6b, 7a, 7b), the first band (1) being heated and the second band (2) being cooled, the fiber web (5) being arranged to run through the drying zone defined by the bands (1, 2) together with at least two felts or wires (3, 4) such that the fiber web (5) is in contact with the surface of the first band (1), a coarse wire (4) is in contact with the surface of the second, cooled band (2), and a fine wire (3) is between the fiber web (5) and the coarse wire (4). The fine wire (3) is cleaned with a cleaning device (11).



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METHOD AND APPARATUS FOR DRYING A FIBER WEB

The method relates to a method of drying a fiber web by an apparatus comprising two endless bands that are impermeable to air, first turning rolls around which the first band is arranged to turn, and second turning rolls around which the second band is arranged to turn; the first band and the second band being arranged to run part of the way in parallel such that they define between them a drying zone, the first band being heated and the second band being cooled, and the fiber web and at least two felts or wires, of which at least one is a coarse wire and at least one is a fine wire being arranged to run between the bands in such a manner that the fiber web is in contact with the first, heated band, the coarse wire is in contact with the second, cooled band, and the fine wire, correspondingly, is between the fiber web and the coarse wire.

The invention further relates to an apparatus for drying a fiber web, the apparatus comprising two endless bands that are impermeable to air, first turning rolls around which the first band is arranged to turn, and second turning rolls around which the second band is arranged to turn; the first band and the second band being arranged to run part of the way in parallel such that they define between them a drying zone, the first band being heated and the second band being cooled, and the fiber web and at least two felts or wires, of which at least one is a coarse wire and at least one is a fine wire being arranged to run between the bands in such a manner that the fiber web is in contact with the first, heated band, the coarse wire is in contact with the second, cooled band, and the fine wire, correspondingly, is between the fiber web and the coarse wire.

Many patent publications, such as WO 96/11300 ja US 4 461 095, teach the drying of a fiber web between two parallel metal bands moving in the same direction such that the fiber web is in contact the heated metal band and there is a wire between the fiber web and the second, cooled metal band, whereby steam separated from the fiber web by heating condenses to the wire by the effect of the cold metal band. The basic idea is that two endless metal bands are arranged to turn around turning rolls and that against the inner surface of the loops formed by the bands are provided pressure chambers containing hot steam and water, respectively, such that the pressure produced presses the hot and cold bands, respectively, against the fiber web and the

wire running between them. Together with seals, the bands located between the pressure chambers define one side of the pressure chambers, whereby the steam and the water can directly affect the bands. The operation of the apparatus is fully known per se and has been disclosed, for example, in the
5 above patent publications, which are incorporated herein by reference.

The basic idea of the operation of the drying apparatus is that because of the heat of the heated band, the water in the web is vaporized and transferred through the wire or wires towards the cooled band. The steam produced on the surface of the cooled band condenses into water and is removed
10 with the cooled band and the wire against it. US 5 594 997 teaches the removal of water from the wire against a cooled band by means of blow and/or suction boxes. In the drying apparatuses described above, the fiber web is guided to and from the apparatus by means of a fine wire. The fine wire is placed between the coarse wire located against the cooled band and the fiber
15 web, and the fine web further aims to prevent the wiremark on the surface of the web caused by the coarse wire. The small apertures of the wire against the fiber web are susceptible to being clogged, which causes the wire to adhere to the surface of the fiber web. This, again, renders the surface of the web uneven. In addition, clogged apertures prevent the water from passing
20 from the web to the coarse wire, resulting in a lowered drying efficiency of the web.

An object of the present invention is to provide a method and an apparatus which can avoid the above disadvantages.

The method of the invention is characterized by cleaning the fine
25 wire.

Further, the apparatus of the invention is characterized by comprising a cleaning device for cleaning the fine wire.

The essential idea of the invention is that a fine wire is arranged between the wire against the cooled band and the fiber web, and the fine wire
30 is cleaned. In a preferred embodiment, the cleaning is performed by spraying water onto the wire by a water nozzle. In another preferred embodiment, after the water nozzles, warm or hot air is blown through the wire from the opposite side to the water nozzles. In a third preferred embodiment, after the water nozzle, warm or hot air is blown through the wire also from the same side of
35 the water nozzle.

The advantage of the invention is that the small apertures of the

wire can be kept unclogged and the wire does not adhere to the surface of the wire. Further, as the apertures are unclogged, water from the web passes easily through the wire; in all, the surface of the web can be made even. The water nozzles allow the cleaning to be performed extremely efficiently; the air blowing allows harmful moisture to be discharged from the wire. The moisture would also show in the moisture profile of the web and in the characteristics of finished paper and board. By blowing air also from the opposite side of the wire to the water nozzles allows moisture from the wire to be removed extremely efficiently.

10 The invention will be described in closer detail with reference to the attached figure, which is a schematic, sectional side view of a drying apparatus of a fiber web in accordance with the invention, taken in the travel direction of the web.

15 The figure is a schematic sectional side view of an apparatus of the invention in the travel direction of the web. The apparatus comprises a drying device comprising a first band 1, i.e. an upper band, and a second band 2, i.e. a lower band, that are endless, impermeable to air, have good thermal conductivity, and are preferably made of metal. A fine wire or felt 3, a coarse wire 4 and a fiber web 5 pass between those surfaces of the bands that face each other. The fiber web 5 moves in the direction indicated by arrow A. The fiber web is a paper web or a board web, for instance. The first band 1 is arranged to turn around first turning rolls 6a and 6b located at the ends of the drying apparatus. Correspondingly, the second band 2 is arranged to turn around second turning rolls 7a, 7b located below the first turning rolls 6a and 6b likewise at the ends of the drying apparatus. Wires 3 and 4 are supported and guided by means of guide rolls 8. Since the pressure prevailing in the drying zone in the area between the bands 1 and 2 is usually different from the pressure prevailing outside or on the sides of the bands 1 and 2, seals are arranged on both sides of the apparatus between or at the edges of the bands 1 and 2, said seals preventing liquid or vapour from escaping from the space between the bands 1 and 2 through the sides, or vice versa. To effect the vapour heating required by the drying process, the drying apparatus comprises a pressure chamber 9, which is located above the first band 1. The first band 1 is sealed with seals 9a in respect of the body 9b of the pressure chamber 9 such that the steam in the pressure chamber 9 is maintained at a suitable pressure. Below the second band 2 there is a water chamber 10, which con-

tains a cooling medium, such as water, that cools the second band 2. At the edges of the water chamber 10 there are seals 10a, with which the second band 2 is sealed in respect of the body 10b of the water chamber 10.

The operation of the drying apparatus is based on heating the first
5 band 1, which comes into contact with the web 5, with hot steam contained in the pressure chamber 9, whereby the water in the web 5 is vaporized and transferred through the wires 3 and 4 toward the second band 2 by the effect of the temperature of the first band 1. The second band 2, in turn, is continuously cooled with the water located below it, whereby the steam produced on
10 the surface thereof condenses into water and is removed with the band 2 and the wire 4.

The fine wire 3 against the fiber web 5 is cleaned by a cleaning device 11. The cleaning device 11 comprises water nozzles 12 for spraying water from the side of the surface against the fiber web 5 of the fine wire 3 onto the
15 fine wire 3 and through it. After the water nozzles 12 in the travel direction of the fine wire 3, there is a first air nozzle 13 arranged on the opposite side of the fine wire 3 in the cleaning device 11. Warm or hot air is blown through the fine wire 3 at a high rate by means of the first air nozzle 13. Further, in the travel direction of the fine wire 3 after the first air nozzle 13, a second air nozzle 14 is arranged on the same side of the fine wire 3 with the water nozzle 12.
20 By means of the second air nozzle, warm or hot water is also blown through the fine wire 3 at a high rate. The first air nozzle 13 and the second air nozzle 14 can also be placed in an opposite order in the travel direction of the fine wire 3, but most preferably the order is as shown in the figure, whereby the
25 surface of the fine wire 3 against the fiber web 5 more readily remains sufficiently dry.

A plurality of water nozzles 12 and air nozzles 13 and 14 can be provided in the machine and/or cross direction of the fine wire 3. The water nozzles 12 and the air nozzles 13 and 14 can be arranged to traverse, or
30 move back and forth, in the cross direction of the fine wire 3. The nozzles are then, however, arranged with respect to each other such that they process the same point of the fine wire 3. For the sake of clarity, traversing means
35 moving the nozzles back and forth in the cross direction of the fine wire 3 is shown as greatly simplified in the attached figure; for the same reason, the feeding arrangements for feeding air and water to the nozzles are not shown here. The air nozzles 13 and 14 can, however, be so wide that they blow air

through the fine wire 3 along the entire width of the wire 3. The fine wire 3 moves also during the cleaning in the direction indicated by arrow B, in other words the fine wire 3 is being cleaned while it is moving.

5 The air nozzles 13 and 14 are most preferably arranged at an angle of approximately 45° with respect to the weft threads and warp threads of the fine wire 3. The air jets can thus be made to flow more efficiently through the apertures between the weft threads and warp threads in the wire.

10 The figure and the accompanying description are only intended to illustrate the idea of the invention. The details of the invention may vary within the scope of the claims. It is thus not essential what pressure medium is used in the pressure chamber 9 and the water chamber 10. The pressure medium in the pressure chamber 9 can thus be, for instance, steam, air, hot fuel combustion products or water. The cooling medium in the water chamber 10 can be, for instance, air as well as water.

15 In addition to the heating by the pressure chamber 9, the first band 1 can also be heated at other places in manners known per se. Further, the first band 1 can also be heated entirely outside the pressure chamber 9, or the fiber web 5 can be dried even without the pressure chamber 9.

20 Furthermore, the second band 2 can be also cooled outside the water chamber 10 or it can also be cooled even without the water chamber 10 in a manner fully known per se.

CLAIMS

1. A method of drying a fiber web (5) by an apparatus comprising two endless bands (1, 2) that are impermeable to air, first turning rolls (6a, 6b) around which the first band (1) is arranged to turn, and second turning rolls (7a, 7b) around which the second band (2) is arranged to turn; the first band (1) and the second band (2) being arranged to run part of the way in parallel such that they define between them a drying zone, the first band (1) being heated and the second band (2) being cooled, and the fiber web (5) and at least two felts or wires (3, 4), of which at least one is a coarse wire (4) and at least one is a fine wire (3) being arranged to run between the bands (1, 2) in such a manner that the fiber web (5) is in contact with the first, heated band (1), the coarse wire (4) is in contact with the second, cooled band (2), and the fine wire (3), correspondingly, is between the fiber web (5) and the coarse wire (4), **characterized** by cleaning the fine wire (3).
2. A method as claimed in claim 1, **characterized** in that the fine wire (3) is cleaned with water jets.
3. A method as claimed in claim 2, **characterized** in that after the fine wire (3) is cleaned with the water jet, the fine wire (3) is dried by blowing air through it.
4. A method as claimed in claim 3, **characterized** in that water is sprayed from the side of the fine wire (3) against the fiber web (5) and subsequently, the fine wire (3) is dried by blowing air from both the side of the fine wire (3) against the fiber web (5) and the opposite side of the fine wire (3).
5. A method as claimed in claim 4, **characterized** in that after the fine wire (3) is cleaned with the water jet, the fine wire (3) is dried by blowing air from the opposite side of the surface against the fiber web (5) and subsequently, from the side of the surface against the fiber web (5).
6. A method as claimed in any one of the preceding claims, **characterized** in that the fine wire (3) is cleaned with cleaning means being made to travel back and forth in the cross direction of the travel direction of the fine wire (3).
7. A method as claimed in any one of the preceding claims, **characterized** in that the first band (1) is heated by means of a pressure chamber (9) and the second band (2) is cooled by means of a chamber (10) comprising a pressurized medium.

8. An apparatus for drying a fiber web (5), the apparatus comprising two endless bands (1, 2) that are impermeable to air, first turning rolls (6a, 6b) around which the first band (1) is arranged to turn, and second turning rolls (7a, 7b) around which the second band (2) is arranged to turn; the first band (1) and the second band (2) being arranged to run part of the way in parallel such that they define between them a drying zone, the first band (1) being heated and the second band (2) being cooled, and the fiber web (5) and at least two felts or wires (3, 4), of which at least one is a coarse wire (4) and at least one is a fine wire (3) being arranged to run between the bands (1, 2) in such a manner that the fiber web (5) is in contact with the first, heated band (1), the coarse wire (4) is in contact with the second, cooled band (2), and the fine wire (3), correspondingly, is between the fiber web (5) and the coarse wire (4), **characterized** in that the apparatus comprises a cleaning device (11) for cleaning the fine wire (3).

9. An apparatus as claimed in claim 8, **characterized** in that the cleaning device (11) comprises at least one water nozzle (12) for spraying water onto the fine wire (3).

10. An apparatus as claimed in claim 9, **characterized** in that the cleaning device (11) comprises at least one air nozzle (13, 14) arranged after the water nozzle (12) in the travel direction of the fine wire (3) for blowing air through the fine wire (3).

11. An apparatus as claimed in claim 10, **characterized** in that the cleaning device (11) comprises at least two air nozzles (13, 14) arranged after the water nozzle (12) in the travel direction of the fine wire (3) and that the first air nozzle (13) and the second air nozzle (14) are arranged on the opposite sides of the fine wire (3).

12. An apparatus as claimed in claim 11, **characterized** in that the water nozzle (12) is arranged on the side of the fine wire (3) against the fiber web (5), after which the first air nozzle (13) is arranged on the opposite side of the fine wire (3), after which the second air nozzle (14) is arranged on the same side as the water nozzle (12).

13. An apparatus as claimed in any one of claims 10 to 12, **characterized** in that the air nozzle (13, 14) is arranged at an angle of approximately 45° with respect to the weft threads and the warp threads of the fine wire (3).

14. An apparatus as claimed in any one of claims 8 to 13, **characterized** in that the apparatus comprises traversing means (15) for moving the cleaning device back and forth in the cross direction of the travel direction of the fine wire (3).

- 5 15. An apparatus as claimed in any one of claims 8 to 14, **characterized** in that the apparatus comprises a pressure chamber (9) which is arranged to heat the first band (1), and a chamber (10) comprising a pressurized medium, the chamber (10) being arranged to cool the second band (2).

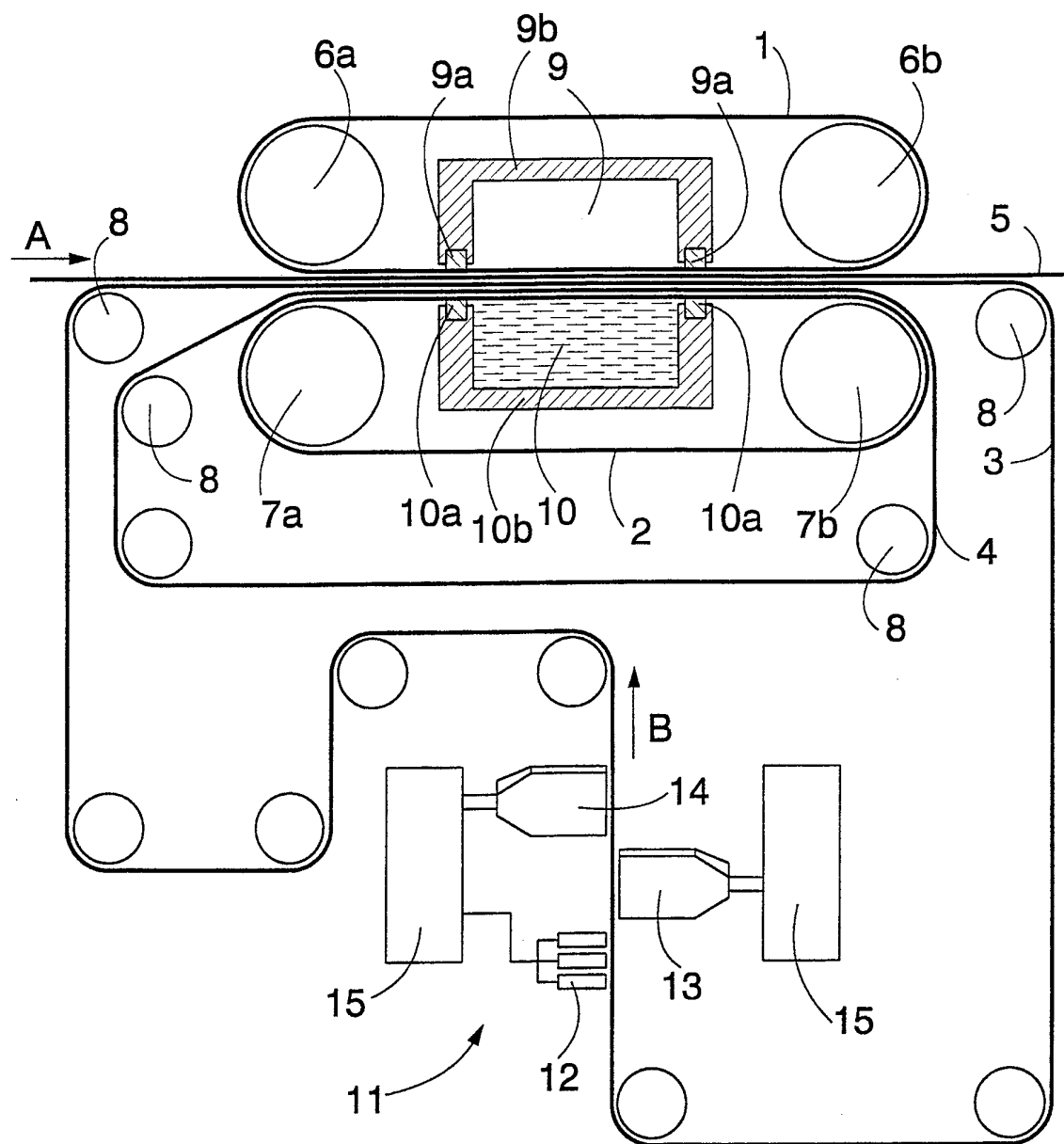


FIG.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00251

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21F 5/00, D21F 1/32

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)

IPC6: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9611300 A1 (VALMET CORPORATION), 18 April 1996 (18.04.96), figure 2, claims 1-3, abstract --	1-15
Y	WO 9701668 A1 (VALMET CORPORATION), 16 January 1997 (16.01.97), page 9, line 14 - line 22, figure 8, abstract --	1-5,7-13,15
Y	US 3910815 A (CLIFFORD D. SHELOR), 7 October 1975 (07.10.75), column 1, line 19 - line 25, figure 5, claims 1-4, abstract --	6,14
P,A	US 5822880 A (JARMO PUUMALAINEN), 20 October 1998 (20.10.98) --	1-15

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

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5517714 A (GERHARD KOTITSCHKE), 21 May 1996 (21.05.96) -- -----	1-15

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/07/99

International application No.

PCT/FI 99/00251

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9611300 A1	18/04/96	CA 2202381 A EP 0791104 A FI 96790 B,C FI 944775 D JP 10506962 T US 5778555 A	18/04/96 27/08/97 15/05/96 00/00/00 07/07/98 14/07/98
WO 9701668 A1	16/01/97	CA 2198253 A EP 0778911 A FI 102775 B FI 953226 A JP 10505391 T US 5863386 A	16/01/97 18/06/97 00/00/00 30/12/96 26/05/98 26/01/99
US 3910815 A	07/10/75	CA 1010695 A DE 2512922 A,C FR 2265910 A,B GB 1469047 A JP 1050660 C JP 50132206 A JP 55023959 B SE 407245 B,C SE 7503485 A	24/05/77 09/10/75 24/10/75 30/03/77 26/06/81 20/10/75 26/06/80 19/03/79 29/09/75
US 5822880 A	20/10/98	FI 99270 B,C FI 961638 D WO 9739186 A	14/11/97 00/00/00 23/10/97
US 5517714 A	21/05/96	CA 2130311 A DE 4327601 C FI 97981 B,C FI 943764 A JP 7173787 A	18/02/95 05/01/95 13/12/96 18/02/95 11/07/95