

(57) Abstract: A dewatering element (100) comprises a straight or curvilinear cover (110) coming against the fabric, which cover includes a leading edge (111) and a trailing edge (112) and between them a section with holes consisting of cross-machine directional strips (120) being at a distance from each other in the machine direction (S), between which strips there are openings (130). A width (A) of the strips (120) in the machine direction (S) is less than 10 mm, advantageously 2-8 mm, and a width (B) of the openings (130) between the strips (120) in the machine direction (S) is less than 10 mm, advantageously 3-8 mm.

Dewatering element in web-forming machine

FIELD OF INVENTION

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The invention relates to a dewatering element in a web-forming machine according to the preamble of claim 1.

10 In this specification, a web-forming machine comprises all such machines by means of which a web can be formed, such as paper, board, tissue, and pulp machines.

PRIOR ART

15 In the forming section of a web-forming machine, several types of dewatering elements are known, such as stationary forming shoes which include thorough holes and underpressure, strip-covered suction boxes, hitch rolls, suction rolls, and rolls provided with an open surface. These dewatering elements have been used in many compositions and arrays when trying to optimise the volume, time and
20 location of water being removed in the forming of the web.

Specification WO2004/018768 describes a twin-wire former. Forming wires travel each over their own breast rolls, after which the forming wires form a gap which starts the twin-wire section. The twin-wire section includes at least two
25 dewatering zones. The first dewatering zone consists of a curvilinear, non-pulsating forming shoe and the second dewatering zone consists of a pulsating strip cover. The non-pulsating forming shoe is located on the twin-wire section immediately after the closing point of the gap and the headbox feeds a pulp suspension jet in the gap, on the non-supported wire before the forming shoe.
30 Through the cover of the non-pulsating shoe have been bored holes which are at

an acute angle in relation to the wire travelling over the shoe cover. The open surface of the shoe cover is at least 50% of the surface of the whole cover.

Strip covers according to prior art induce pulsating dewatering in the web. The strips of the strip cover and the slots between the strips are relatively large in prior-art arrangements. Due to the width of the strips, the effect of underpressure prevailing below the strip cover is damped at the point of the strips. The wire travelling over the strip cover dips into the slots between the strips due to the underpressure prevailing under the cover, whereby the wire exits the trailing edge of the previous strip at an angle directed downwards and enters the leading edge of the following strip at an angle directed upwards. As a result of these phenomena, pressure pulses are applied to the stock travelling over the strip cover. The strips manufactured of ceramics have to have a specific width in order to endure the load caused by the fabrics and stocks travelling over the strips.

On the other hand, prior-art arrangements commonly employ stationary forming shoes when desiring non-pulsating dewatering. These stationary forming shoes include holes bored through the cover or machine-directional slots via which water is removed from the web travelling over the cover of the forming shoe. Underpressure arranged below the cover can further intensify the dewatering of the web. Arranging the holes obliquely in the cover such that the central axes of the holes form an acute angle in relation to the travel direction of the web can further intensify the flow of water from the web to the holes. The boring of oblique holes in the cover requires special tools and high expertise. Furthermore, boring the holes is a slow and expensive work phase.

SUMMARY OF INVENTION

The object of the arrangement according to the invention is to minimise disadvantages related to prior-art arrangements or to eliminate them totally.

The principal characteristics of a dewatering element in a web-forming machine according to the invention are presented in the characterising part of claim 1.

Other characteristics of the invention are presented in the dependent claims.

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The dewatering element in a web-forming machine according to the invention comprises a straight or curvilinear cover coming against the fabric i.e. the wire, which cover includes a leading edge and a trailing edge and between them a section with holes consisting of cross-machine directional strips being at a
10 distance from each other in the machine direction, between which strips there are openings. The machine-directional width of the strips is less than 10 mm, and the machine-directional width of the openings between the strips is less than 10 mm.

When the strips are narrow and the openings between the strips are narrow, the
15 wire travelling over the cover cannot dip into the slots between the strips. The wire is then supported densely and the change of angle experienced by the wire on the supply and delivery side of the strip is small. A narrow strip will not either cut the effect of underpressure at the point of the strip in the same way as a wide strip. Hence, uniform dewatering pressure is applied to the stock travelling over the
20 cover for the whole time. The dewatering element thus induces non-pulsating dewatering in the stock travelling over the cover of the dewatering element.

The narrow slot again limits the volume of water exiting via a single slot. This means that a smaller water volume being removed via a single narrow slot causes
25 fewer disturbances in the web than a larger water volume being removed via a wider slot.

The dewatering element according to the invention can be manufactured as a welded or machined e.g. steel structure. The strips of the dewatering element can
30 then be manufactured e.g. of flat steel bars which are fastened in support ribs by welding. Thus, the narrow strips are provided with required strength in order for

them to endure the load caused by the fabric and stock travelling over it. The surface of the strips of the dewatering element contacting the fabric is hard-covered to provide better durability and lower friction. Hence, the manufacture of the dewatering element according to the invention is relatively cost-effective.

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The dewatering element according to the invention can be used e.g. as a non-pulsating forming shoe on top of which the pulp suspension jet of the headbox is controlled. Such a non-pulsating forming shoe formed of a strip cover substantially decreases the take-off and beading (stock jump) of the pulp suspension jet, because the pulp suspension jet lands on the non-pulsating surface having a large open surface. The immediate start of dewatering directly at the impact point damps impact energy.

The non-pulsating forming shoe formed of the strip cover can remove water from a very wet web without breaking the structure of the web, because no peak of underpressure occurs on the delivery side of the stationary forming shoe. Underpressure connected to the forming shoe can provide very effective dewatering and adjusting the underpressure level can affect the dewatering distribution between the upper and lower web surface, whereby it is possible to control, inter alia, the fines distribution between the upper and lower web surface and the Z-directional symmetry of the web.

The great dewatering capacity of the non-pulsating forming shoe formed of the strip cover enables the fact that the headbox can employ consistency lower than normal and a slice opening larger than normal. The lower feeding consistency improves the formation of the web being formed.

The invention will now be described with reference to the figures of the accompanying drawings.

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BRIEF DESCRIPTION OF FIGURES

Fig. 1 shows a schematic view of a forming section in a web-forming machine which can employ a dewatering element according to the invention.

5 Fig. 2 shows a schematic cutaway diagram of a dewatering element according to the invention.

Fig. 3 shows a schematic cutaway diagram of another dewatering element according to the invention.

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Fig. 4 shows an enlargement of the tip part of one strip of the dewatering element.

Fig. 5 shows an enlargement of the strip structure of the dewatering element.

15 DESCRIPTION OF ADVANTAGEOUS EMBODIMENTS

Fig. 1 shows a schematic view of a forming section in a web-forming machine which can employ a dewatering element according to the invention. The forming section comprises a lower wire 11 which forms a fourdrinier-wire section after
20 having circled over a breast roll 12. On the fourdrinier-wire section, below the lower wire 11 there is a forming board 40 on top of which a headbox 30 feeds a pulp suspension jet. The forming board 40 is followed on the fourdrinier-wire section by a pulsating strip cover 50 provided with underpressure. The fourdrinier-wire section is followed by a twin-wire section where an upper wire
25 21 forms a gap G with the lower wire 11 after a guide roll 22. At the beginning of the twin-wire section, within the upper wire 21 there is a dewatering box 60 provided with underpressure. The dewatering box 60 consists of a non-pulsating dewatering shoe and of pulsating strip covers following it. The dewatering box 60 is followed on the twin-wire section by a pulsating strip cover 70 located below
30 the lower wire 11 and a transfer suction box 80.

The dewatering element according to the invention can be used in the forming section shown in Fig. 1 e.g. at the beginning of the forming board 40 or at the beginning of the dewatering box 60 where non-pulsating dewatering has to be applied to the web being formed.

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Fig. 2 shows a schematic cutaway diagram of a dewatering element according to the invention. The dewatering element 100 comprises a cover 110 coming against the wire which cover includes a leading edge 111 and a trailing edge 112. Between the leading edge 111 and the trailing edge 112, there is a section with
10 openings consisting of cross-machine directional strips 120 being at a distance from each other in the machine direction S, between which strips there are openings 130. A width A of the strips 120 in the machine direction S is less than 10 mm, advantageously 2 – 8 mm and a width B of the openings 130 between the strips 120 in the machine direction S is less than 10 mm, advantageously 3–8 mm.
15 The narrower strips and strip slots are used, the more uniform dewatering pressure is provided. A practical lower limit of the machine-directional width A, B of the strips 120 and the openings 130 can be considered the value of 2 mm.

The dewatering element 100 is advantageously connected to a source of
20 underpressure (not shown in the figure), whereby an underpressure effect P is applied via the openings 130 of the cover 110 of the dewatering element 100 to the web travelling over the cover. The dewatering element 100 induces non-pulsating dewatering in the pulp suspension supported by the fabric travelling over the cover 110. The dewatering element 100 can remove a lot of water from
25 the pulp suspension. In the embodiment shown in Fig. 2, the cover 110 of the dewatering element 100 is slightly curvilinear and the width A of the strips 120 in the machine direction S is smaller than the machine directional width B of the openings 130. The surfaces of the strips 120 of the cover 110 of the dewatering element 100 contacting the wire form a curvilinear travel direction for the wire.
30 Then, the upper surfaces of the strips 120 are at a very small angle in relation to

each other or the cover 110 has been machined curvilinear in the section between the leading edge 111 and the trailing edge 112.

5 The strips 120 are supported on the cover 110 with machine-directional ribs 140 located at a suitable distance from each other in the cross-machine direction. These ribs 140 are located at an adequate distance from the outer surface of the cover 110 such that water exiting the stock travelling on top of the cover 110 within the cover 110 does not spill back towards the stock.

10 Fig. 3 shows a schematic cutaway diagram of another dewatering element according to the invention. This embodiment is equivalent to the embodiment shown in Fig. 2 with the difference that the cover 110 of the dewatering element 100 is in this embodiment straight and the width A of the strips 120 in the machine direction S is approximately equal to the machine-directional width B of the openings 130. The surfaces of the strips 120 of the cover 110 of the
15 dewatering element 100 contacting the wire are on the same plane.

The open surface defined by the openings 130 of the cover 110 of the dewatering element 100 is advantageously 50–90% of the section with openings 130 between
20 the leading edge 111 and the trailing edge 112 of the cover 110.

The strips 120 of the cover 110 of the dewatering element 100 are located obliquely against the travel direction of the fabric travelling over the cover 110 i.e. against the machine direction S such that the strips 120 form an angle α of 30–60 degrees with
25 the machine direction S in the section. In the embodiment shown in Fig. 2, this angle α in question is greater than the one in the embodiment shown in Fig. 3. The angle α provides better dewatering due to a doctoring effect.

Fig. 4 shows an enlargement of the tip part of one strip of the dewatering element. A
30 rounding R of the leading edge of the strip 120 against the machine direction S is in the range of 0.5–0.01 mm. Due to the narrowness of the strips 120 and the openings

130, the fabric travelling over the cover is not able to dip within at the point of the openings 130. Therefore, it is possible to use a very sharp tip in the strips 120 against the incoming direction of the fabric without the sharp tip damaging the fabric travelling over the cover 110. The sharp leading edge in the strip 120 again has an effect on the fact that no water which would deviate the travel direction of the fabric can access between the strip 120 and the fabric travelling over the strip.

Fig. 5 shows an enlargement of the strip structure of the dewatering element. An average pressure level P1 induced at the point of the curvilinear dewatering element 100 is determined by equation (1):

$$P1 = \frac{T}{R1} \quad (1)$$

where: T = the tension of wires and R1 = the curvature of the upper surface of the dewatering element cover.

A pressure pulse P2 induced by the strips of the dewatering element is obtained by equation (2):

$$P2 = T * \sin(\beta) \quad (2)$$

where: T is the tension of wires and β is a refraction angle of the wire being formed on the strip.

The pressure pulse P1 formed at the point of the strip 120 is advantageously less than 10% of the average pressure level P. The pressure pulses P1 formed at the point of the strip 120 then remain so small that it can be called substantially non-pulsating dewatering. The radius of curvature R1 of the upper surface of the cover of the dewatering element 100 is advantageously in the range of 600–8,000 mm and the tension T of the wires is typically in the range of 5–10 kN/m.

In the embodiments shown in Figs. 2 and 3, the machine-directional width A of all strips 120 is the same. This is advantageous from the viewpoint of manufacturing techniques but not essential for the invention. The strips 120 can also have various widths e.g. such that at the beginning of the cover 110 there are wider strips 120 and at the end of the cover 110 there are narrower strips 120.

In the embodiments shown in Figs. 2 and 3, the machine-directional width B of all openings 130 between the strips 120 is the same. This is advantageous from the viewpoint of manufacturing techniques but not essential for the invention. The openings 130 between the strips 120 can also have various widths e.g. such that at the beginning of the cover 110 there are narrower openings 130 and at the end of the cover 110 there are wider openings 130. The width B of the openings 130 can also increase progressively from the beginning of the cover 110 to the end of the cover 110.

In the embodiments shown in Figs. 2 and 3, it is possible to divide the cover 110 into compartments with partition walls in the machine direction, whereby each compartment can employ different underpressure. At the beginning of the cover 110, it is possible to use lower underpressure and, at the end of the cover 110, it is possible to use higher underpressure.

The usage of the dewatering element 100 according to the invention is by no means limited to the forming section shown in Fig. 1 but, in principle, it can be used in connection with any forming section.

Above were described only some advantageous embodiments of the invention and it is evident to those skilled in the art that several modifications can be made to them within the scope of the enclosed claims.

CLAIMS

1. A dewatering element (100) in a web-forming machine, which comprises a straight or curvilinear cover (110) coming against the fabric, which cover includes a leading edge (111) and a trailing edge (112) and between them a section with holes consisting of cross-machine directional strips (120) being at a distance from each other in the machine direction (S), between which strips there are openings (130), **characterised** in that a width (A) of the strips (120) in the machine direction (S) is less than 10 mm, advantageously 2–8 mm, and that a width (B) of the openings (130) between the strips (120) in the machine direction (S) is less than 10 mm, advantageously 3–8 mm.
2. A dewatering element (100) according to claim 1, **characterised** in that the strips (120) are located at even intervals in the machine direction (S).
3. A dewatering element (100) according to claim 1 or 2, **characterised** in that the width (A) of the strips (120) in the machine direction (S) is equal to or smaller than the machine-directional width (B) of the openings (130) between the strips (120).
4. A dewatering element (100) according to claim 1, **characterised** in that the strips (120) are located in the machine direction (S) such that the width (B) of the openings (130) between the strips (120) in the machine direction (S) increases progressively in the machine direction (S).
5. A dewatering element (100) according to any one of claims 1–4, **characterised** in that the strips (120) are located obliquely against the machine direction (S) such that an angle (α) between each strip (120) and the machine direction (S) is in the range of 30–60 degrees.

6. A dewatering element (100) according to any one of claims 1–5, **characterised** in that a rounding (R) of the leading edge of the strip (120) against the machine direction (S) is in the range of 0.5–0.01 mm.

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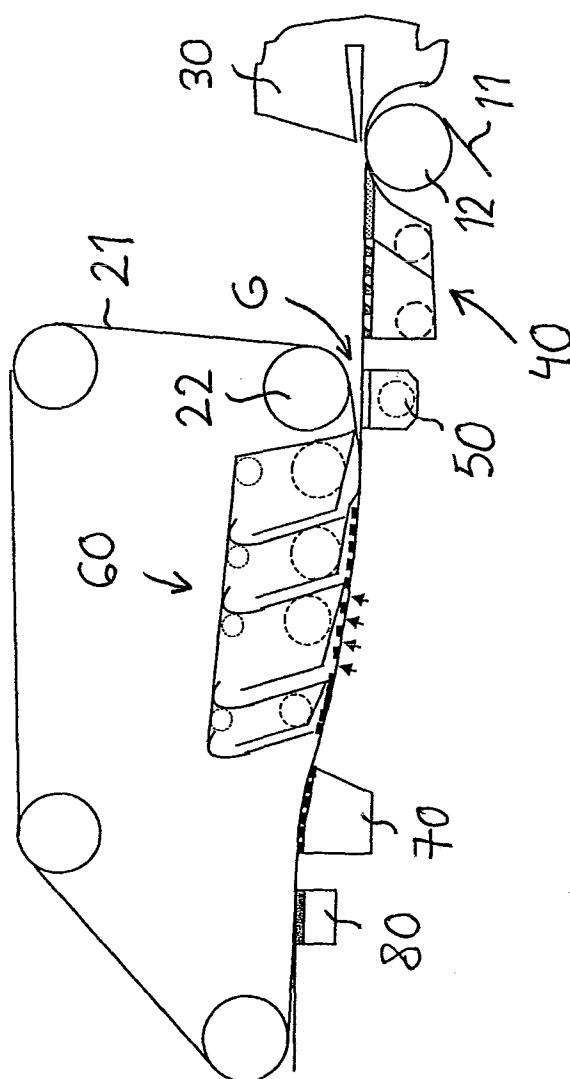


FIG. 1

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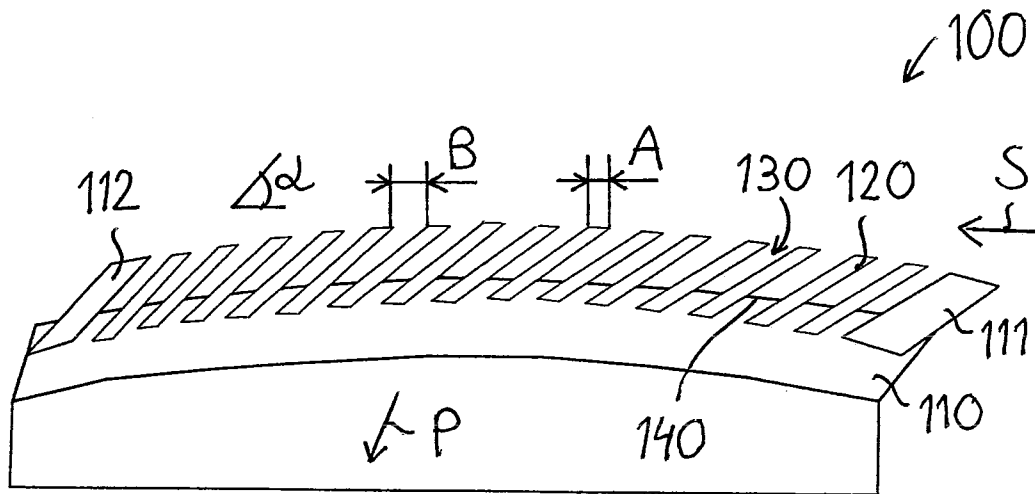


FIG. 2

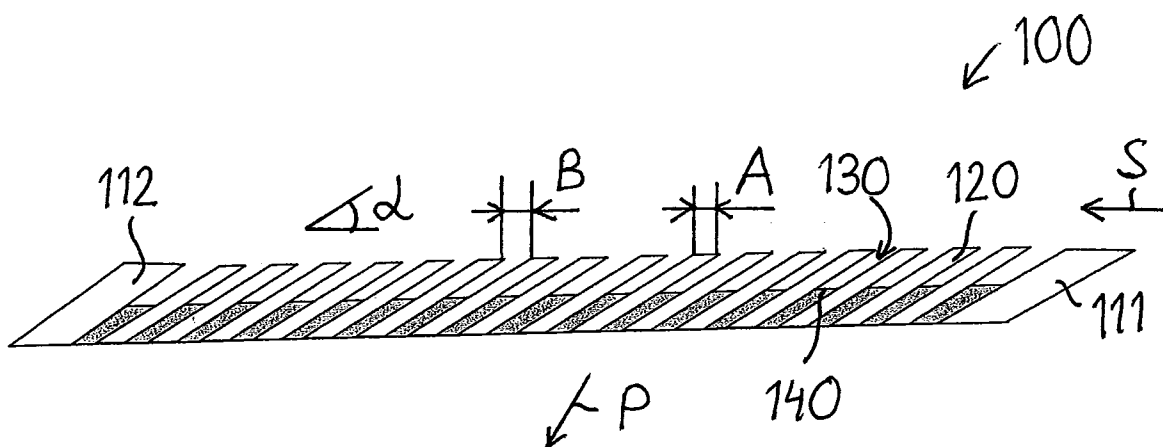


FIG. 3

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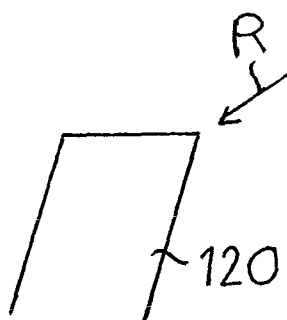


FIG. 4

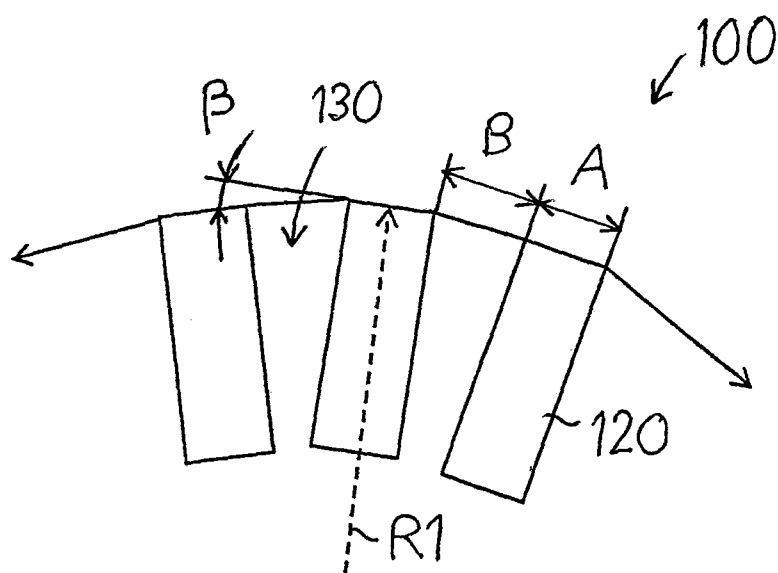


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2010/050174

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

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

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4140573 A (JOHNSON HENRY) 20 February 1979 (20.02.1979) figure 4; column 4, lines 23-54 and column 6, lines 4-14	1-6
A	GB 1382791 A (PULMAC RESEARCH LTD) 05 February 1975 (05.02.1975)	1-6
A	EP 0105636 B1 (BELOIT WALMSLEY LTD) 23 December 1987 (23.12.1987)	1-6



Further documents are listed in the continuation of Box C.



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

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2010/050174

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 4140573 A	20/02/1979	CA 1045432 A1 GB 1559277 A	02/01/1979 16/01/1980
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INTERNATIONAL SEARCH REPORT

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CLASSIFICATION OF SUBJECT MATTER

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D21F 9/02 (2006.01)