



(51) International Patent Classification:
D21G 1/02 (2006.01) *F16C 13/00* (2006.01)

(21) International Application Number:
PCT/FI2009/050290

(22) International Filing Date:
20 April 2009 (20.04.2009)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: AN INDICATOR FOR DETERMINING USABLE THICKNESS OF A COVER OF A PAPER MACHINE ROLL

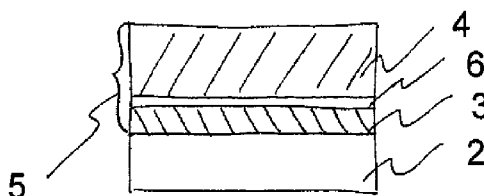


Fig. 2

(57) Abstract: The present invention relates to a cover of a roll of a paper, board, finishing or tissue machine, comprising a bottom layer comprising a polymer matrix and fibres, an intermediate layer comprising a polymer matrix and fibres and a functional layer comprising a polymer matrix and fibres. In a typical cover according to the invention, the intermediate layer further comprises material having a colour different from the colour of the bottom and functional layers.

AN INDICATOR FOR DETERMINING USABLE THICKNESS OF A COVER OF A PAPER MACHINE ROLL

FIELD AND BACKGROUND OF THE INVENTION

- 5 The present invention relates to a cover of a roll of a paper, board, finishing or tissue machine, comprising a bottom layer comprising a polymer matrix and fibres, an intermediate layer comprising a polymer matrix and fibres and a functional layer comprising a polymer matrix and fibres.

Paper, board, finishing and tissue machines use several different types of rolls, 10 such as press rolls, suction rolls and calender rolls. It is known that these rolls, which are typically made of metal, can be covered by polymers.

Typically, a calender is used for smoothing out and for increasing the gloss of the paper surface. A calender comprises typically a number of rolls, some of which may be covered by a soft polymeric cover. The role of the cover is important for 15 the process, as the paper web or the like is typically led to the calender unsupported, i.e. without the support of a fabric, to a nip formed between a calender roll, covered by a polymer, and a hard-faced counter roll. In such nip, the paper web is thus in direct contact with the roll surfaces.

As stated, calender rolls and other rolls have several effects on the paper web, i.e. 20 on the gloss and smoothness of the finished paper, and also on the paper bulk. The size of the calender rolls is typically 3-12 m in length and 600-1500 mm in diameter. The magnitude of linear loads in these rolls can be as high as 300-600 N/mm.

In general, there is a difference in stiffness between the polymeric cover and the 25 metallic roll body, which difference under loaded state causes shear stress on the metal-polymer interface. To minimise this stress, the polymer cover is manufactured of several layers of different stiffness properties. Typically the polymer cover is two-layered comprising a bottom layer on the metal body and a

functional layer on the bottom layer, the stiffness of the bottom layer being lower than that of the metal body but higher than the stiffness of the functional layer.

During the use of the rolls in a paper machine, the roll covers are subjected to wear. A typical thickness of a polymeric cover is 10-15 mm, including 6-8 mm of
5 cover that can be subjected to wear in the paper manufacturing process, this thickness corresponding to approximately 3/4 of the functional layer. Indeed, usually only the functional layer is designed to be worn in the paper manufacturing process, as the bottom layer is mainly designed to make the transition from the stiff metal body of the roll to the less stiff functional layer. Usually the functional
10 layer cannot be used completely, but the roll needs to be re-covered before.

Typically, the roll cover is ground e.g. at the paper factory for example after a period of 1-3 months and this grinding can usually be performed up to twenty times. The roll cover needs to be ground because it may wear unevenly and/or because problems during operation may cause dents, cracks or barring in the
15 cover that then result in quality problems in the manufactured paper web.

In order to be able to predict the need for re-covering of a roll cover, it would be advantageous to know when the functional layer of the cover reaches the thickness limit below which the cover is not renewable by grinding but has to be replaced by a new cover or by a new functional layer. At that point the functional
20 layer is lost to its minimum. In this application this thickness limit is called the usable thickness.

In the manufacturing of polymer covers for rolls for paper machines, especially for calenders, the fibres used are submitted to very hard conditions and therefore typically aramide fibres are used. Aramide fibres are however highly difficult or
25 even impossible to dye.

Document WO 2005/061787 presents a solution for detecting wear in paper machine fabrics. According to this document, the lower layers, i.e. the layers that are not surface layers of the fabric, are produced using coloured stable fibre batt material. These coloured layers are exposed when the fabric is worn and needs to
30 be replaced. Such product is however not known for polymer covers used in rolls.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to minimise or even totally eliminate the problems existing in the prior art.

An object of the invention is thus to provide a solution to the problem of easily
5 determining the usable thickness of a roll cover. An object of the invention is thus to provide a usable thickness indicator for polymer covers of rolls used in paper, board, finishing and tissue machines.

Another further object of the invention is to provide a roll of a paper machine, which roll comprises a cover whose usable thickness can be easily detected and
10 predicted. A yet further object is to provide a calender and a paper machine which can be used more efficiently than the prior art calenders and paper machines.

The present invention relates to a cover of a roll of a paper, board, finishing or tissue machine, comprising a bottom layer comprising a polymer matrix and fibres, an intermediate layer comprising a polymer matrix and fibres and a functional layer
15 comprising a polymer matrix and fibres. In a typical cover according to the invention, the intermediate layer further comprises material having a colour different from the colour of the bottom and functional layers.

DETAILED DESCRIPTION OF THE INVENTION

Now it has been surprisingly found out that dyeable fibres may be added and used
20 in the intermediate layer without decreasing its other properties, such as strength, at least in a detrimental manner. An advantage of the present invention is thus that it allows obtaining a usable thickness indicator for a roll cover without any major modifications to the cover manufacturing process and without having any effect on the use properties of the cover. With the aid of the present invention, the
25 manufacturing steps and costs associated with the covering of the roll are not significantly changed, but the usable thickness of the cover can be easily and visually observed during the cover grinding.

The rolls and the cover of rolls according to the present invention can be used in any kind of paper and board machines as well as off-line finishing machines such

as calenders and coating machines. Moreover, when paper web is mentioned in this text, it is clear that also webs of board, tissue and other webs comprising mainly cellulosic fibres are covered by this expression, which is only used for simplicity of wording.

- 5 According to an embodiment of the invention, the coloured material is in the form of fibres. In the following, the word fibre is used for sake of conciseness, but it is to be understood that any suitable material is covered by the following embodiments and variations.

10 According to one embodiment of the invention the fibres of the intermediate layer that have a colour different from the colour of the bottom and functional layers are preferably present in the intermediate layer in the amount of 1-50 % of the total amount of fibres of this layer, preferably 10-30 % of the total amount of fibres. The amount of these coloured fibres can be for example from 2, 5, 9, 10, 15, 18, 20, 25, 30, 34, 40 or 45 % of the total amount of fibres in this layer, up to 5, 9, 10, 15, 15 18, 20, 25, 30, 34, 40, 45 or 50 % of the total amount of fibres in this layer. The amount of fibres is preferably such that the intermediate layer is clearly distinguishable from the bottom layer and the functional layer but on the other hand also as small as possible so as not to alter the properties of the cover.

20 According to one embodiment of the invention the amount of coloured fibres in the intermediate layer may vary inside the intermediate layer. It is possible that the amount of coloured fibres is increasing towards the bottom layer, whereby the colour of the intermediate layer deepens towards the bottom layer thus facilitating the visualisation of how much the intermediate layer has been used. Typically the amount of the coloured fibres is practically constant through the whole layer.

25 According to an embodiment of the invention, the coloured fibres can be natural fibres, organic synthetic fibres or inorganic synthetic fibres, synthetic fibres being preferred. Suitable organic synthetic fibres include i.a. polyester, polyamide, acryl, viscose, polypropylene, polyimide, polyphenyl sulphide (PPS), melamine, polyphenylene benzobisoxazol (PBO) and polybenzimidazol (PBI) fibres. Some 30 suitable synthetic inorganic fibres are carbon, metal, ceramic or glass fibres. It is furthermore possible to use fibres having a coloured cover on a core.

The coloured fibres may thus be for example polyester fibres that can be easily dyed to the colour required. The intermediate layer may be for example manufactured of a non-woven felt comprising aramide fibres and polyester fibres, either dyed beforehand or as part of the non-woven felt. It is also possible to print
5 figures or text to such a nonwoven felt. Thus it is possible to print indicator figures, symbols or text to a certain part of the roll surface. When this indicator becomes visible as a result of grinding the operator knows at which level of the roll cover he is operating. Thus it is not necessary to dye all the dyeable fibres of the intermediate layer, but a part of them may be used as printing base for indicator
10 symbols.

It is clear to a person skilled in the art that also woven fabrics and other suitable material may be used in this intermediate layer, as long as it comprises material that is either of another colour than the fibres of the bottom layer and functional layer or that may be dyed to another colour. It is also clear that any other dyeable
15 fibre than polyester can be used, such as those mentioned above.

In addition to coloured fibres, it is possible to use a felt or mat comprising filler particles that have a colour different from the colour(s) of the other components of the cover. Coloured filler particles can also be added to the cover by dispersing them on the desired layer. Also a coloured binder can be used in a non-woven felt,
20 thus leading to the desired colour difference. A yet further alternative is to use a coloured plastic film at a suitable place between the bottom layer and the functional layer.

According to yet a further embodiment, the cover comprises a second intermediate layer arranged between the functional layer and a first intermediate layer, said
25 second intermediate layer comprising a polymer matrix and at least two types of fibres, of which at least one type is coloured fibres having a colour different from the colour of the fibres of the bottom, first intermediate and functional layers.

The cover according to the present invention may also comprise more than two intermediate layers each comprising fibres of different colours, so as to give a
30 gradual view of the wear of the cover. It is also possible that one intermediate

layer comprises first fibres having a first colour and second fibres having a second colour.

Use of a non-woven felt comprising aramide fibres and a small amount of coloured or naturally different coloured fibres, such as polyester fibres, does not require any significant modifications to the cover manufacturing process. Moreover, the effect to the performance of the so obtained roll cover is minimal. It is possible that the properties of this intermediate layer might be different from those of the functional layer, but it is believed that by careful selection of the fibres employed the difference is small enough not to have any major negative effect on the performance of the finished cover. It is therefore possible to use the cover even once the intermediate layer is reached after several grinding operations, although it would be preferable to re-cover the roll at this stage or after the following use period.

An advantage of the invention is thus that the cover can be used for a certain time even after the wear indicator is visible, i.e. after the intermediate layer is visible. This allows the user to foresee and plan the changes of the rolls, as it can be easily predicted when a roll needs to be re-covered.

It is believed that the intermediate layer needs to have a minimum thickness, such as for example a thickness of 0.2 mm. It is however also clear that it would be difficult to make an intermediate layer that does not have this required minimum thickness, due to the manufacturing process of the cover.

The fibre material in the invention may comprise inorganic, organic, natural and synthetic fibres. Inorganic fibres applicable in the invention are for example glass or boron fibres. Organic fibres applicable in the invention are for example polyacrylonitriles, polyamides, aromatic polyamides and carbon fibre. Type of the fibre can be woven, non-woven or roving fibre. Preferred types of fibres for the functional layer are para-aramide fibres, such as Kevlar® by DuPont and Twaron® by Teijin.

The bottom layer typically comprises glass fibres and/or para-aramide fibres, as well as carbon fibres. Suitable matrix materials for all the layers are epoxides and other plastic materials, preferably thermoset plastics.

5 The cover of the present invention may contain fillers. With the fillers properties of the cover can be improved or its cost can be cut. Typically, fillers are used to improve wear resistance and to adjust matrix stiffness and hardness. Fillers applicable in the invention are inorganic fillers, such as metal, ceramic and mineral fillers, for example aluminium oxide, silicon oxide, carbides, nitrides, glass, silicates and mica in many different particle forms like powder, balls, pearls, fibres
10 etc., and synthetic organic fillers, such as synthetic polymers for example UHMWPE, synthetic fibres such as short fibres, chopped fibres, powdered fibres, aliphatic or aromatic polyamide as an example. Fillers are generally applied to the composition as a mixture with the matrix material and they can be used in each layer of the cover.

15 The cover of the invention may also contain other additives and process aid agents such as polymerization initiators, activators and accelerators, plasticizers, thermal stabilisers, antioxidants, antiozonates, pigments, air release agents, filler wetting and dispersing agents, levelling agents, defoaming agents dispersion stabilisers etc. for promoting the process and improving physical properties of the
20 cover. These agents are mixed with the matrix before bringing into contact with the fibre material.

One aspect of the present invention also relates to a roll for a paper, board, finishing or tissue machine having a cover according to the present invention, i.e. to a roll comprising a roll body and a cover arranged on said roll body, said cover
25 comprising

- a bottom layer comprising a polymer matrix and fibres,
- an intermediate layer comprising a polymer matrix and fibres and
- a functional layer comprising a polymer matrix and fibres,

and wherein the intermediate layer further comprises coloured material having a
30 colour different from the colour of the bottom and functional layers.

A typical roll for a paper, board, finishing or tissue machine comprises a cylindrical roll body. The roll body is typically made of metal, such as cast iron or hardened steel.

The present invention also relates to a calender for a paper, board or finishing machine comprising a roll according to the present invention. Typical multiplex
5 calenders comprise a number of rolls, arranged on top of each other. All or some of the calender rolls may comprise a cover according to the present invention. Especially the first and/or the last roll of a multiplex calender may have a cover according to the present invention. The invention also relates to a machine for
10 manufacturing or treating a cellulosic web comprising at least one roll according to the present invention. Possible machines for manufacturing or treating a cellulosic web are, for example, paper machines, board machines, tissue machines, on-line calenders, off-line calenders, etc.

The invention also relates to a method for manufacturing a cover for a roll of a paper, board, finishing or tissue machine, comprising the steps of
15 - providing a bottom layer comprising a polymer matrix and fibres on a roll body,
- providing an intermediate layer comprising a polymer matrix and fibres on said bottom layer, and
20 - providing a functional layer comprising a polymer matrix and fibres on said intermediate layer.

A typical method also comprises the step of providing the intermediate layer with coloured material having a colour different from the colour of the bottom and functional layers.

25 In the method according to the invention the cover layers of the roll are formed sequentially from the inside to the out, and directly on the roll body, which may also comprise an adhesive layer. The layers can be manufactured, for example, by coiling, casting, filament winding or extrusion.

The invention yet further relates to a use of dyeable fibres in the manufacture of a
30 cover of a roll of a paper, board, finishing or tissue machine.

The grinding operation may be controlled visually by the operator, or different kinds of sensors or cameras for detecting colour and/or its strength may be employed. Used sensor or detector may be connected to an automated circuit comprising an electronic memory. To this memory a predetermined value
5 representing target colour or colour strength is stored. When during the grinding process the predetermined value is detected by the sensor or detector the grinding is stopped automatically, or preferably the operator is alarmed.

All the embodiments and characteristics disclosed in this specification apply to all the different aspects of the invention, i.e. the embodiments listed for the cover
10 apply *mutatis mutandis* to the roll, calender, paper machine, use and methods.

In this context, the term “comprising” is to be construed as an open term, i.e. that other features may be included in addition to those listed. Moreover, the reference numbers are not to be construed as limiting the scope of protection of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 shows a schematic view of a roll cover as known in the prior art.

Figure 2 shows a schematic view of a roll cover according to a first embodiment of the invention.

Figure 3 shows a schematic view of a roll cover according to a second embodiment of the invention.

20 DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic view of a roll cover as known in the prior art. The roll cover 1 is arranged on the metallic roll body 2 of the roll, and consists of a bottom layer 3 on the roll body 2 and of a functional layer 4 on the bottom layer 3.

Figure 2 shows a schematic view of a roll cover according to a first embodiment of
25 the invention. In this embodiment, the roll cover 5 consists of three layers, a bottom layer 3 arranged on the roll body 2, an intermediate layer 6 on the bottom layer 3 as well as a functional layer 4 on the intermediate layer 6. The intermediate

layer 6 comprises 25 % of polyester fibres that are dyed in red, of the total amount of fibres of this intermediate layer.

Figure 3 shows a schematic view of a roll cover according to a second embodiment of the invention, in which embodiment the roll cover 7 consists of four layers. A bottom layer 3 is arranged on the roll body 2, a first intermediate layer 8 on the bottom layer 3, a second intermediate layer 9 on the first intermediate layer 8 and a functional layer 4 on the second intermediate layer 9. The first intermediate layer 8 comprises 20 % of polyamide or polyester fibres that are dyed in green, of the total amount of fibres of the first intermediate layer. The second intermediate layer 9 comprises 30 % of polyester or polyamide fibres, of the total amount of fibres of the second intermediate layer. On this second intermediate layer, logo of the manufacturer has been printed to the non-woven instead of dyeing the dyeable fibres.

CLAIMS

1. A cover of a roll of a paper, board, finishing or tissue machine, comprising
- a bottom layer comprising a polymer matrix and fibres,
 - an intermediate layer comprising a polymer matrix and fibres and
 - 5 - a functional layer comprising a polymer matrix and fibres,
- characterised** in that the intermediate layer further comprises coloured material having a colour different from the colour of the bottom and functional layers.
2. A cover according to claim 1, **characterised** in that the coloured material is in the form of fibres.
- 10 3. A cover according to claim 2, **characterised** in that the coloured fibres of the intermediate layer are present in said layer in the amount of 1-50 % of the total amount of fibres.
4. A cover according to claim 3, **characterised** in that the coloured fibres of the intermediate layer are present in said layer in the amount of 10-30 % of the total
- 15 amount of fibres.
5. A cover according to any of the preceding claims, **characterised** in that the coloured fibres are selected from the group consisting of polyester fibres, polyamide fibres, acryl fibres, viscose fibres, polypropylene fibres, polyimide fibres, polyphenyl sulphide fibres (PPS), melamine fibres, polyphenylene benzobisoxazol
- 20 fibres (PBO) polybenzimidazol (PBI) fibres, carbon fibres, metal fibres, ceramic fibres, glass fibres and mixtures thereof.
- 6 A cover according to any of the preceding claims, **characterised** in that it comprises a second intermediate layer arranged between the functional layer and a first intermediate layer, said second intermediate layer comprising a polymer
- 25 matrix and at least two types of fibres, of which at least one type is coloured fibres having a colour different from the colour of the fibres of the bottom, first intermediate and functional layers.
7. A roll for a paper, board, finishing or tissue machine, comprising a roll body and a cover arranged on said roll body, said cover comprising

- a bottom layer comprising a polymer matrix and fibres,
- an intermediate layer comprising a polymer matrix and fibres and
- a functional layer comprising a polymer matrix and fibres,

characterised in that the intermediate layer further comprises coloured material
5 having a colour different from the colour of the bottom and functional layers.

8. A method for manufacturing a cover for a roll of a paper, board, finishing or tissue machine, comprising the steps of

- providing a bottom layer comprising a polymer matrix and fibres on a roll body,
- 10 - providing an intermediate layer comprising a polymer matrix and fibres on said bottom layer, and
- providing a functional layer comprising a polymer matrix and fibres on said intermediate layer,

characterised in providing the intermediate layer with coloured material having a
15 colour different from the colour of the bottom and functional layers.

9. A calender for a paper, board or finishing machine comprising a roll according to claim 7.

10. A manufacturing or treatment apparatus for a cellulosic fibre web comprising a roll according to claim 7.

20 11. Use of dyed fibres in the manufacture of a cover of a roll of a paper, board, finishing or tissue machine.

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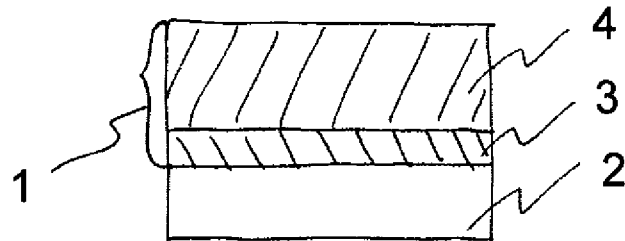


Fig. 1 Prior Art

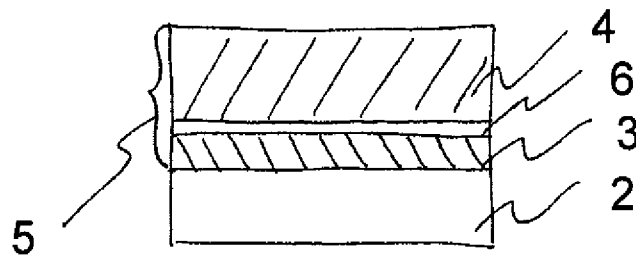


Fig. 2

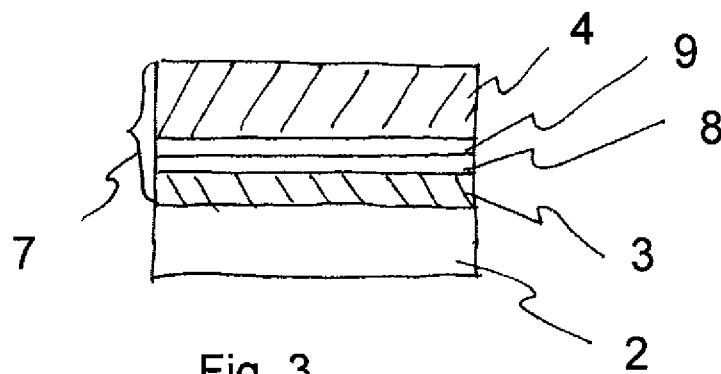


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2009/050290

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: D21G, D21F, F16C

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, COMPDX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 20319653 U1 (GH BESCHICHTUNGSTECHNIK GMBH) 28 April 2005 (28.04.2005)	1-11
A	US 5428437 A (CARTER DANIEL L et al.) 27 June 1995 (27.06.1995)	1-11



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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

01 December 2009 (01.12.2009)

Date of mailing of the international search report

08 December 2009 (08.12.2009)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/FI2009/050290

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
DE 20319653 U1	28/04/2005	None	
.....			
US 5428437 A	27/06/1995	None	
.....			

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2009/050290

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

D21G 1/02 (2006.01)

F16C 13/00 (2006.01)