(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 202 356 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.06.2010 Bulletin 2010/26

(51) Int Cl.:
D21F 5/16 *(2006.01)*

(21) Application number: **08172811.5**

(22) Date of filing: **23.12.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(71) Applicant: **Tecnerga S.r.l.**
38082 Cimego (TN) (IT)

(72) Inventor: **Cuomo, Vincenzo**
38082 Cimego (TN) (IT)

(74) Representative: **Vinci, Marcello**
Ufficio Veneto Brevetti
Via Sorio 116
35141 Padova (IT)

(54) **System for adjusting and controlling the water content in paper during the production cycle**

(57) The invention is a new system for adjusting and controlling at least the humidity content of paper (F) during the production cycle in paper production plants, comprising one or more devices (M) that emit microwaves at controlled frequency and are suited to dehumidify areas of the paper (F) while the paper (F) slides. The new system comprises also measuring devices (C) suited to determine the paper humidity profile (P) along a measurement section (F2) and an electronic unit (S) that receives data from said measuring devices (C) and activates/deactivates and/or modifies the power of the microwave emitting devices (Mx) that act where humidity peaks are detected.

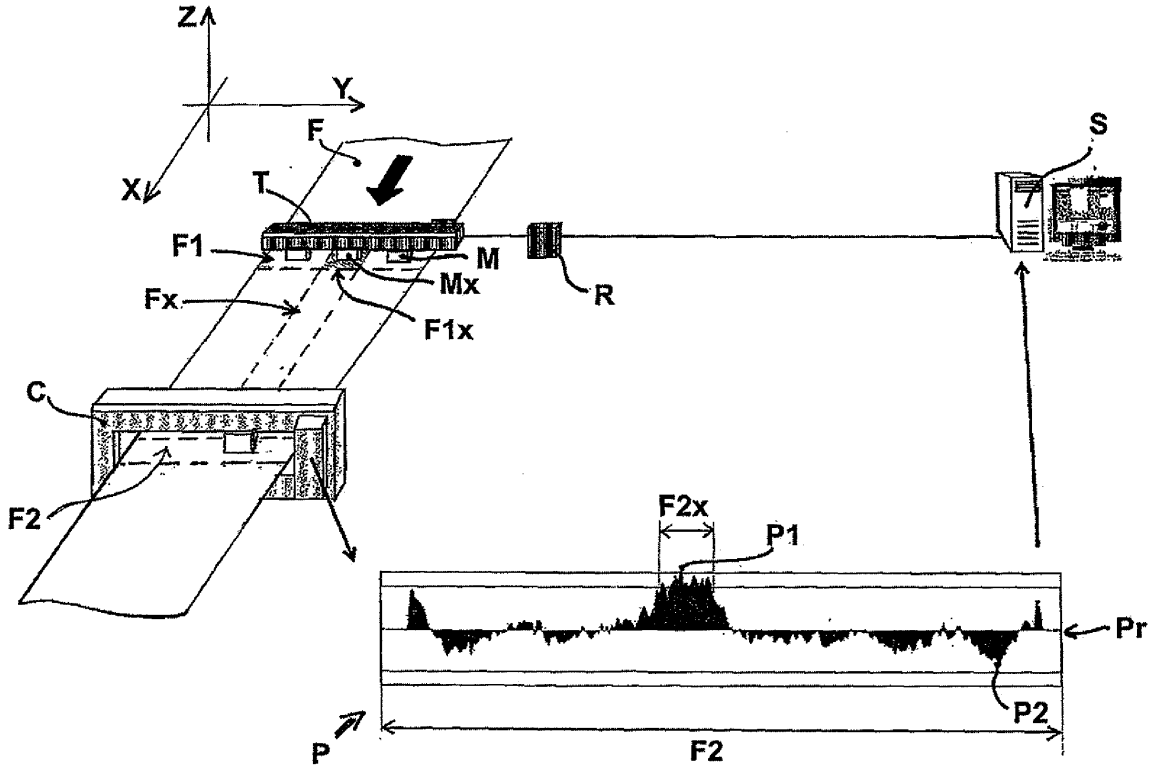


Fig. 1

EP 2 202 356 A1

Description

[0001] The present invention concerns devices for checking paper quality control parameters during the production cycle, and in particular it concerns a new system for adjusting and controlling the water content in paper in the transverse direction with respect to the forming direction during the production cycle.

[0002] The paper production cycle, first of all, includes the preparation of the liquid compound for the production of the paper sheet, said compound consisting of approximately 99 % of water and of cellulose fibre and technological aids for the remaining 0,4-1 %, said fibre and additive percentage varying according to the weight and type of paper to be produced.

[0003] Said liquid compound is introduced in the system and spread homogeneously on a surface, commonly defined forming wire, having first of all the function to guarantee the distribution of the fibre and the natural drainage of at least part of the water.

[0004] Said formation wire slides so that the liquid compound spread on it passes through various processing stations, where it is progressively dehydrated due to the effect of gravity only and/or due to the action of vacuum sucking devices.

[0005] At the end of the formation station the paper web has a content of dry material that ranges from 15 to 20%.

[0006] In the successive station, or pressing station, the material is pressed and further dehydrated until reaching a fibre content included between 40 and 50%, according to the technology adopted and the type of product.

[0007] In particular, said dehydration is obtained by pressing, through the use of pressing cylinders and a simultaneous sucking action.

[0008] Considering the special chemical structure of cellulose, drying the sheet further means using considerable energy. At present heat energy is employed, in the form of vapour or infrared radiation.

[0009] For example, systems are known in which the paper web, moving out of said pressing station, passes through drying cylinders whose contact surface is heated to a temperature of approximately 130° C and thus dries the paper web.

[0010] The paper web obtained in this way, before being wound in a coil, passes through a continuous computerized monitoring station that carries out nondestructive measurements mainly focused on two parameters, that is, grammage and humidity.

[0011] Usually the grammage parameter, that is, the weight expressed in grams per square meter of paper, is determined using a scanner installed downstream of the production line, before the final winder.

[0012] Said scanner employs radiation emitters and, by means of an apposite correlation algorithm, determines said grammage starting from the evaluation of the intensity extinction of said radiations.

[0013] In the known systems, the grammage control system thus works retroactively and communicates with the devices installed upstream of the system and responsible for adjusting the quantity of liquid compound introduced in the production line.

[0014] Said devices, therefore, modify said quantity of liquid compound according to the grammage measured downstream of the system.

[0015] In this way it is possible to guarantee a constant grammage of the paper web with good approximation, at least in the longitudinal direction, that is, parallel to the advance direction of the paper web in the production line. Sensors are also known that are positioned downstream of the production line, too, and that are suited to determine the variations in the grammage value along different sections positioned crosswise with respect to the direction of the production line.

[0016] Said sensors thus make it possible to retroactively correct the grammage values, thus guaranteeing rather limited variability, in the order of 0.1 - 0.2%.

[0017] Regarding the other parameter, that is, the humidity contained in the paper web, in the systems known at present said value is determined by means of a measuring head installed on said scanner for measuring the grammage, that is, downstream of the production line.

[0018] The presence of some more or less humid areas can be due for example to the non-homogeneous distribution of the compound during the formation step, or to particular conditions in the setting up of the system.

[0019] Also in this case the humidity control system works retroactively, causing a variation in the heat energy introduced upstream of the system in order to obtain the evaporation of water.

[0020] In particular, systems are known in which said variation in the heat energy supplied to the system is obtained by varying the quantity of overheated vapour that feeds said drying cylinders.

[0021] This system is rather effective in the control of the water content in the longitudinal direction with respect to the production line.

[0022] Vice versa, at present the operation for controlling the water content crosswise with respect to the direction of the production line is extremely complicated and articulated, and its results are not satisfying.

[0023] In particular, according to the current state of the art, in order to intervene on the inevitable oscillations of the humidity content in the transverse direction, water is introduced using mixed air/vapour systems, in the driest areas where the water content is lower, thus levelling the peak values below the desired average value.

[0024] On the contrary, it is much more complicated to properly dry some bands of the paper web in order to level the peak values above the average value or the desired reference value.

[0025] In fact, the devices currently known are able to operate on areas or bands whose width exceeds a dozen centimetres, while the humid areas, that is, the areas containing more water than desired, are often narrower,

so that the dehumidifying process involves also portions of the paper web that are already in optimal humidity conditions and that therefore do not need a higher energy supply.

[0026] A further drawback posed by the known technique lies in that the heat is always supplied to the paper web from the outside towards the inside, so that a positive humidity gradient is inevitably obtained from the surface layers of the paper web towards the inner layers of the same, and consequently the surface layers contain less water than the inner ones.

[0027] This gradient is a function of the total thickness of the paper web and of the possible use of technological-functional aids employed in the production cycle.

[0028] In fact, the thicker the paper web, the more evident the gradient, for example in paper webs with high grammage values and above all in paperboard sheets made up of two or more overlapping layers.

[0029] Furthermore, since cellulose fibre varies its dimensions depending on the water content, this gradient causes lengthening and/or shortening stresses that become evident with the appearance of deformations on the paper web at the end of the production cycle, that is, waves, curves, etc.

[0030] In order to overcome all the drawbacks described above, a new type of system for adjusting and controlling at least the water content in paper during the production cycle has been studied and implemented.

[0031] The main object of the present invention is to guarantee minimum variability of the humidity content in paper both in the longitudinal direction with respect to the production line and crosswise.

[0032] Another object of the present invention is to be able to treat in a focused manner and with maximum precision only the areas or paper portions that require such a treatment, according to the humidity profile measured along one or more cross sections of the paper web.

[0033] Another object of the present invention is to minimize the humidity gradient between the surface layers and the inner layers of the paper web, by means of microwave dehumidifying devices that effectively act on the innermost part of the web thickness, differently from the systems currently used.

[0034] Another object of the present invention is to ensure reduced treatment times, particularly in relation to the feeding speed of the paper web in the production line.

[0035] These and other direct and complementary objects are achieved by the new system for adjusting and controlling at least the water content in paper during the production cycle, comprising one or more dehumidifying devices that emit microwaves at controlled frequency, connected to at least one device suited to measure and determine the paper humidity profile along at least one given cross section, said cross section being preferably located downstream of the production line and of said microwave emitting devices. Said measuring device thus acts retroactively, determining the humidity content profile of a cross section downstream of the production line.

[0036] The data referring to said humidity profile are processed by an electronic unit that communicates with said microwave emitting devices positioned upstream, activating or deactivating them and/or adjusting their power so that they have effect only on the areas with humidity peaks above the reference value or outside a reference interval.

[0037] Said microwave emitting devices are preferably installed on a head and are suited to act on all the points of a cross section located upstream of said cross section where the measurement has been carried out.

[0038] In particular, according to the invention said head can be a mobile head, travelling crosswise with respect to the direction of the production line, in such a way as to position said microwave emitting devices exactly at the height of the paper portion to be dehumidified, according to the humidity profile given by said measuring device.

[0039] In this way, during the paper feeding movement, an entire longitudinal area is treated at the level of the portion of paper web to be dried.

[0040] Alternatively, according to the invention, said head may occupy an entire cross section, and said microwave emitting devices can be distributed in such a way as to affect the whole cross section and to be activated alternately or simultaneously in order to act on some specific areas, according to the humidity profile given by said measuring device.

[0041] The main advantage offered by the new control system lies in that it makes use of said dehumidifying devices that emit microwaves and are suited to make the water contained in the paper evaporate starting from the innermost layers, thus obtaining also the normalization of the humidity gradient through the thickness of the paper web.

[0042] Thus the surface layers of paper will not be drier than the inner layers, as is the case when the known drying systems, for example the drying cylinders, are used.

[0043] Furthermore, the use of microwave emitters guarantees higher precision of the paper dehumidifying treatment, since even very narrow or very wide areas can be treated.

[0044] The action of the microwave emitting devices, furthermore, is very rapid, in fact said devices can be activated and deactivated instantaneously and operate rather quickly, differently from the known dehumidifying devices that on the contrary do not have the same effects in the required time as dictated by the paper feeding speed, considering also the heat insulation effect exerted by the paper surface layers.

[0045] The characteristics of the new system will be highlighted in greater detail in the following description with reference to the drawing shown in Figure 1, provided as a non-limiting example.

[0046] The new system for adjusting and controlling the water content can be installed in paper (F) production plants.

[0047] The paper (F), produced in webs by pouring on a surface a given quantity of liquid compound consisting of water and cellulose fibre, slides in a direction (X), or direction of the production line, and passes through various stations, where it is progressively dehydrated so that the dry material passes from the initial value of 0.4-1% to an optimal value of 40-50%.

[0048] In order to further dehydrate the paper web (F), the new system for adjusting and controlling the water content comprises one or more dehumidifying devices (M) that emit microwaves at controlled frequency, suited to treat at least one area of the paper web (F).

[0049] Said dehumidifying devices (M) are arranged at the level of at least one part or section (F1) of the paper web (F), crosswise (Y) with respect to the direction (X) of the production line and therefore, while the paper slides in said direction (X), said dehumidifying devices (M) treat a longitudinal area (Fm), that is, an area that is parallel to said direction (X) of the production line.

[0050] In particular, said dehumidifying devices (M) are installed on a head (T) in such a way as to allow the paper (F) to be treated alternately or simultaneously on all the points of said section (F1).

[0051] According to a possible solution, said head (T) can move and travel crosswise (Y) with respect to the direction (X) of the production line, in such a way as to position one or more of said microwave emitting devices (M) along said section (F1) only at the level of the portion of paper (F) to be treated.

[0052] In this way, it is possible to treat only some parts of said section, while for the parts that do not require further dehydration the treatment will be interrupted or will not be carried out at all.

[0053] In the preferred embodiment of the invention, as an alternative to or in combination with said travelling head (T), said head (T) may occupy the whole section (F1) of the paper web (F) and said microwave emitting devices (M) may be distributed in such a way as to occupy the whole section (F1), too. Said microwave emitting devices (M) can thus be activated alternately or simultaneously so that they act only on some given portions of said section (F1) of the paper web (F).

[0054] The new adjusting and controlling system also comprises at least one measuring device (C) suited to determine the humidity profile (P) of the paper web (F) along a measurement section (F2) preferably located downstream of the section (F1) to be treated by said microwave emitting devices (M).

[0055] Said measuring device (C), in particular, determines the humidity content at every point of said measurement section (F2), thus tracing a profile (P) as schematically shown in Figure 1, wherein peak values (P1) are taken that, for example, are higher than a reference value (Pr), for example an average or optimal value, or than the maximum value of a reference interval.

[0056] Said profile (P) also shows peak values (P2) that are lower than the reference value (Pr) or than the minimum value of a reference interval.

[0057] Said measuring device (C) thus operates retroactively, determining the humidity profile (P) of a measurement section (F2) located downstream of the section (F1) where the dehumidifying treatment is carried out with respect to the direction (X) of the production line.

[0058] The new adjusting and controlling system also comprises at least one electronic unit (S) that receives from said measuring device (C) the data concerning said humidity profile (P), processes them and, through a PLC control unit (R) of said microwave emitting devices (M), activates or deactivates one or more of said microwave emitting devices (M) so that they operate in a focused manner only on some portions (Fx) of the paper web (F).

[0059] In particular, once said peak values (P1) of said humidity profile (P) and the corresponding portion (F2x) of said measurement section (F2) have been identified, one or more of said microwave emitting devices (Mx) are activated, said microwave emitting devices (Mx) being positioned and operating only on the corresponding section (F1x) of paper (F) that is aligned, along said direction (X) of the production line, with said section (F2x) presenting said peak humidity values (P1).

[0060] In combination with the feeding motion of the paper (F), said activated microwave emitting devices (Mx) thus generate a continuous band (Fx) of dehumidified paper.

[0061] Said measuring device (C), being positioned downstream of said microwave emitting devices (Mx) and therefore of said dehumidified band (Fx), continues measuring said humidity profile (P) and, according to the measured values, deactivates said microwave emitting devices (Mx) or modifies their power so that the paper (F) is correctly dehumidified.

[0062] Said electronic unit (S), in fact, processes said data concerning said humidity profile (P), identifying also peak values (P2) that are lower than a reference value or value interval and, through said PLC control unit (R) of said microwave emitting devices (M), deactivates and/or modulates the power of one or more of said microwave emitting devices (Mx) that act on said portions of paper (F) aligned, along said direction (X) of the production line, with the portions of said measurement section (F2) corresponding to said peak values (P2).

[0063] The humidity ratio of the paper (F) is thus controlled continuously in the different areas, both in the longitudinal direction, that is, parallel to the direction (X) of the production line, and crosswise (Y).

[0064] Said microwave dehumidifying devices (M) cause the evaporation of the water contained in the paper (F) starting from the innermost layers, thus obtaining also the normalization of the humidity gradient through the thickness of the paper (F), that is, also in the direction (Z) orthogonal to the sliding plane (XY) of the paper (F).

[0065] Therefore, with reference to the above description and the attached drawing, the following claims are expressed.

Claims

1. System for adjusting and controlling the humidity content of paper (F) during the production cycle in paper production plants, comprising one or more devices suited to dehumidify said paper (F), **characterized in that** said dehumidifying devices comprise one or more devices (M) that emit microwaves at controlled frequency and are suited to treat at least one area of the paper (F) while said paper (F) slides.

2. System for adjusting and controlling at least the humidity content of paper (F) during the production cycle according to claim 1, **characterized in that** it comprises one or more measuring devices (C) suited to determine the humidity profile (P) of said paper (F) along at least one measurement section (F2), and wherein said measurement section (F2) is located downstream of the area to be dehumidified and of said microwave emitting devices (M) with respect to said direction (X) of the production line.

3. System for adjusting and controlling at least the humidity content of paper (F) during the production cycle according to claims 1, 2, **characterized in that** it also comprises at least one electronic unit (S) suited to receive data from one or more of said measuring devices (C) in order to determine said humidity profile (P), processes said data identifying the peak values (P1) higher than a reference value or value interval and, through at least one PLC control unit (R) of said microwave emitting devices (M), activates/deactivates and/or modifies the power of one or more of said microwave emitting devices (Mx) that act on portions (F1x) of paper aligned, along said direction (X) of the production line, with the portions (F2x) of said measurement section (F2) corresponding to said peak values (P1), and wherein, in combination with the feeding movement of the paper in said direction (X) of the production line, said microwave emitting devices (Mx) generate a dehumidified band (Fx), said band (Fx) being parallel to said direction (X) of the production line and being substantially as wide as said portion (F1x).

4. System for adjusting and controlling at least the humidity content of paper (F) during the production cycle according to claim 3, **characterized in that** said electronic unit (S) processes said data concerning said humidity profile (P), identifying the peak values (P2) that are lower than a reference value or value interval and, through said PLC control unit (R) of said microwave emitting devices (M), activates/deactivates and/or modifies the power of one or more of said microwave emitting devices (M) that act on portions of paper (F) aligned, along said direction (X) of the production line, with the portions of said measurement section (F2) corresponding to said peak values (P2).

5. System for adjusting and controlling at least the humidity content of paper (F) during the production cycle according to claims 1, 2, 3, 4, **characterized in that** said dehumidifying devices (M) are suited to treat said paper (F) at the level of at least one section (F1) or portion of section (F1x) to be treated arranged crosswise (Y) with respect to the sliding direction (X) of said paper (F).

6. System for adjusting and controlling at least the humidity content of paper (F) during the production cycle according to claim 5, **characterized in that** one or more of said dehumidifying devices (M) travel crosswise (Y) with respect to said direction (X) of the production line, in such a way as to be positioned at the level of one or more points or portions (F1x) of said section (F1) to be treated.

7. System for adjusting and controlling at least the humidity content in paper (F) during the production cycle according to claim 5, **characterized in that** said microwave emitting devices (M) are distributed in such a way as to occupy the entirety or part of said section (F1), and wherein two or more of said microwave emitting devices (M) are activated alternately or simultaneously so that they act only on some portions (F1x) of said section (F1) to be treated.

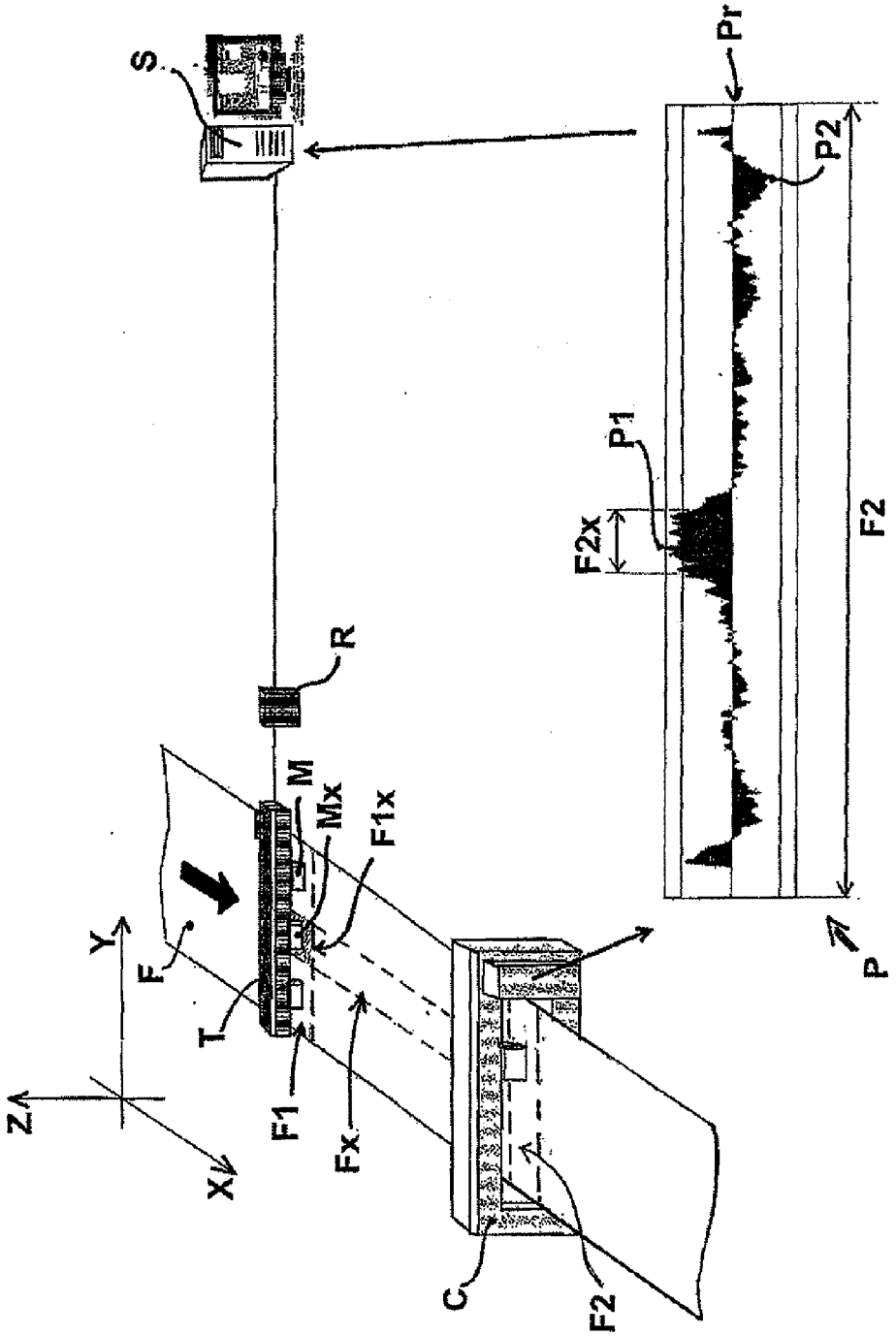


Fig. 1

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 08 17 2811

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 42 21 904 A1 (BHS BAYERISCHE BERG [DE] BHS CORR MASCH & ANLAGENBAU [DE]) 5 January 1994 (1994-01-05) * abstract; figures * * column 1, line 35 - line 65 * * column 2, line 12 - line 48 *	1,2,5,7	INV. D21F5/16
X	WO 87/03632 A (IMATRAN VOIMA OY [FI]) 18 June 1987 (1987-06-18) * abstract; figures * * page 4 *	1,5-7	
X	DE 198 41 638 A1 (VOITH SULZER PAPIERTECH PATENT [DE]) 16 March 2000 (2000-03-16) * abstract; figures * * column 2, line 48 - column 3, line 11 *	1,5,7	
X	WO 92/12291 A (NYGREN SVEN GUNNAR [SE]) 23 July 1992 (1992-07-23) * abstract; figures * * page 3, line 31 - page 5, line 5 *	1,5,7	

TECHNICAL FIELDS SEARCHED (IPC)

D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 March 2009	Helpiö, Tomi

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 17 2811

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-03-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4221904 A1	05-01-1994	NONE	
WO 8703632 A	18-06-1987	DE 3673162 D1	06-09-1990
		EP 0248866 A1	16-12-1987
		FI 854916 A	13-06-1987
		US 4823477 A	25-04-1989
DE 19841638 A1	16-03-2000	EP 0989231 A2	29-03-2000
		US 6425190 B1	30-07-2002
WO 9212291 A	23-07-1992	AU 1165992 A	17-08-1992
		SE 9100064 A	08-07-1992

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82