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Amended claims in accordance with Rule 137(2) EPC.

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(54) **Calender arrangement**

(57) The invention relates to a calender (10) for calendering fiber web, which calender comprises two rolls (11, 12) forming one calendering nip (N), a frame (14), loading means (19) for loading the rolls (11,12) against

each other for providing nip load in the calendering nip (N), a drive (13) and a driving motor (15). The calender rolls (11, 12) are hard thermo rolls providing calendering of both sides of the fiber web simultaneously.

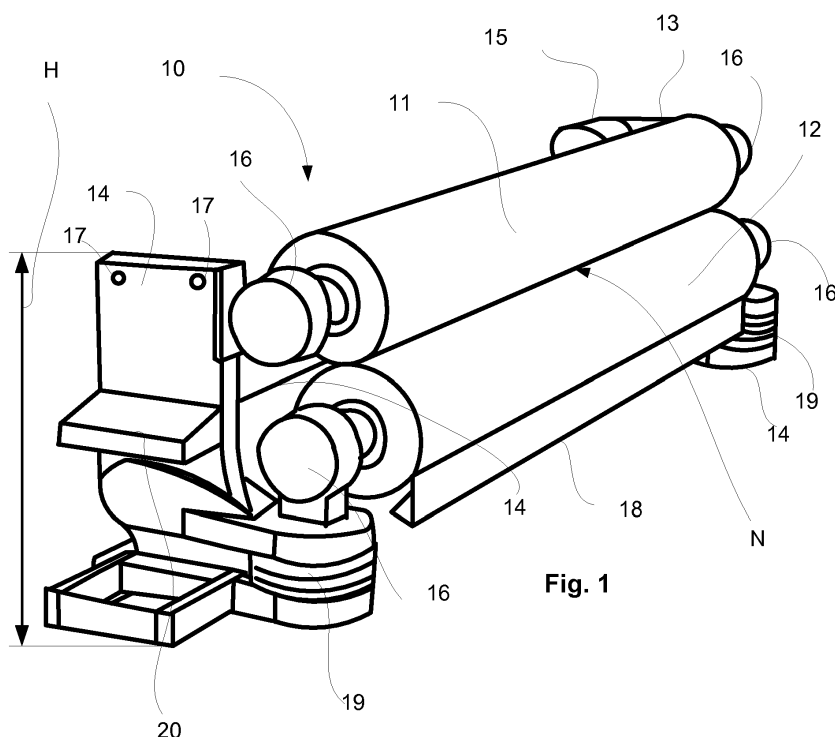


Fig. 1

Description

[0001] In general present invention relates to a calender of a fiber web machine. More especially the present invention relates to a calender according to preamble part of claim 1.

[0002] Calendering is generally carried out in order to improve the properties; surface properties, like smoothness and gloss, and caliber of a fiber web such as a paper or board web. Calendering has different functions depending on the location of the calender in the fiber web production line and on the fiber web grade to be produced. For example when producing coated fiber web grades a precalender is used before coating and after coating the fiber web is calendered in final calender.

[0003] Calender can be an incorporated part of the fiber web production line or the coating machine i.e. an on-line-calender. In case a calender forms an independent unit, it is called offline-calender. Into online-calenders the fiber web is guided from the drying section of the fiber web machine or of the coater. Into offline-calenders the fiber web is guided from a reel-up.

[0004] In calendering the web is passed into a nip, i.e. calendering nip, formed between rolls that are pressed against each other, in which nip the web becomes deformed as by the action of temperature, moisture and nip pressure.

[0005] Various different types of calendars are used in calendering of fiber webs: in hard nip calendars (machine calendars) there are typically 1-2 nips and the web is calendered in a nip between two hard rolls, in soft calendars there are typically 1 - 4 nips and at least one of the nip rolls of the nip is a soft surface polymer roll. In hard nip calendars and in soft calendars on of nip rolls is a heatable thermo roll. Multiroll calendars have usually 5 - 11 nips i.e. 6 - 12 calender rolls, of which 2 - 5 are thermo rolls and 4 - 7 soft surfaced, polymer coated rolls.

[0006] In hard nip calendars the fiber web is calendered between two or more hard rolls. Two-roll hard nip calendars are primarily used for calendering webs that do not need heavy calendering: for precalendering before coating and for finishing of uncoated wood-free paper grades. Other types of hard nip calendars are multiroll hard nip calendars. Most commonly the two-roll hard nip calender comprise a heated cast-iron roll and a deflection compensated roll supported by bearing housings of the rolls on frame, at one side on open frames and at both sides on closed frames. Heated rolls are either double-walled rolls or peripherally drilled rolls, in which hot water is circulated for heating the roll surface to temperatures 80 - 120 °C. Deflection compensated rolls are swimming rolls, CD-rolls, hydrostatically supported deflection rolls, hydraulically deflection compensated swimming rolls or zone controlled deflection compensated rolls. Nip rolls are loaded against each other with pneumatic bellows, pneumatic or hydraulic cylinders or with hydrostatic roll itself. One or two drives are used depending on the speed of the calender.

[0007] An object of the present invention is to create a new type of calender.

[0008] A particular, conditional object of the present invention is to create a calender with simple environmentally friendlier and cheaper construction.

[0009] In order to achieve the above mentioned objects and those that will be disclosed later, the calender according to the invention is mainly characterized by the features of the characterizing part of claim 1.

[0010] The new type of calender according to advantageous aspects of the invention has many advantageous features:

[0011] According to one aspect the calender comprises two hard thermo rolls forming the one calendering nip and provides calendering both sides of the fiber web simultaneously and advantageously provides a symmetric calendering of the fiber web. Advantageously the rolls are similar and are thus exchangeable and furthermore only one spare roll is needed for the calender. The deflection compensation of the rolls is provided by crowning at least one of the two rolls. The edges of the fiber web are advantageously profiled by adjusting nip load.

[0012] According to another aspect the calender comprises one hard thermo roll and one deflection compensated roll forming the one calendering nip and provides calendering both sides of the fiber web simultaneously. Advantageously the deflection compensated roll is a swimming roll that is a chamber roll running light.

[0013] The hard thermo roll/-s is/are advantageously of over 350 HV₁₀ hardness and advantageously has/have a drying cylinder type construction, i.e. a mantle type construction not a peripherally drilled construction. The diameter of the roll is 400 - 1100 mm. The thermo roll/-s is/are connected directly to the steam system of the fiber web production plant for heating and pressure of the heating steam is 1 - 40 bar.

[0014] According to another advantageous feature the rolls are not heated.

[0015] Advantageously the calender comprises one drive that is connected to one of the two rolls and the drive is integrated to the calender and advantageously located between the frames of the calender i.e. advantageously next to the roll of the calender not extending in the longitudinal direction over the calender roll length. Advantageously the drive is a belt drive or a direct drive.

[0016] Advantageously the calender comprises a driving motor that is located inside the calender i.e. advantageously next to the roll of the calender not extending in the longitudinal direction over the calender roll length, more advantageously in between the bearings of the rolls.

[0017] The calender according to the invention is constructed as one unit and the weight of the whole calender ready to start (including rolls) is 10 - 100 tons such that is transferrable as a single unit. Advantageously the calender is connected to an outside energy source.

[0018] Advantageously the frame of the calender is constructed of solid plates and comprises no box type

structures nor beam structures and thus 5 - 75 % raw material saving in construction materials of the calender is achieved. Advantageously the lifting brackets are integrated to the frame and thus part of the calender complex. Advantageously the height of the calender is 1 - 5 m.

[0019] Advantageously a gravity-loadable doctor is used in threading the fiber web. The doctor can be only a short piece doctor and can oscillate also. Furthermore no spreading roll is used for guiding the web into or from the calender neither a web splicing unit is needed.

[0020] The calender comprises pneumatic loading means for loading the calendaring rolls against each other and providing the nip load that is advantageously 5 - 100 kN/m and advantageously the pneumatic loading means are pneumatic bellows with gas or air loading. By this simple structure is achieved as no hydraulic power units nor hydraulic hosing is needed.

[0021] The construction of the calender provides itself for safety and no separate safety devices are needed. The calender comprises a mechanical brake that is connected to one of the rolls of the calender and in the event of possible web winding around the roll the calendaring nip is forced open and the mechanical brake stops the calender.

[0022] Advantageously the calender is operated manually and the controls of the calender are local and integrated to the calender. For example the control console is an integrated part of the calender. This provides for easy operation and no connections to other systems in the fiber web production line are needed.

[0023] In the calender according to the invention the need for maintenance is minimized as the calender has simple construction of all components. Furthermore the fault seeking in possible failure situation is easy, since the calender is not complicated.

[0024] The calender according to the invention can be utilized as an online-calender or as an offline-calender. Furthermore the calender can be a new calender to be installed or a modernization or a rebuild calender replacing an already existing calender.

[0025] The calender according to the invention is applicable in calendaring all types of fiber web grades.

[0026] Paper and board are available in a wide variety of types and can be divided according to basis weight in two grades: papers with a single ply and a basis weight of 25-300 g/m² and boards manufactured in multi-ply technology and having a basis weight of 150-600 g/m². It should be noted that the borderline between paper and board is flexible since board grades with lightest basis weights are lighter than the heaviest paper grades. Generally speaking, paper is used for printing and board for packaging.

[0027] The subsequent descriptions are examples of values presently applied for fibrous webs, and there may be considerable fluctuations from the disclosed values. The descriptions are mainly based on the source publication Papermaking Science and Technology, section Papermaking Part 3, edited by Rautiainen, P., published

by Paper Engineers' Association, Helsinki 2009, 404 pages.

[0028] Mechanical-pulp based, i.e. wood-containing printing papers include newsprint, uncoated magazine and coated magazine paper.

[0029] Today's newsprint furnishes mostly contain between 80 and 100 % deinked pulp (DIP). The rest of the furnish is mechanical pulp (typically TMP). However, there is also newsprint made of 100 % mechanical fiber furnishes. DIP based newsprint may contain up to 20 % filler. The filler content of a virgin-fiber based newsprint furnish is about 8 %.

[0030] General values for CSWO newsprint can be regarded as follows: basis weight 40-48.8 g/m², PPS s10 roughness (SCAN-P 76:95) 4.0-4.5 μm, Bendtsen roughness (SCAN-P21:67) 150 ml/min, density 600-750 kg/m³, brightness (ISO 2470:1999) 58-59 %, and opacity (ISO 2470:1998) 92-95%.

[0031] Uncoated magazine paper (SC-supercalendered) grades usually contain 50 % - 75 % mechanical pulp, 5 % - 25 % chemical pulp, and 10 % - 35 % filler. The paper may also contain DIP. Typical values for calendered SC paper (containing e.g. SC-C, SC-B, and SC-A/A+) include basis weight 40-60 g/m², ash content (SCAN-P 5:63) 0-35%, Hunter gloss (ISO/DIS 8254/1) <20-50%, PPS s10 roughness (SCAN-P 76:95) 1.0-2.5 μm, density 700-1250 kg/m³, brightness (ISO 2470:1999) 62-75%, and opacity (ISO 2470:1998) 90-95%.

[0032] Coated mechanical papers include for example MFC (machine finished coated), LWC (light weight coated), MWC (medium weight coated), and HWC (heavy weight coated) grades. Coated mechanical papers usually contain 45 % -75 % mechanical or recycled fiber and 25 % - 55 % chemical pulp. Semi-chemical pulps are typical in LWC paper grades made in the Far East. The filler content is about 5 % -10 %. The grammage is typically in the range 40-80 g/m².

[0033] General values for LWC paper can be regarded as follows: basis weight 40-70 g/m², Hunter gloss 50-65%, PPS S10 roughness 1.0-1.5 μm (offset) and 0.6-1.0 μm (roto), density 1100-1250 kg/m³, brightness 70-75%, and opacity 89-94%.

[0034] General values for MFC paper (machine finished coated) can be regarded as follows: basis weight 48-70 g/m², Hunter gloss 25-40%, PPS S10 roughness 2.2-2.8 μm, density 900-950 kg/m³, brightness 70-75%, and opacity 91-95%. General values for MWC paper (medium weight coated) can be regarded as follows: basis weight 70-90 g/m², Hunter gloss 65-70%, PPS S10 roughness 0.6-1.0 μm, density 1150-1250 kg/m³, brightness 70-75%, and opacity 89-94%.

[0035] Woodfree paper is divided into two segments: uncoated and coated. Conventionally, the furnish of woodfree papers consists of bleached chemical pulp, with less than 10 % mechanical pulp.

[0036] Typical values are for uncoated WFU Copy paper: grammage 70-80 g/m², Bendtsen roughness

150-250 ml/min and bulk $> 1.3 \text{ cm}^3/\text{g}$; for uncoated offset paper: grammage 60-240 g/m^2 , Bendtsen roughness 100-200 ml/min and bulk $1.2- 1.3 \text{ cm}^3/\text{g}$; and for color copy paper: grammage 100 g/m^2 , Bendtsen roughness $< 50 \text{ ml/min}$ and bulk $1.1 \text{ cm}^3/\text{g}$.

[0037] In coated pulp-based printing papers (WFC), the amounts of coating vary widely in accordance with requirements and intended application. The following are typical values for once- and twice-coated, pulp-based printing paper: once-coated basis weight $90 \text{ g}/\text{m}^2$, Hunter gloss 65-80%, PPS s10 roughness $0.75-1.1 \text{ }\mu\text{m}$, brightness 80-88%, and opacity 91-94%, and twice-coated basis weight $130 \text{ g}/\text{m}^2$, Hunter gloss 70-80%, PPS S10 roughness $0.65-0.95 \text{ }\mu\text{m}$, brightness 83-90%, and opacity 95-97%.

[0038] Containerboard includes both linerboard and corrugating medium. Liners are divided according to their furnish base into kraftliner, recycled liner and white top liner. Liners are typically 1- to 3-ply boards with grammages varying in the range $100-300 \text{ g}/\text{m}^2$.

[0039] Linerboards are generally uncoated, but the production of coated white-top liner is increasing to meet higher demands for printability.

[0040] The main cartonboard grades are folding boxboard (FBB), white-lined chipboard (WLC), solid bleached board (SBS) and liquid packaging board (LPB). In general, these grades are typically used for different kinds of packaging of consumer goods. Carton board grades vary from one- up to five-ply boards ($150-400 \text{ g}/\text{m}^2$). The top side is usually coated with from one to three layers ($20-40 \text{ g}/\text{m}^2$), the back side has less coating or no coating at all. There is a wide range of different quality data for the same board grade. FBB has the highest bulk thanks to the mechanical or chemimechanical pulp used in the middle layer of the base board. The middle layer of WLC consists mainly of recycled fiber, whereas SBS is made from chemical pulp, exclusively.

[0041] FBB's bulk typically is between $1.1-1.9 \text{ cm}^3/\text{g}$ whereas WLC is on range $1.1-1.6 \text{ cm}^3/\text{g}$ and SBS $0.95-1.3 \text{ cm}^3/\text{g}$. The PPS-s10-smoothness is respectively for FBB between $0.8 - 2.1 \text{ }\mu\text{m}$, for WLC $1.3- 4.5 \text{ }\mu\text{m}$ and for SBS $0.7 - 2.1 \text{ }\mu\text{m}$.

[0042] Release paper is used in label base paper in various end-use applications, such as food packaging and office labels. The most common release paper in Europe is supercalendered glassine paper coated with silicone to provide good release properties.

[0043] Typical values for supercalendered release papers are basis weight $60 - 95 \text{ g}/\text{m}^2$, caliper $55-79 \text{ }\mu\text{m}$, IGT $12-15 \text{ cm}$, Cobb Unger for dense side $0.9-1.6 \text{ g}/\text{m}^2$ and for open side $1.2-2.5 \text{ g}/\text{m}^2$.

[0044] Coated label paper is used as face paper for release, but also for coated backing paper and flexible packings. Coated label paper has a grammage of $60-120 \text{ g}/\text{m}^2$ and is typically sized or precoated with a sizer and single-blade coated on one side. Some typical paper properties for coated and calendered label paper are basis weight $50-100 \text{ g}/\text{m}^2$, Hunter gloss 70-85%, PPS s10

roughness $0.6-1.0 \text{ }\mu\text{m}$, Bekk smoothness 1500-2000 s and caliper $45-90 \text{ }\mu\text{m}$.

[0045] In the following the invention is described with reference to the accompanying drawing in which

in figure 1 is shown schematically one example of a calender according to the invention.

[0046] In the example of figure 1 the calender 10 comprises two hard thermo rolls 11, 12 forming the calendaring nip N of the calender 10. Advantageously the rolls are similar and exchangeable. According to another aspect the calender 10 comprises one hard thermo roll 12 and one deflection compensated roll 11 forming the calendaring nip N of the calender.

[0047] The hard thermo roll 11; 12 has advantageously hardness of over 350 HV_{10} and advantageously have a drying cylinder type construction, i.e. a mantle type construction. The diameter of the roll is $400 - 1100 \text{ mm}$.

[0048] The thermo roll/s 11; 12 is/are connected directly to the steam system (not shown) of the fiber web production plant for heating. The calender 10 comprises one drive 13 that is connected to one of the two rolls 11; 12 and the drive 13 is integrated to the calender and advantageously located inside the frame 14 of the calender. The calender also comprises a driving motor 15 that is located between the frames 14 of the calender, more advantageously in between the bearings 16 of the rolls 11, 12. The calender 10 is constructed as one complex. The frame 14 of the calender is constructed of solid plates and comprises no box type structures nor beam structures. The lifting brackets 17 are integrated to the frame 14 and thus part of the calender unit. Advantageously the height H of the calender 10 is $1 - 5 \text{ m}$. Gravity-loadable doctor 18 is used in threading the fiber web. As can be seen from the figure 1 no spreading roll is for guiding the web into or from the calender 10 and no web splicing unit exists.

[0049] The calender 10 comprises pneumatic loading means 19 for loading the calender rolls 11, 12 against each other and the calender nip N load is advantageously $5 - 100 \text{ kN/m}$ and advantageously the pneumatic loading means are pneumatic bellows with gas or air loading.

[0050] The calender comprises a mechanical brake (not shown) that is connected to one of the rolls 11;12 of the calender 10 and in the event of possible web winding around the roll the calendaring nip N is forced open and the mechanical brake stops the calender 10.

[0051] The control console 20 is an integrated part of the calender and fixed to the frame 14.

Claims

1. A calender (10) for calendaring fiber web, which calender comprises two rolls (11, 12) forming one calendaring nip (N), a frame (14), loading means (19) for loading the rolls (11,12) against each other for

- providing nip load in the calendering nip (N), a drive (13) and a driving motor (15), **characterized in that** the rolls (11, 12) are hard thermo rolls providing calendering of both sides of the fiber web simultaneously. 5
2. Calender according to claim 1, **characterized in that** the rolls (11, 12) are similar and exchangeable.
3. Calender according to claim 2, **characterized in that** the calender (10) comprises only one spare roll. 10
4. Calender according to claim 1, **characterized in that** at least one of the calender rolls (11, 12) is provided by crowning and that the rolls (11, 12) are of over 350 HV₁₀ hardness and have a drying cylinder type construction and diameter of the calender rolls is 400 - 1100 mm. 15
5. Calender according to claim 1, **characterized in that** at least one of the calender rolls is connected directly to the steam system of the fiber web production plant for heating. 20
6. Calender according to claim 1, **characterized in that** the drive (13) is a belt drive or a direct drive connected to one of the rolls (11) and the drive is integrated to the calender. 25
7. Calender according to any of previous claims, **characterized in that** the calender is constructed as one unit and the weight of the calender unit is 10 - 100 tons and the height of the calender (10) is 1 - 5 m. 30
8. Calender according to any of previous claims, **characterized in that** the frame (14) of the calender (10) is constructed of solid plates and comprises no box type structures nor beam structures. 35
9. Calender according to claim 1, **characterized in that** the calender (10) comprises lifting brackets (17) that are integrated to the frame (14). 40
10. Calender according to any of claims 1 - 4 or 6 - 9, **characterized in that** the rolls (11, 12) are not heated. 45
11. Calender according to claim 1, **characterized in that** the calender (10) comprises a gravity-loadable doctor (18) for threading the fiber web. 50
12. Calender according to claim 1, **characterized in that** the loading means are pneumatic loading means (19), advantageously pneumatic bellows. 55
13. Calender according to claim 1, **characterized in that** the calender (10) comprises a mechanical brake that is connected to one of the calender rolls (11, 12).

14. Calender according to claim 1, **characterized in that** the calender (10) is operated manually and comprises a control console (20) that is an integrated part of the calender (10).

15. Calender according to any of previous claims, **characterized in that** the calender (10) is an online-calender or an offline-calender and that the calender (10) is applicable in calendering of all types of fiber web grades.

Amended claims in accordance with Rule 137(2) EPC.

1. A calender (10) for calendering fiber web, which calender comprises two rolls (11, 12) forming one calendering nip (N), which rolls (11, 12) are hard thermo rolls providing calendering of both sides of the fiber web simultaneously, **characterized in that** the calender comprises a frame (14), loading means (19) for loading the rolls (11,12) against each other for providing nip load in the calendering nip (N), a drive (13) and a driving motor (15), **that** the calender is constructed as one unit and the weight of the calender unit is 10 - 100 tons and the height of the calender (10) is 1 - 5 m and **that** the frame (14) of the calender (10) is constructed of solid plates and comprises no box type structures nor beam structures.

2. Calender according to claim 1, **characterized in that** the rolls (11, 12) are similar and exchangeable.

3. Calender according to claim 2, **characterized in that** the calender (10) comprises only one spare roll.

4. Calender according to claim 1, **characterized in that** at least one of the calender rolls (11, 12) is provided by crowning and that the rolls (11, 12) are of over 350 HV₁₀ hardness and have a drying cylinder type construction and diameter of the calender rolls is 400 - 1100 mm.

5. Calender according to claim 1, **characterized in that** the drive (13) is a belt drive or a direct drive connected to one of the rolls (11) and the drive is integrated to the calender.

6. Calender according to claim 1, **characterized in that** the calender (10) comprises lifting brackets (17) that are integrated to the frame (14).

7. Calender according to any of claims 1 - 6, **characterized in that** the rolls (11, 12) are not heated.

8. Calender according to claim 1, **characterized in that** the calender (10) comprises a gravity-loadable doctor (18) for threading the fiber web.

9. Calender according to claim 1, **characterized in that** the loading means are pneumatic loading means (19), advantageously pneumatic bellows.

10. Calender according to claim 1, **characterized in that** the calender (10) comprises a mechanical brake that is connected to one of the calender rolls (11, 12). 5

11. Calender according to claim 1, **characterized in that** the calender (10) is operated manually and comprises a control console (20) that is an integrated part of the calender (10). 10

12. Calender according to any of previous claims, **characterized in that** the calender (10) is an online-calender or an offline-calender and that the calender (10) is applicable in calendering of all types of fiber web grades. 15

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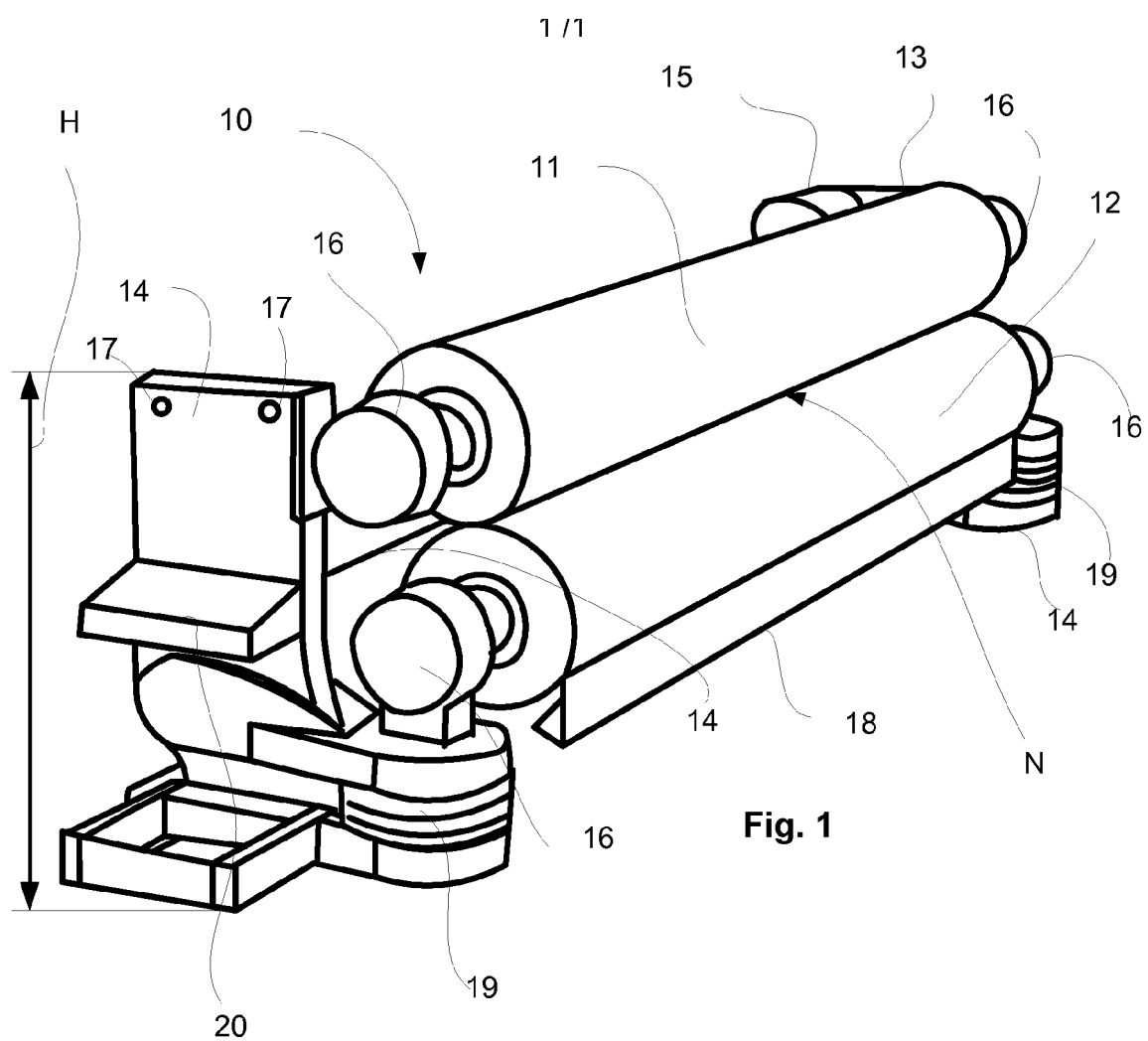
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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 0039

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* page 1, line 3 - page 2, line 32 * * page 8, line 27 - page 9, line 31; figure 3 *	4	
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Y	DE 20 2009 012345 U1 (METSO PAPER INC [FI]) 26 November 2009 (2009-11-26) * paragraph [0001] - paragraph [0004] * * paragraph [0024] - paragraph [0029]; figure 1 *	4	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			D21G
Place of search		Date of completion of the search	Examiner
Munich		22 July 2013	Sabatucci, Arianna
CATEGORY OF CITED DOCUMENTS			
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 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			

EPO FORM 1503 03.82 (P04C001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 17 0039

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The members are as contained in the European Patent Office EDP file on
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22-07-2013

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REFERENCES CITED IN THE DESCRIPTION

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