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

(11) **EP 1 980 665 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
15.10.2008 Bulletin 2008/42

(21) Application number: **06843774.8**

(22) Date of filing: **28.12.2006**

(51) Int Cl.:
D21F 7/08 *(2006.01)*

(86) International application number:
PCT/JP2006/326405

(87) International publication number:
WO 2007/077974 (12.07.2007 Gazette 2007/28)

(84) Designated Contracting States:
DE FI FR IT SE

(30) Priority: **06.01.2006 JP 2006001000**

(71) Applicant: **Ichikawa Co., Ltd.**
Tokyo 113-0033 (JP)

(72) Inventors:
- **ONIKUBO, Akira**
  Tokyo 113-0033 (JP)
- **KAWASHIMA, Shin**
  Tokyo 113-0033 (JP)
- **ODA, Hiroyuki**
  Tokyo 113-0033 (JP)

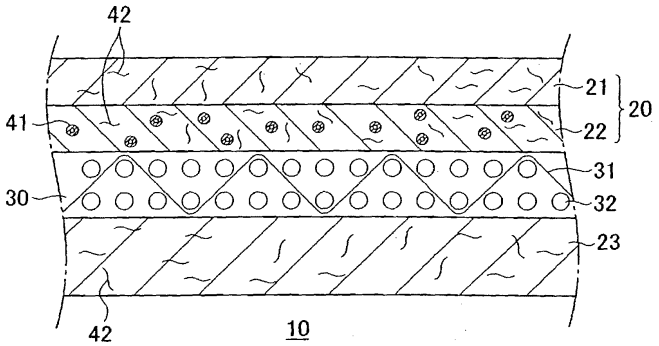
(74) Representative: **Giles, Ashley Simon**
Haseltine Lake
Lincoln House
300 High Holborn
London WC1V 7JH (GB)

(54) PRESS FELT FOR PAPERMAKING

(57) A press felt 10 comprises a base body 30, a wet paper web side batt layer 20, and a press side batt layer 23. The wet paper web side batt layer 20 has a wet paper web contact side batt layer 21 and a base body side batt layer 22, the base body side batt layer 22 being made of a core-in-sheath fiber 41 which has a core member made of high-molecular-weight nylon with an absolute viscosity of 80mPa·s or more and a sheath member made of nylon with a lower melting point than the core member, and the wet paper web contact side batt layer 21 being made of a nylon fiber 42 which does not include the core-in-sheath fiber 41.

Rewetting of the wet paper web can be prevented, because water within the press side batt layer 23 is blocked from moving to the wet paper web side due to increased density of the base body side batt layer 22 resulted from melting of the sheath member of the core-in-sheath fiber 41. Moreover, the invention successfully enhances resistance to dehairing, abrasion, and compression fatigue of the press felt by enhancing viscosity of the core member of the core-in-sheath fiber.

Fig.1



EP 1 980 665 A1

Description

FIELD OF THE INVENTION

[0001] This invention relates to a press felt for papermaking used in a papermaking machine (hereinafter referred to as a "press felt").

BACKGROUND ART

[0002] Press machines have been used to dewater a wet paper web in a papermaking process. In a press machine, a wet paper web formed with layers therein is dewatered within a press nip, sandwiched between a pair of press felts. Press machines generally have a plurality of press nips.

[0003] Figure 5 is a schematic view of a press nip in a press machine.

[0004] A pair of press rolls P', P' and a pair of press felts 11', 11' form a press nip. The press felts 11', 11' and a wet paper web W' are compressed within a pressure portion between the press rolls P' , P', where water is removed from the wet paper web W' and absorbed by the press felts 11', 11'.

[0005] The volume of the wet paper web W' and the press felts 11', 11' rapidly expands when they travel through the middle of the press portion (the nip) to the exit thereof, as they are rapidly released from compression. This expansion generates negative pressure within the press felts 11', 11' which, coupled with the capillary phenomenon within the wet paper web W' associated with thin fibers therein, results in rewetting, a phenomenon in which water absorbed by the press felts 11', 11' backs to the wet paper web.

[0006] Unexamined Japanese Patent Publication No. 143627/2004 (patent document 1) discloses a press felt intended to prevent rewetting. This felt comprises a base layer, a paper side batt layer, and press side batt layer, with a hydrophilic nonwoven fabric being disposed within the paper web side batt layer. According to this invention, the hydrophilic nonwoven fabric absorbs and retains water contained within the wet paper web, thereby effectively preventing rewetting.

[0007] Moreover, it is also essential for a press felt to have a capability of recovering to its uncompressed state after compression without being flattened (resistance to compression fatigue), a capability of improving smoothness of the wet paper web by smoothness of the felt itself (smoothness), and dehairing and abrasion resistance.

[0008] Unexamined Japanese Patent Publication No.302584/1996 (patent document 2), for example, discloses a felt with such capabilities which includes fibers with a core-in-sheath structure made from a two-component material.

[0009] According to this invention, the two-component material used for a fiber to form a batt layer is composed of a sheath member with a low melting point and a core member with a high melting point. With heat hardening processing of the press felt, the sheath member with a low melting point gets softened to form a matrix within the batt layer, which enhances dewatering capability and compression resistance of the press felt.

[0010] Further, press felts made of a woven fabric with improved dewatering capability and smoothness are employed in recent high-speed papermaking machines. The fabric is woven with a warp yarn (CMD yarn) and a weft yarn (MD yarn), both of which are monofilament single yarns (see Unexamined Japanese Patent Publication No. 170086/2000: patent document 3).

DISCLOSURE OF THE INVENTION

[0011] However, the press felts disclosed in the patent documents 1 and 2 tend to be vulnerable to compression.

[0012] In addition, the press felt with the batt layer made from the two-component material, as disclosed in the second publication No.302584/1996, tends to require short-term replacement due to cutoffs of fibers during use, dehairing or abrasion, because thermal pressurization in the manufacturing process causes deterioration of mechanical strength or chemical degradation.

[0013] On the other hand, the press felt disclosed in the patent document 3 is known to be much inferior to conventional felts using twist yarns in terms of dehairing and abrasion resistance, because batt fibers and the woven fabric are not firmly integrated by needlepunching.

[0014] Thus, there is a need for a press felt not only with an anti-rewetting capability but with a balanced combination of advantages, such as resistance to compression, smoothness, and dehairing and abrasion resistance.

[0015] In view of the above problems, the object of the present invention is to provide a press felt for papermaking being capable of preventing rewetting and having superior smoothness and resistance to abrasion and compression fatigue.

[0016] The present invention solved the above-mentioned problems with a press felt comprising a base body and batt layers having a wet paper web side layer and a press side layer, characterized in that said wet paper web side layer is composed of a wet paper web contact side batt layer and a base body side batt layer, said base body side batt layer having a core-in-sheath fiber comprising a core member made of high-molecular-weight nylon with an absolute viscosity

of 80mPa·s or more and a sheath member made of nylon with a lower melting point than the core member, said wet paper web contact side batt layer being made of nylon without said core-in-sheath fiber.

[0017] "An absolute viscosity of 80mPa·s or more" was measured at the temperature of 25 degrees C after solving nylon in 100ml of 0.5g/95% sulfuric acid, which can be measured using an oscillating viscometer.

[0018] The content rate of said core-in-sheath fibers within said base body side batt layer is preferably in the range of 10-60%.

[0019] Said base body side batt layer can be multi-layered, in which the content rate of said core-in-sheath fibers increases incrementally from the press side toward the paper side thereof.

[0020] Further, said base body is preferably a fabric woven with a warp yarn (CMD yarn) and a weft yarn (MD yarn), both of which are monofilament single yarns.

[0021] According to this invention, the base body side batt layer is made dense due to melting of the sheath portion of the core-in-sheath fiber. As a result, said base body side batt layer works as a barrier to block water within the press side layer from moving to the paper side, thereby preventing rewetting.

[0022] Moreover, the invention successfully enhances resistance to dehairing, abrasion, and compression fatigue of the press felt by providing the core member of the core-in-sheath fiber with high viscosity, i. e. by using high-molecular-weight nylon. As a result, the press felt of this invention is made more durable, reducing the need for replacement, contributes to improve the quality of the finished paper with less fibers attached thereon due to dehairing and abrasion, and is capable of maintaining smoothness of the paper contact surface.

[0023] Further, since the base body side batt layer is made of the core-in-sheath fiber while the wet paper web contact side batt layer is made of nylon without the core-in-sheath fiber, the press felt of this invention is provided with a balanced combination of smoothness and resistance to dehairing, abrasion, and compression fatigue.

[0024] Furthermore, the present invention improves dewatering capability as well as resistance to dehairing and abrasion of the press felt by using a fabric woven with monofilament single yarns for the base body and thus enhancing water permeability thereof.

BRIEF DESCRIPTION OF DRAWINGS

[0025]

Figure 1 is a sectional view of an embodiment of the press felt of the present invention.
Figure 2 is a sectional view of another embodiment of the press felt of the present invention.
Figure 3 is a schematic view of an apparatus to evaluate the effects of the press felt of the present invention.
Figure 4 is a schematic view of an apparatus to evaluate the effects of the press felt of the present invention.
Figure 5 is a schematic view of a press apparatus of a papermaking machine.

PREFERRED EMBODIMENTS OF THE INVENTION

[0026] A press felt of this invention is to be detailed hereafter.

[0027] Figure 1 is a CMD sectional view of a press felt 10 of the present invention.

[0028] "Machine direction (MD)" refers to the longitudinal direction in which a press felt is transferred in a papermaking machine, whereas "cross machine direction (CMD)" refers to the lateral direction which crosses the machine direction.

[0029] As shown in Figure 1, the press felt 10 comprises a base body 30, a wet paper web side batt layer 20, and a press side batt layer 23, the wet paper web side batt layer 20 having a wet paper web contact side batt layer 21 and a base body side batt layer 22 which is formed on the side closer to the base body of the wet paper web contact side batt layer 21.

[0030] The wet paper web contact side batt layer 21, the base body side batt layer 22, and the press side batt layer 23 are made of staple fibers, with the base body side batt layer 22 and the press side batt layer 23 intertwiningly integrated by needlepunching with the wet paper web side and the press side of the base body 30 respectively. The wet paper web contact side batt layer 21 is intertwiningly integrated with the base body side batt layer 22 by needlepunching.

[0031] In the press felt 10 of this invention, the base body side batt layer 22 is made of a core-in-sheath fiber 41, a staple fiber, which has a core member made of high-molecular-weight nylon with an absolute viscosity of 80mPa·s or more and a sheath member of nylon with a lower melting point than the core member, whereas the wet paper web contact side batt layer 21 is made of a staple fiber of a conventional nylon fiber 42 without the core-in-sheath fiber 41.

[0032] "An absolute viscosity of 80mPa·s or more" was measured at the temperature of 25 degrees C after solving nylon in 100ml of 0.5g/95% sulfuric acid, which can be measured using an oscillating viscometer.

[0033] In Figure 1, the core-in-sheath fiber 41 is enlarged for the purpose of illustration.

[0034] Conventionally, no attention has been paid to viscosity of a core member, or its molecular weight, when a fiber with a core-in-sheath structure made from two-component material is used for a batt layer of a press felt. However, the

present invention successfully achieved a balance of such advantages as smoothness, dehairing and abrasion resistance, and resistance to compression fatigue by employing a fiber with a higher viscosity as compared to conventional practices, namely high-molecular-weight nylon, for a core member, and by disposing a layer made of this core-in-sheath material on the base body side of the wet paper web contact side batt layer.

[0035] Nylon used for the core member of the core-in-sheath fiber 41 should be high-molecular-weight nylon with an absolute viscosity of 80mPa·s or more at 25 degrees C and with a higher melting point than the sheath member. When nylon with a high viscosity (80mPa·s or more) is used for the core member, dehairing, abrasion, and compression resistance of the felt can be enhanced. It may be because high-molecular-weight nylon has a longer molecular chain, which improves mechanical strength (intensity or durability such as abrasion and attrition resistance) as a result of entanglement of such long molecular chains. Nylon with an absolute viscosity of less than 80mPa· s (moderate viscosity) is not advantageous in enhancing dehairing, abrasion, and compression resistance.

[0036] Preferable nylon used for the core member includes high-molecular-weight nylon 6, high-molecular-weight nylon 66, high-molecular-weight nylon 46, high-molecular-weight nylon 610, and high-molecular-weight nylon 612. More specifically, nylon obtained by way of polycondensation of nylon salt is preferable, such as polymerization of E caprolactam (nylon 6), polycondensation of hexamethylenediamine adipate (nylon 66), polycondensation of 1,4-diaminobutane adipate (nylon 46), polycondensation of hexamethylenediamine sebacate (nylon 610), polycondensation of hexamethylenediamine dodecanedioic diacid (nylon 612), and aliphatic nylon can also be included which has a melting point of 200 degrees C or more measured by DSC (Differential Scanning Calorimetry). Preferably, an absolute viscosity of the high-molecular-weight nylon above in 100ml of 0.5g/95% sulfuric acid is 80mPa·s or more. These high-molecular-weight nylon is produced with a well-known polymerization procedure or a solid phase polymerization procedure in which polimerized nylon flake is placed in an inert gas atmosphere of 120-200 degrees C without oxygen (for example, Unexamined Japanese Patent Publication No. 529604/2002).

[0037] Nylon used for the sheath member of the core-in-sheath fiber 41 should have a lower melting point than the core member. Preferred nylon includes binary copolymerized nylon such as nylon 6/12, nylon 6/610, nylon 66/6, nylon 66/12, nylon 66/610, and ternary copolymerized nylon such as nylon 6/66/12 and nylon 6/66/610. As is known in the art, a melting point of these copolymerized nylon fluctuates depending on their composition (or weight percentages of copolymerized elements), and only those with a melting point of 180 degrees C or less is usable for this invention.

[0038] Accordingly, the sheath member is melted by thermal pressurization in the manufacturing process, which leads to constriction of the core-in-sheath fiber 41, thereby making the base body side batt layer 22 and the wet paper web contact side batt layer 21 more dense and therefore adding smoothness to the felt surface.

[0039] The base body side batt layer 22 and the wet paper web contact side batt layer 21 with added density are also effective in preventing rewetting, because they block water within the press side batt layer 23 from moving therein.

[0040] In the present invention, only the base body side batt layer 22 is composed of the core-in-sheath fiber 41, with the wet paper web contact side batt layer 21 being made of the normal nylon fiber 42 without the core-in-sheath fiber 41. This composition enabled the press felt to have a balanced combination of smoothness, dehairing and abrasion resistance, and resistance to compression fatigue. When the wet paper web contact side batt layer 21 has the core-in-sheath fiber 41, surface areas to contact with the wet paper web is expanded due to melting of the sheath member, and hence smoothness of the press felt is improved. However, dehairing and abrasion resistance, and durability are degraded, because mechanical strength of copolymerized nylon is relatively low.

[0041] The base body side batt layer 22 is preferably made of a blend of the core-in-sheath fiber 41 and the normal nylon fiber 42 to achieve a better balance of smoothness, abrasion and compression resistance. Preferably, the blend consists of 60-10% of the core-in-sheath fiber 41 and 40-90% of the nylon fiber 42.

[0042] When the content rate of the core-in-sheath fiber 41 is less than 10%, the press felt lacks smoothness and is incapable of preventing rewetting effectively.

[0043] On the other hand, when the content rate of the core-in-sheath fiber 41 exceeds 60%, the felt tends to be flattened with the base body side batt layer 22 susceptible to compression fatigue, while it has smoothness, abrasion resistance and is effective in prevention of rewetting.

[0044] The base body side batt layer can be multi-layered, in which the content rate of the core-in-sheath fiber 41 increases incrementally from the press side toward the paper side thereof to provide more improvements in smoothness and abrasion resistance.

[0045] Figure 2 illustrates an embodiment in which the base body side batt layer comprises a first layer 22a and a second layer 22b, the first layer 22a having more core-in-sheath fibers 41 than the second layer 22b.

[0046] Such a structure increases density of the base body side batt layer 22 and the wet paper web contact side batt layer 21. More specifically, as compared to the embodiment in which the base body side batt layer 22 is a single layer, the felt is provided with enhanced anti-rewetting capability due to the doubled dense layers as well as improved smoothness and resistance to dehairing and abrasion.

[0047] On the contrary, when the base body side batt layer 22 is formed with incrementally decreasing content rate of the core-in-sheath fiber 41 from the press side toward the paper side, smoothness, dehairing and abrasion resistance,

and anti-rewetting properties of the felt are degraded, as compared to the embodiment in which the base body side batt layer 22 is a single layer.

[0048] Although the base body side batt layer 22 is double-layered in Figure 2, it may comprise three or more layers.

[0049] The ratio of the volume of the core and the sheath members of the core-in-sheath fiber 41 can range from 5: 1 to 1:5, but preferably 1:1.

[0050] The nylon fiber 42 used for the wet paper web contact side batt layer 21, the press side batt layer 23, and for the blend with the core-in-sheath fiber 41 is preferably nylon 6, nylon 66, nylon 46, nylon 610, and nylon 612 etc.

[0051] Preferably, the base body 30 is a fabric woven with a warp yarn 31 (CMD yarn) and a weft yarn 32 (MD yarn) which are monofilament single yarns. It can be a double cloth such as [2/1, 1/2], [3/1, 1/3], and [5/1, 1/5], a triple cloth, or multilayered texture such as [a single cloth + a double cloth], [a double cloth + a double cloth] . The monofilament single yarn may be the one with a diameter of 0.1mm-0.6mm and a yarn density of the texture can be 10-100 yarns/25mm.

[0052] However, the base body 30 need not be a woven fabric, and other structures and methods can be employed as appropriate, such as simply overlapping an MD yarn and a CMD yarn, a film, a knitted fabric, or winding a narrow belt-shaped body to make a belt-shaped body of relatively large width. Further, appropriate materials for the base body 30 include natural fibers such as wool, and synthetic fibers such as polyester, nylon 6, and nylon 66 which have superior abrasion and fatigue resistance, distensibility, and antifouling properties.

[0053] Preferable fineness of the core-in-sheath fiber 41 is 15-25dtex for a pick-up felt used in a first press in a press section of a papermaking machine, 10-20dtex for a felt in a second and third press, and 5-20dtex for a felt in a fourth press and a shoe press.

[0054] Preferred fineness of the nylon fiber 42 is 10-25dtex and 15-25dtex for the paper side batt layer 20 and the press side batt layer 23 of the pick-up felt used in the first press respectively, whereas it is 10-15dtex and 10-20dtex for the corresponding layers of the felt used in the second and third press, and 5-15dtex and 5-20dtex for the corresponding layers of the felt used in the fourth press and the shoe press.

[Examples]

[0055] A first embodiment of the press felt of this invention is to be described using following examples. However, it should be noted that the present invention is not limited to these examples.

Production of the core-in-sheath fiber;

[0056] Refined nylon 6 (caprolactam, melting point: 220 degrees C) and copolymerized nylon 6/12 (caprolactam/ laurolactam, melting point: 140 degrees C) are individually put into an extruder with an opening to ablate volatiles. Melted nylon 6 of the core member and copolymerized nylon 6/12 of the sheath member are quantified by a metering gear pump and sent to respective spinning nozzles. Core-in-sheath fibers spun out of the spinning nozzles are reeled at a natural draw ratio after cooling and oiling, stretched, crimped, and then cut with a fixed length.

[0057] In the procedure above, a spinning machine of MODEL-EMF made by Toyo Seimitsu Kogyo Co., Ltd. can be employed, which can be used with an extruder, a multistage stretching machine of a Nelson roller system, and winder.

[0058] In the examples, high-molecular-weight nylon 6 (absolute viscosity: 85mPa·s at 25 degrees C, melting point: 220 degrees C)and middle-molecular-weight nylon 6 (absolute viscosity: 70mPa·s at 25 degrees C, melting point: 220 degrees C) are used for the core member and copolymerized nylon 6/12 (melting point: 140 degrees C) is used for the sheath member to produce two kinds of core-in-sheath staple fibers in which a volume ratio of the core and sheath member is 1:1. A fiber with the core member made of high-molecular-weight nylon 6 is hereinafter referred to as a composite fiber A, while the one with the core member made of middle-molecular-weight nylon 6 is referred to as a composite fiber B.

[0059] The absolute viscosity of 85mPa·s and 70mPa·s are 4.5 and 3.0ηr respectively in relative viscosity measured by generally-used Ubbelohde viscosimeter. For reference, absolute viscosity of 80 mPa·s equals 4.0ηr.

Production of the press felt for papermaking;

[0060] Examples and comparative examples are all provided with a common basic structure as follows so as to compare them under the same conditions;

Base body: Woven fabric A [a double cloth of (3/1, 1/3) using plied yarns made by twisting two yarns made of two nylon monofilaments of 240dtex for an MD yarn and a CMD yarn], basis weight: 300g/m^2

: Woven fabric B [a double cloth of (3/1, 1/3) using single yarns of 1100dtex nylon monofilament for an MD yarn and a CMD yarn], basis weight: 300g/m^2

Batt layer: staple fibers of 17 dtex nylon 6 and 17 dtex composite fibers A or B for the wet paper web contact side

batt layer, total basis weight: 120g/m^2
: staple fibers of 17 dtex nylon 6 and 17 dtex composite fibers A or B for the base body side batt layer (the first layer), total basis weight: 120g/m^2
: staple fibers of 17 dtex nylon 6 and 17 dtex composite fibers A for the base body side batt layer (the second layer), total basis weight: 120g/m^2
: staple fibers of 17 dtex nylon 6 for the press side batt layer, total basis weight: 100g/m^2
Needling frequency: 700 times/cm^2
Thermal pressurization: a needled felt was subjected to compression 5 times between a pair of calendar rolls (heated at 160 degrees C, with a pressure of 50kg/cm) at a speed of 2m/min to have a density of 0.5g/cm^3

[0061] The compositions of Examples 1-7 and Comparative Examples 1-7 are shown in Table 1 and 2 respectively.

(Table 1)

Examples	1	2	3	4	5	6	7	8
Wet Paper Web Contact Side Batt Layer	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon
Base Body Side Batt Layer(First Layer)	Composite FiberA 60%	Composite FiberA 40%	Composite FiberA 10%	Composite FiberA 60%	Composite FiberA 40%	Composite FiberA 70%	Composite FiberA 70%	Composite Fiber A 60%
Base Body Side Batt Layer (Second Layer)	Nylon	Nylon	Nylon	Composite FiberA 40%	Composite FiberA 10%	Nylon	Composite FiberA 40%	Nylon
Base Body	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric B
Press Side Batt Layer	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon

(Table 2)

Comparative Examples	1	2	3	4	5	6	7	8
Wet Paper Web Contact Side Batt Layer	Composite FiberA 60%	Composite FiberB 40%	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon
Base Body Side Batt Layer(First Layer)	Nylon	Nylon	Composite FiberA 5%	Nylon	Composite FiberA 5%	Composite FiberA 10%	Composite FiberA 40%	Nylon
Base Body Side Batt Layer(Second Layer)	Nylon	Nylon	Nylon	Nylon	Composite FiberA 5%	Composite FiberA 40%	Nylon	Nylon
Base Body	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven Fabric A	Woven B Fabric B
Press Side Batt Layer	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon	Nylon

[0062] Tests are conducted with following conditions and methods to evaluate anti-rewetting properties, resistance to compression fatigue, dehairing and abrasion resistance, and smoothness, using Examples and Comparative Examples listed above.

Evaluation of anti-rewetting properties;

[0063] Tests to evaluate anti-rewetting properties are conducted by using the apparatus shown in Figures 3 and 4.
[0064] In Figures 3 and 4, P is a press roll, 110 is an upper side felt, 10 is a downside felt, SC is a suction tube, and SN is a shower nozzle.
[0065] Examples and Comparative Examples of the above are all used as the downside felt 10, whereas Comparative Example 4 is used for the upper side felt.
[0066] The apparatuses shown in Figures 3 and 4 drive the felt at a speed of 500m/min with a pressure of 100kg/cm.
[0067] In the apparatus of Figure 3, a wet paper web released from compression within a nip is placed onto and transferred by the downside felt 10. Accordingly, water content data of a rewetted paper web can be gathered by measuring humidity of the paper web when it passes through the nip and is placed onto and transferred by the downside felt 10 (at a press exit 1).
[0068] On the other hand, in the apparatus of Figure 4, the downside felt 10 contacts with the press roll over a larger area, which means the wet paper web released from the nip pressure is in contact with the press felts 10 and 110 only briefly. Therefore, water content data of a slightly rewetted paper web can be gathered by measuring humidity of the paper web immediately after it traveled out of the nip (at a press exit 2).
[0069] Anti-rewetting properties can be evaluated based on the differences between the water content data gathered using the apparatuses of Figure 3 and 4. A felt with the difference less than 0.5% is regarded to be not rewetted (evaluated as "good"), whereas with the difference of 0.5%-less than 1.0% is regarded to be slightly rewetted (evaluated as "fair"), and with the difference of more than 1.0% is regarded to be rewetted (evaluated as "failure").

Compression fatigue resistance test;

[0070] Felts are subjected to 200,000 times of 10 Hz pulse load at 150 kg/cm^2. Resistance to compression fatigue is evaluated based on a ratio of density after tests to that of a finished felt, where the ratio of less than 1.4 is evaluated as "excellent", 1.40-1.49 as "good", and over 1.50 as "failure".

Dehairing and abrasion resistance test;

[0071] Dehairing and abrasion resistance of the felts was determined by means of a Taber abrasion tester based on JIS1023-1992. The amount of fibers dropped was measured by placing a discoidal sample piece on a rotating turntable and applying a rotating roll with intense resistance on the sample piece (load: 1kg, wheel: CS-17, rotation: 5000 times, unit of measurement: mg).
[0072] The amount of less than 50mg is evaluated as "excellent", with 50mg-99mg evaluated as "good" and over 100g evaluated as "failure".

Surface roughness test;

[0073] Smoothness of felt surfaces are determined by measuring average roughness Rz (μm) of 10 points of finished felts (JIS-B0601) before the dehairing and abrasion test. The average roughness of less than 30μm is evaluated as "excellent", with 30μm-70μm evaluated as "good" and over 71μm evaluated as "failure".
[0074] Results of measurement and evaluation are shown in Table 3.

(Table 3)

	Density (g/cm^3)	Compression Fatigue Resistance	Deha ing and Abrasion Resistance (mg)	Surface Roughness (μm)	Dewatering & Anti-rewetting Tests		
					Water Content at Press Exit 1 (%)	Water Content at Press Exit 2 (%)	Evaluation of Rewetting
Example 1	0.505	1. 46 (Good)	55 (Good)	25 (Excellent)	48.3	48.6	Good
Example 2	0. 505	1. 43 (Good)	60 (Good)	50 (Good)	48	48.5	Good

(continued)

	Density (g/cm^3)	Compression Fatigue Resistance	Deha ing and Abrasion Resistance (mg)	Surface Roughness (μm)	Dewatering & Anti-rewetting Tests		
					Water Content at Press Exit 1 (%)	Water Content at Press Exit 2 (%)	Evaluation of Rewetting
Example 3	0.500	1. 40 (Good)	75 (Good)	70 (Good)	47. 5	48.4	Fair
Example 4	0. 510	1.49(Good)	40 (Excellent)	20 (Excellent)	48.4	48.6	Good
Example 5	0.510	1.46(Good)	45 (Excellent)	35 (Good)	48. 3	48.4	Good
Example 6	0.505	1.49(Good)	55 (Good)	25 (Excellent)	48.5	48.6	Good
Example 7	0. 510	1.51(Failure)	40 (Excellent)	20 (Excellent)	48.4	48.6	Good
Example 8	0. 510	1.48(Good)	60 (Good)	25 (Excellent)	47.1	47.3	Good
Comparative Example 1	0.530	1.48(Good)	105 (Failure)	15 (Excellent)	49. 5	49.7	Good
Comparative Example 2	0.550	1. 51 (Failure)	130 (Failure)	20 (Excellent)	49. 5	49.7	Good
Comparative Example 3	0.500	1.35 (Excellent)	75 (Good)	80(Failure)	47.3	49	Failure
Comparative Example 4	0. 500	1.30 (Excellent)	80 (Good)	100 (Failure)	47	49	Failure
Comparative Example 5	0. 500	1.36 (Excellent)	75 (Good)	75(Failure)	47.3	48.4	Failure
Comparative Example 6	0. 505	1.47(Good)	70 (Good)	70 (Good)	48	49	Failure
Comparative Example 7	0.510	1.50(Failure)	75 (Good)	60 (Good)	48.1	48.6	Fair
Comparative Example 8	0.500	1.30 (Excellent)	100 (Failure)	100 (Failure)	46	48.6	Failure

[0075] As indicated by the test results of Examples 1-5 in Table 3, it is determined that the press felt of this invention not only prevents rewetting but achieves a balanced combination of resistance to compression fatigue, dehairing and abrasion resistance, and smoothness.

[0076] Although Comparative Examples 1 and 2, in which the wet paper web contact side batt layer is made of the core-in-sheath fiber, are superior in terms of smoothness, they lack dehairing and abrasion resistance, and hence are not durable. In addition, they have anti-rewetting properties but not dewatering capability, as indicated by the water content data at both the exit 1 and 2.

[0077] Comparative Examples 3 and 5 with less than 10% of the core-in-sheath fiber in the base body side batt layer and Comparative Example 4 without such fibers, on the other hand, have resistance to compression fatigue but not anti-rewetting properties.

[0078] Further, Comparative Example 6, in which the content rate of the core-in-sheath fiber decreases incrementally from the press side toward the paper side of the base body side batt layer, does not have anti-rewetting capability, while it has all the other effects, i.e. resistance to compression fatigue, dehairing and abrasion resistance, and smoothness. The explanation may be that the density of the base body side batt layer and the wet paper web contact side batt layer is made relatively low due to the distance between the base body side batt layer (the second layer) and the wet paper web contact side batt layer, letting water within the base body side batt layer (the first layer) pass through the wet paper

web contact side batt layer to rewet the wet paper web when the press felt is released from nip pressure.

[0079] Furthermore, Comparative Example 7, in which middle-molecular-weight nylon is used for the core member of the core-in-sheath fiber, is inferior to examples with high-molecular-weight nylon in terms of resistance to compression fatigue.

[0080] And finally, Example 8, in which the base body is the fabric B woven with monofilament single yarns, is superior to Example 1, in which the base body is the fabric A woven with monofilament twist yarns, in terms of dewatering capability as indicated by the water content rate at both the press exits 1 and 2.

INDUSTRIAL APPLICABILITY

[0081] As stated above, according to the present invention, rewetting of the wet paper web can be avoided, because water within the press side layer is blocked from moving to the wet paper web side due to increased density of the base body side batt layer resulted from melting of the sheath member of the core-in-sheath fiber.

[0082] Moreover, the invention successfully enhances resistance to dehairing, abrasion, and compression fatigue of the press felt by enhancing viscosity of the core member of the core-in-sheath fiber, i.e. by using high-molecular-weight nylon. As a result, the press felt of this invention is made more durable, reducing the need for replacement, contributes to improve the quality of the finished paper with less fibers attached thereon due to dehairing and abrasion, and is capable of maintaining smoothness of the paper contact surface.

[0083] Further, since the base body side batt layer is made of the core-in-sheath fiber while the wet paper web contact side batt layer is made of nylon without the core-in-sheath fiber, the press felt of this invention is provided with a balanced combination of smoothness and resistance to dehairing, abrasion, and compression fatigue.

[0084] Furthermore, the present invention improves dewatering capability as well as resistance to dehairing and abrasion of the press felt by using a fabric woven with monofilament single yarns for the base body and thus enhancing water permeability thereof.

Claims

1. A press felt for papermaking comprising a base body and a batt layer having a wet paper web side layer and a press side layer;
   characterized in that said wet paper web side layer is composed of a wet paper web contact side batt layer and a base body side batt layer;
   said base body side batt layer having a core-in-sheath fiber comprising a core member made of high-molecular-weight nylon with an absolute viscosity of 80mPa·s or more and a sheath member made of nylon with a lower melting point than the core member; and
   said wet paper web contact side batt layer being made of nylon without said core-in-sheath fiber.

2. A press felt as claimed in Claim 1, in which a content rate of said core-in-sheath fiber in said base body side batt layer ranges from 10% to 60%.

3. A press felt as claimed in Claim 1 or Claim 2, in which said base body side batt layer has a plurality of layers in which the content rate of said core-in-sheath fiber increases incrementally from the press side toward the paper side thereof.

4. A press felt as claimed in Claim 1 to Claim 3, in which said base body is a fabric woven with a warp yarn and a weft yarn which are monofilament single yarns.

Fig.1

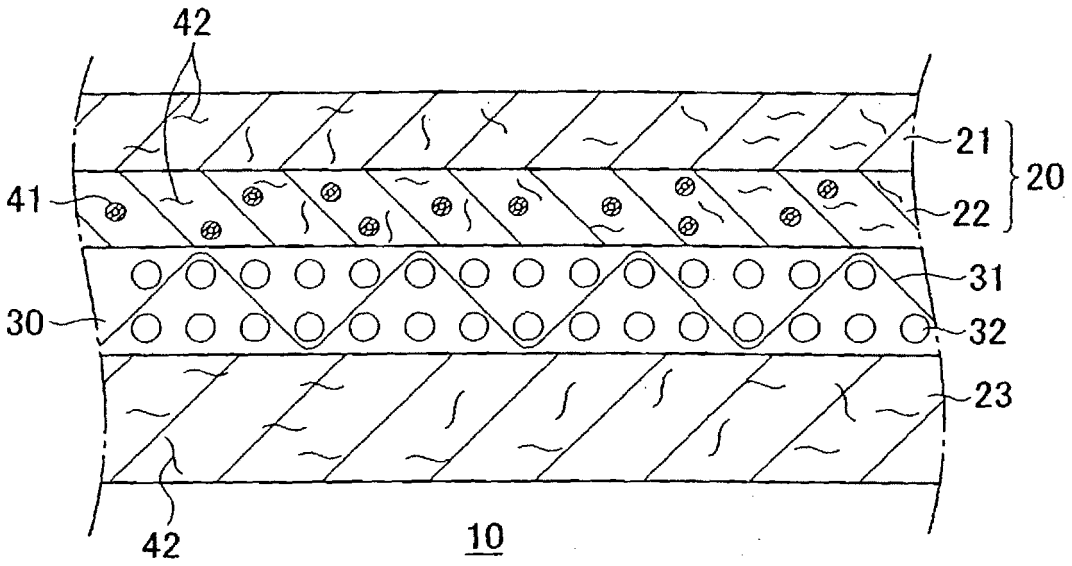


Fig.2

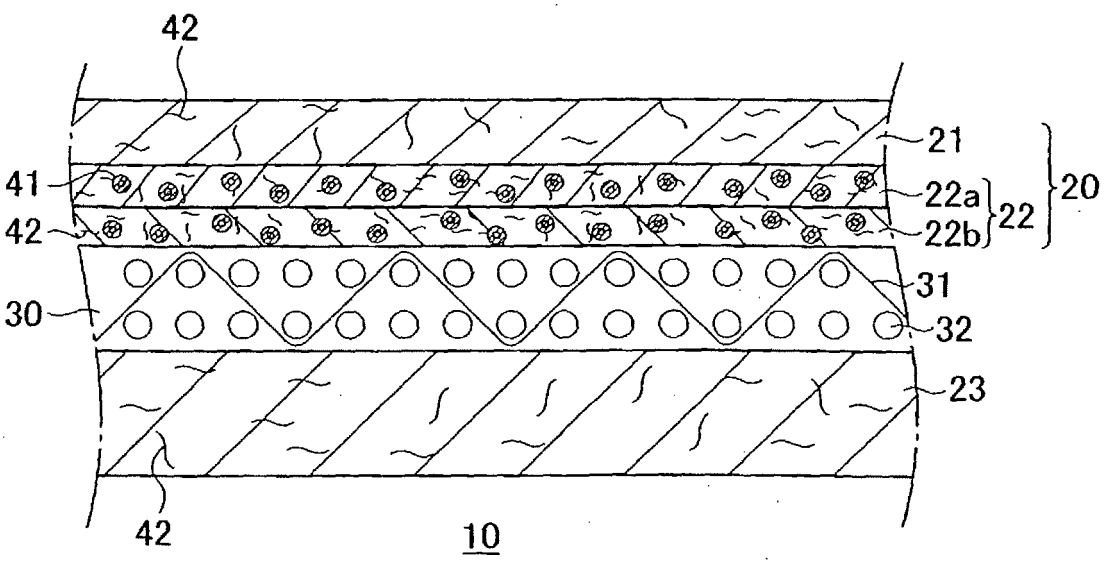


Fig.3

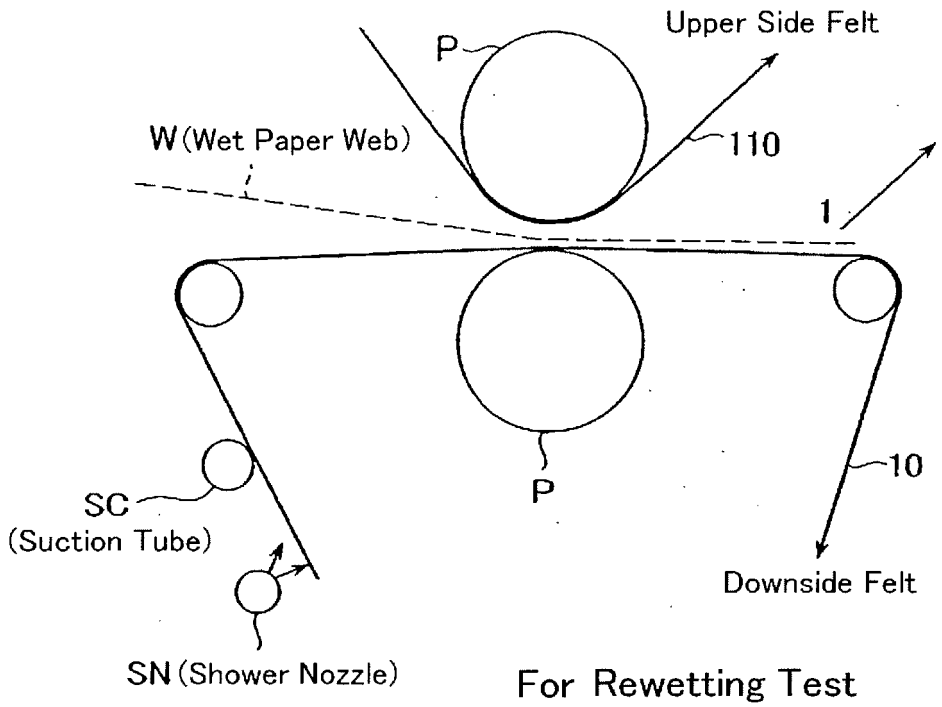
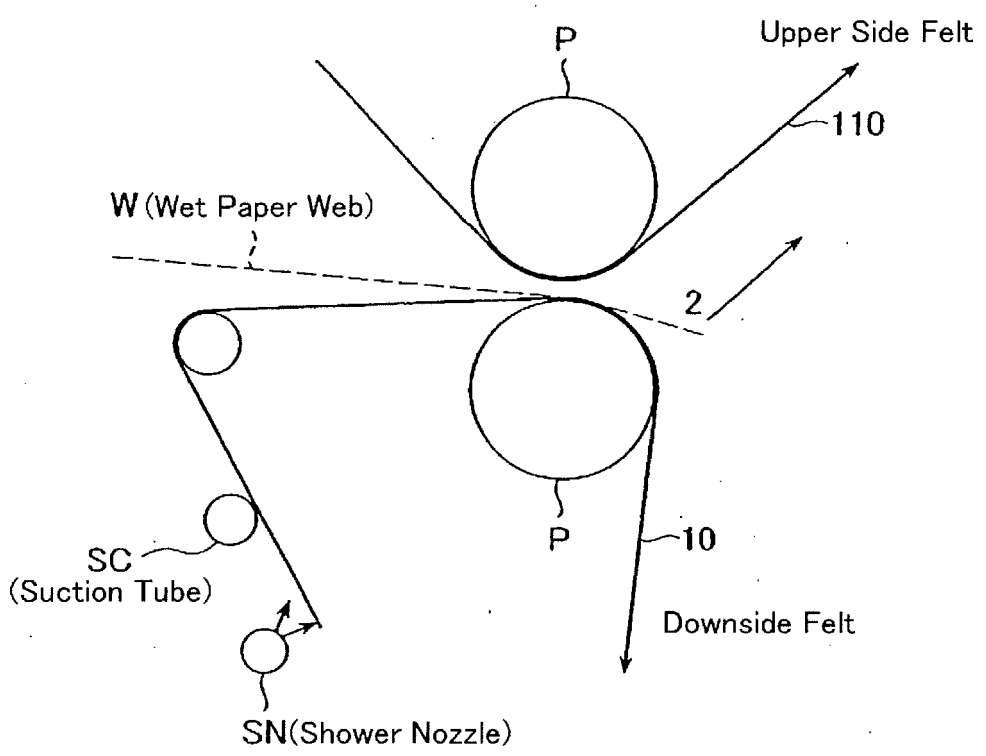
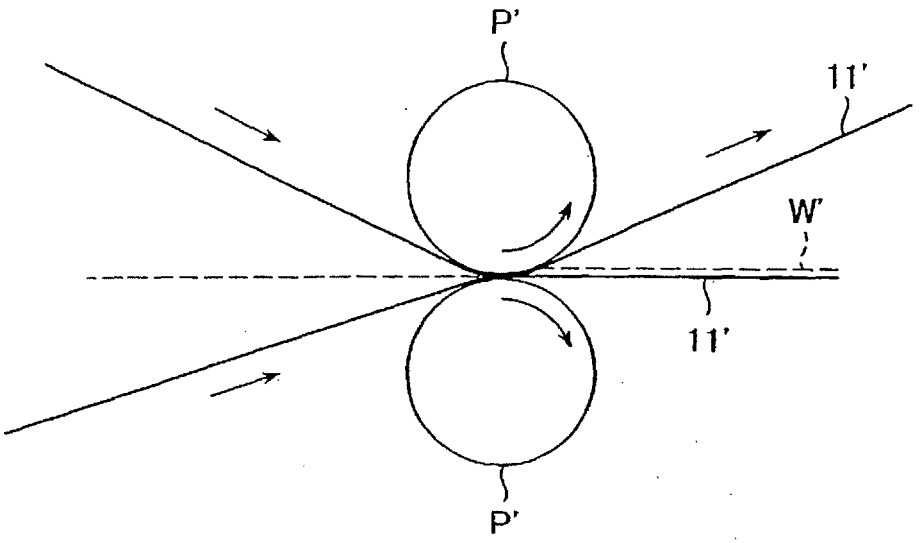

P
Upper Side Felt
W (Wet Paper Web)
110
1
P
10
SC
(Suction Tube)
Downside Felt
SN (Shower Nozzle)
For Rewetting Test
(to gather water content
data at press exit 1)

Fig. 4



For Rewetting Test
(to gather water content data at press exit 2)

Fig.5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/326405

A. CLASSIFICATION OF SUBJECT MATTER
D21F7/08(2006.01)i

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)
D21F7/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2006/001191 A1 (Ichikawa Co., Ltd.), 05 January, 2006 (05.01.06), Claims 1, 3 & JP 2006-009188 A	1,2,4 3
Y	JP 8-302584 A (Huyck Licensco, Inc.), 19 November, 1996 (19.11.96), Par. Nos. [0028], [0029], [0032] & US 5549967 A & EP 741204 A2	1,2,4
Y	JP 2000-170087 A (Ichikawa Keori Kabushiki Kaisha), 20 June, 2000 (20.06.00), Par. Nos. [0005], [0006] (Family: none)	4

☒ 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	Date of mailing of the international search report
03 April, 2007 (03.04.07)	17 April, 2007 (17.04.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/326405

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3-104995 A (Daiwabo Co., Ltd.), 01 May, 1991 (01.05.91), Claim 1; page 2, lower right column, lines 12 to 15 (Family: none)	1-4
A	JP 7-082685 A (Nippon Felt Co., Ltd.), 28 March, 1995 (28.03.95), Claims (Family: none)	1-4
A	JP 9-268431 A (Toray Industries, Inc.), 14 October, 1997 (14.10.97), Claim 1; Par. No. [0017] (Family: none)	1-4

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2004143627 A **[0006]**
- JP 8302584 A **[0008]**
- JP 2000170086 A **[0010]**
- WO 3025841996 A **[0012]**
- JP 2002529604 A **[0036]**