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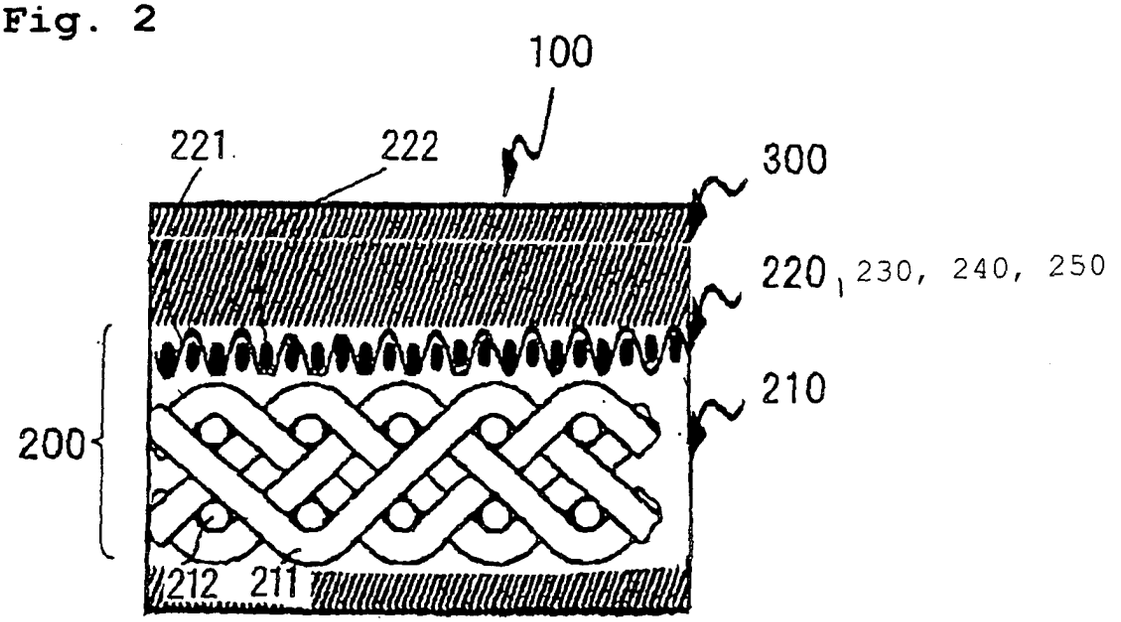
(54) Papermaking press felt and papermaking press apparatus

(57) A papermaking press felt (100) includes a plurality of base materials (200; 260; 210; 220; 230; 240; 250) of an identical or a different type; and a fiber web (300) layered on one or both faces of at least one of the base materials (210; 220) and integrally entwined therewith by needling. At least one of the base materials (210; 220; 230; 240; 250) is a woven fabric including a machine direction (MD) yarn (22; 212; 222) and a cross-machine direction (CD) yarn (21; 211; 221) such that one thereof is a twine made from a filament having a fineness of 50 to 250 dtex, and the other thereof is a single yarn having a fineness of 50 to 600 dtex.

Fig. 2



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Description

[0001] The present invention relates to a papermaking press felt (hereinafter simply referred to as "felt" as the case may be) and a papermaking press apparatus to be used in a papermaking machine. More particularly, the present invention relates to a papermaking press felt to be pressed in a pressing section of the papermaking machine so as to squeeze water out of a wet paper web, and to a papermaking press apparatus.

[0002] A papermaking machine is provided with a papermaking press apparatus (hereinafter simply referred to as "press apparatus" as the case may be), which dewaters a wet pulp (wet paper web) while it presses in its pressing section formed in a paper layer forming apparatus. Moisture in the wet paper web is squeezed out by applying a pressure thereto with the press apparatus.

[0003] For example, Fig. 4 schematically shows a configuration of a pressing section 700 of a conventional paper making machine, wherein a wet paper web (wet pulp) W transferred from a wire section 400 on the side of the paper layer forming apparatus is introduced to the pressing section side via a suction pick-up roll 701, and transferred to a first press 1P by a pick-up felt 101. The first press 1P is constituted as a double felt press through which the wet paper W passes between a first press roll (grooved roll) 703 and a suction press roll 702 via the pick-up felt 101 and a bottom felt 102, so that water is squeezed out of the wet paper W through a nip of these rolls 702 and 703 via the felts 101 and 102. Then, the wet paper W is transferred to a second press 2P by the suction press roll 702, to be dewatered by a nip of a second press roll (grooved roll) 704 and of a center roll 705. The wet paper web W further sticks to a surface of the center roll 705 to be thereby transferred to a third press 3P, and is again dewatered while passing between a nip portion of a third press roll (grooved roll) 706 and the center roll 705, together with a third press felt (P3 press felt) 103.

[0004] The wet paper W which has thus lost a considerable amount of water is further transferred to a fourth press 4P by a paper roll 708 and a fourth press felt 104, to be dewatered between a nip portion of a fourth press roll (grooved roll) 707 and a P4 top roll 709, and to finish the watering process in the pressing section. Then, the wet paper web W is transferred from the 4P top roll 709 to a subsequent drying process where a drier cylinder 710 and so forth are installed.

[0005] Basic functions of the papermaking press felt include squeezing water from a wet paper web (dewatering), providing surface smoothness of the wetpaper web (smoothness), and feeding the wet paper web forward (wet paper web transference).

[0006] Among the functions of the papermaking press felt, squeezing water from a wet paper web is performed such that water is transferred into the felt by a pressure while the wet paper web passes between a pair of press rolls, and the water in the felt is either discharged through a rear face of the felt, or aspired by a suction box of the papermaking machine, to then be discharged out of the felt system. Accordingly, water permeability and a function to recover the original shape instead of remaining flattened (durability against flattening) upon relief from the pressure are essential factors required from the felt. Also, the dewatering function based on such factors has to be maintained undegraded from an initial stage of use.

[0007] Also, among the functions of the papermaking press felt, when performing the feeding function of the wet paper web, the pick-up felt 101 aspires the wet paper web (wet pulp) from the wire section 400 via the suction pick-up roll 701 for transferring the same to the pressing section side, therefore durability of the water permeability is required, and also surface smoothness is important to ensure that the wet paper web W sticks to the felt and is kept from coming off.

[0008] Regarding the surface smoothing function (smoothness) of the papermaking press felt for the wet paper, it is necessary to upgrade the surface smoothness of the papermaking press felt in the posterior steps 3P or 4P of the pressing section, so as to minimize a difference between a contact area of the wet paper web W with the roll and that with the felt.

[0009] Therefore, the felt is required to be in well balanced for all these functions of dewatering, recovery against compaction and surface smoothing, in each section.

[0010] Most of papermaking press felts generally used are either of a batt-on-base type or batt-on-mesh type, constituted of a woven fabric on which a staple fiber batt web is planted by a needle-punch method.

[0011] Referring to Fig. 1, a structure of a popular felt will be described. A papermaking press felt 10 is composed of a base material 20 constituted of a woven fabric or the like and a staple fiber layer 30 integrally entwined with the base material 20 by needle-punching, and formed in an endless shape. The base material 20 is provided for securing a mechanical strength of the felt 10, and a fabric woven with an MD yarn 22 and a CD yarn 21 is employed in Fig. 1.

[0012] The felt 10 is utilized in a pressing section (Fig. 4) of the papermaking machine as 101 to 104, as already stated. More specifically, in the pressing section the felt is disposed over a plurality of guide rolls with a tension applied thereto. And a high pressure is applied to the felt and a wet paper web in the press section constituted of a pair of press rolls or of a press roll and a shoe, so as to squeeze water out of the wet paper web. Here, the felt 10 runs in conformity with a rotation of the press roll.

[0013] An environment where felt is used is becoming more and more harsh in recent years, because of an increase

in operating speed of a papermaking machine associated with the progress inproduction efficiency of the paper and an increase in pressure in a press section. Accordingly, such an increase in the speed of a papermaking machine and in pressure of a roll or a shoe in a pressing section for improving productivity, which is the latest trend with respect to papermaking machines, has incurred a drawback that the papermaking press felt becomes flattened by the high pressure and thereby loses its water permeability and capability of recovery against compaction, thus significantly degrading its dewatering performance.

[0014] Therefore, with respect to the water permeability and durability in dewatering performance based on the recovering capability against compaction, in particular among the functions required from the felt, a still higher performance is being required for use in a high-performance papermaking machine.

[0015] With an object to solve the above-mentioned problem, various structures have been proposed. For example, it has been proposed to increase a proportion of the base material in the felt, so as to prevent flattening of the felt. As a method of increasing the proportion of the base material, JP-A-2003-13385 and JP-A-6-280183 disclose a technique of stacking a plurality of layers of, for example, a double-woven endless base fabric, or a plurality of fabrics of a certain length joined together at the respective end portions thereof to constitute an endless structure, layering a staple fiber thereon, and integrally entwining the base fabric and the staple fiber layer by needling.

[0016] Meanwhile, during an initial period of use in a papermaking machine, the felt structure repeats compaction and recovery, to thereby gradually reduce its thickness. Accordingly, it is well known that the staple fiber of the felt structure is susceptible to flattening. This is because the staple fiber, which is finer than the base material, in felt structure becomes still finer due to the repeated compaction. In an ordinary felt, a staple fiber of 1 to 50 dtex, and more preferably that of 3 to 30 dtex is employed. In the case of employing a staple fiber having a thicker fineness than such values or a felt having a thinner staple fiber layer, flattening of the felt can be restrained, however surface smoothing performance for a wet paper web, which is one of the major functions of the felt, is degraded.

[0017] Here, a conventional technique for improving the surface smoothing performance for a wet paper web is known, for example, in JP-A-2003-13385. This literature discloses a felt structure including a nonwoven fabric formed by arranging yarns only in a transverse direction substantially in parallel, and interposed between two or more fabric layers. The interposed nonwoven fabric serves to alleviate an influence of a knuckle portion (ups and downs of the yarn at an interlacing point of an MD yarn and a CD yarn) of the woven fabric or the MD yarn, to the surface smoothing effect for the wet paper web. However, since a felt structure including such nonwoven cloth is heavier in basic weight, the dewatering performance and ease of installment are degraded.

[0018] Also, utilization of a flat yarn has been proposed, for improving the dewatering performance. An example is disclosed in US Patent No.5,651,394, wherein a twine made from a flat (having an oval cross-section) monofilament yarn is employed for constituting a woven fabric of a papermaking press felt, so as to improve ease of installment in a papermaking machine due to having less rigidity than a conventional woven fabric including a twine of a circular monofilament yarn, and dewatering performance, because of an increased volume of the woven fabric. This literature also describes that since such felt can absorb vibration cf the roll, vibration of the papermaking machine can be reduced. However, the twine made from such flat monofilament yarn has a bulky shape and moreover a distortion, which degrades the surface smoothing performance for the wet paper web.

[0019] It is an object of the present invention to provide a papermaking press felt having an upgraded dewatering performance which grants excellent surface smoothness to a wet paperweb, and particularly a papermaking press felt appropriate forhigh-speedrunning, yet capable of providing a smooth surface to the wet paper web, and a papermaking press apparatus provided with such felt.

[0020] Specifically, it is an object of the present invention to solve the above-mentioned problems by providing a papermaking press felt that offers an upgraded dewatering performance (water permeability), durability against flattening and surface smoothing performance for a wet paper web, and a press apparatus. This and related problems are solved by the papermaking press felt according to claim 1, and the papermaking press apparatus according to claim 7. Further aspects of the invention, improvements and embodiments are disclosed in the dependent claims, the description and the figures.

[0021] Upon studying a felt structure that fits the above-mentioned object, the present inventors have found that the object can be achieved by employing a base material constituted of two (A and B) or more layers; at least one base material B thereof is a woven fabric formed of a twine and a single yarn having a specific fineness, so that the twine turns to a flat cord when woven into the fabric.

[0022] The present invention thus provides a papermaking press felt comprising a plurality of base materials of an identical or a different type; and a fiber web layered on one or both faces of the base material and integrally entwined therewith by needling; wherein at least one of the base materials is a woven fabric constituted of a machine direction (MD) yarn or a cross-machine direction (CD) yarn, such that one thereof is a twine made from a filament having a fineness of 50 to 250 dtex, and the other thereof is a single yarn having a fineness of 50 to 600 dtex.

[0023] Preferably, the above-mentioned papermaking press felt includes a woven fabric having a closed end, more preferably a plain woven fabric, which is wound a plurality of times to thus form a plurality of fabric layers, such that

the gap between the aligned twines is filled by the flattening effect of the twine, to thereby improve the surface smoothing performance for the wet paper and resistance against flattening.

[0024] Preferably, a multiwoven fabric constituted of a double-woven or a thicker structure, is employed as the base woven fabric, so that the gap between the aligned twines constituting the multiwoven fabric is filled by the flattening effect of the twine.

[0025] Further, for facilitating the twine to turn to a flat cord, it is effective to form a loosely twisted twine by giving a final twist of 30 to 100 times per meter, with a ratio of a preliminary twist against the final twist in a range of 1.2 to 1.4.

[0026] Also, to easily narrow the gap between the twines, it is effective to employ a soluble filament yarn as either the MD yarn or CD yarn, to implant thereon a staple fiber by needle-punching, and then to dissolve the single yarn for removal which further facilitates narrowing the gap between the twines.

[0027] The present invention also provides a papermaking press apparatus, in which the above-mentioned papermaking press felt is employed at least as one of the papermaking press felts for the pressing section.

[0028] Especially with respect to a closed draw type papermaking press apparatus designed to hold the wet paper between two pieces of felts for dewatering, which imposes a harsh condition because of a high-speed feeding and a high pressure, a superior resistance against flattening and surface smoothing capability for the wet paper web are required, however, since the papermaking press felt according to the present invention can stand such harsh conditions and maintain the superior dewatering capability to thereby provide a paper having an excellent surface smoothness, the present invention is particularly suitable for a closed draw type papermaking press apparatus.

[0029] The papermaking press felt according to the present invention employs a twine thicker in fineness than a staple fiber as either the MD yarn or the CD yarn, which can easily turn to a flat cord when woven into a fabric, therefore a gap between the twines in the woven fabric can be easily narrowed, and resultantly a papermaking press apparatus provided with such felt offers a superior surface smoothing capability for a wet paper web and resistance against flattening.

[0030] In particular, when the felt is employed in a papermaking press apparatus designed to hold the wet paper web between two pieces of felts for dewatering, a prominent improvement in surface smoothing capability for a wet paper web and resistance against flattening can be achieved.

[0031] The present invention may be more readily described with reference to the accompanying drawings:

Fig. 1 is a schematic cross-sectional view showing a conventional general-purpose papermaking press felt.

Fig. 2 is a schematic cross-sectional view showing a papermaking press felt according to the examples 1 to 4 of the present invention.

Fig. 3 is a schematic cross-sectional view showing a papermaking press felt according to the comparative example 1.

Fig. 4 is a schematic drawing showing a press apparatus of a papermaking machine.

Fig. 5 is a schematic drawing showing a press apparatus of a papermaking machine in which the press felt according to the present invention is installed.

Fig. 6 shows an apparatus for measuring compaction recovery performance and resistance against flattening of a felt.

Fig. 7 shows an apparatus for measuring water permeability coefficient of the felt.

[0032] According to one embodiment of the invention, as a result of weaving the fabric constituting the base material (B) with the above-mentioned twine and single yarn, the twine obtains a flat shape, and thereby a knuckle portion of the woven fabric becomes a plane, and moreover the flat shape of the twine facilitates narrowing a gap therebetween, by which the surface smoothing performance can be upgraded despite having a reduced staple fiber layer. Further, since the twine, which becomes flat, is thicker than the staple fiber, the flattening of the felt as a whole can be restrained.

[0033] Preferably, either of the MD yarn or the CD yarn is a twine formed by twisting filaments of 50 to 250 dtex, more preferably 100 to 200 dtex in fineness. A thickness of the twine is not specifically determined, however a twine of 500 to 3,000 dtex in fineness is generally employed.

[0034] For further ensuring the effect of the embodiment that the twine turns to a flat cord as a result of weaving the fabric with the twine and single yarn having a specific fineness, it is effective to form a loosely twisted twine by giving a final twist of 30 to 100 times per meter, with a ratio of a preliminary twist against the final twist in a range of 1.2 to 1.4. Employing such loosely twisted twine facilitates narrowing a gap between the twines constituting the woven fabric, since the twine easily turns to a flat cord when woven into the fabric.

[0035] Here, in the case where the twine is twisted more than 100 times per meter either in the preliminary twist or final twist, the twine becomes a tightly twisted twine, which is not appropriate for achieving the advantage that the twine turns to a flat cord when woven into the fabric. When the ratio of the preliminary twist against the final twist is in a range of 1.2 to 1.4, the twine not only easily turns to a flat cord when woven into the fabric, but also attains a stable structure free from bumps or loosening. In the case where the ratio of the preliminary twist against the final twist deviates from

the range of 1.2 to 1.4, the twine incurs distortions and end downs in the woven fabric and is thereby restrained from becoming flat.

[0036] Also, it is preferable that either of the MD yarn or the CD yarn is a single yarn of 50 to 600 dtex, more preferably 100 to 400 dtex in fineness. Employing such single yarn as either of the weaving yarns allows reducing an area occupied with a knuckle in the woven fabric. This also leads to an improvement of the surface smoothing performance for a wet paper web.

[0037] According to the embodiment of the invention, a felt is provided wherein a gap between twines can be effectively narrowed in a woven fabric, to thereby improve the surface smoothing performance for a wet paper web and resistance against flattening. Various methods may be employed for facilitating narrowing a gap between the twines, one of which is employing a woven fabric having a closed end, preferably a plain woven fabric, and winding such a woven fabric a plurality of times to thus form a plurality of fabric layers, such that the gap between the aligned twines is filled by the flattening effect of the twine. Such a woven fabric has an increased advantage that the twine in an upper fabric layer can be so easily flattened that it fills a gap between the twines in a lower fabric layer, and moreover the twine in the lower fabric layer itself also easily becomes flat so as to narrow the gap between the twines.

[0038] Also, in another embodiment intended for narrowing the gap between the twines, a multiwoven fabric constituted of a double-woven or a thicker structure, is employed as the base woven fabric, so that the gap between the aligned twines constituting the multiwoven fabric is filled by the flattening effect of the twine, which further facilitates narrowing a gap between the twines of the woven fabric, as in the case of the above-mentioned woven fabric.

[0039] Also, for further facilitating the twine to turn to a flat cord when woven into the fabric, and to fill the gap between the aligned twines by the flattening effect, it is effective to reduce the number of interlacing points of the MD yarn and the CD yarn in the woven fabric. For such a purpose, the single yarn employed as either the MD yarn or CD yarn may be a soluble filament, more particularly a water-soluble filament yarn. Employing a woven fabric constituted of such yarn, implanting thereon a staple fiber by needle-punching, and then dissolving the single yarn for removal further facilitates narrowing the gap between the twines.

[0040] Materials of the soluble filament yarn include a polyvinyl alcohol, an acrylic, a polyester and so forth, among which the water-soluble polyvinyl alcohol is preferable.

[0041] Except for the case of employing the soluble filament, a nylon, a polyester and so forth are employed as materials of a twine and the single yarn to weave the fabric, among which the nylon is particularly preferable because of its superior strength and durability.

[0042] Referring to Fig. 2, an embodiment of the present invention will be described. To start with, a papermaking press felt 100 according to the present invention includes a base material 200 and a staple fiber layer 300. The staple fiber layer 300 is formed by integrally entwining the staple fiber with the base material 200 by needle-punching. The base material 200 includes two base materials, namely a base material A (210) and a base material B (220). One of these 210 serves to secure a mechanical strength of the felt 100, and various materials may be employed for constituting the same without a specific limitation, as long as the material provides an adequate strength. For example, a woven fabric constituted by weaving the MD yarn 212 and the CD yarn 211 may be employed. While two different types of the base materials 210 and 220 are layered in Fig. 2, a similar material maybe employed as long as the base material B 220 satisfies the requirement of the present invention.

[0043] The base material 210 may be a woven fabric constituted of a MD yarn and a CD yarn having a narrower width than that of a felt to be manufactured, which is spirally wound with adjacent edge portions thereof joined to each other. Further, a woven fabric constituted of a MD yarn and a CD yarn having substantially the same width as that of a felt to be manufactured may be coaxially wound, for constituting the base material. Also, apart from a base material constituted of a woven fabric, a base material in which the MD yarn is fixed with an adhesive, or in which the MD yarn and the CD yarns are only layered without being woven may be employed.

[0044] According to the present invention, another base material B 220 is layered on the base material A 210, so as to constitute an entirety of the base material 200. The base material 220 is a woven fabric constituted of a machine direction yarn (MD yarn) 222 and a cross-machine direction yarn (CD yarn) 221, which are features of the present invention. That is, either of the MD yarn or the CD yarn is a twine made from a filament of 50 to 250 dtex in fineness, and the other thereof is a single yarn of 50 to 600 dtex in fineness, in the woven fabric.

[0045] The present invention also provides a papermaking press apparatus in which the above-mentioned felt is installed. The felt of the present invention may be applied to any type of papermaking machine in addition to the one shown in Fig. 4, however, in the case where the felt is employed in a closed draw type papermaking press apparatus designed to hold the wet paper web W from both sides with a top felt and a bottom felt and to transfer and press, the advantage of the felt of the present invention can be more effectively attained.

[0046] The closed draw type press apparatus is, as shown in Fig. 5, constituted so as to hold the wet paper web W between the top felt 101 and the bottom felt 102 for transference and pressing, in order to sustain the high-speed feeding performance for the wet paper. As a result, the wet paper is assuredly retained stably (without break) between the felts or on the felt at a highspeed, throughout the entire travel in the pressing section.

[0047] The papermaking press apparatus 800 shown in Fig. 5 represents a configuration wherein two pressing apparatuses, namely a first press apparatus 810 and a second press apparatus 820 provided on a downstream side thereof, are installed in series along a feeding direction of the wet paper web W, and the first press apparatus 810 is provided with a first roll 811 and a first shoe press 812. The second press apparatus 820 is provided with a second roll 821 and a second shoe press 822.

[0048] In the first press apparatus 810, usually the shoe press apparatus is employed which applies a higher pressure than a conventional papermaking machine, because of which the pick-up felt 101 and the bottom felt 102 are prone to be flattened to thereby lose the dewatering capability, however, employing the felt of the present invention here results in significant improvement in the dewatering performance.

[0049] In the case of the second press apparatus 820 also, since the wet paper web W is held between the top felt 105 and the bottom felt 106 for transference and pressing, it is desirable to employ the felt of the present invention for the top felt 105 and the bottom felt 106, to further ensure durability of dewatering performance and surface smoothness of the wet paper web W.

[0050] Further, while Fig. 6 shows a papermaking press apparatus constituted of two shoe press apparatuses installed in series, one of the shoe press apparatuses may be substituted with a roll press apparatus, or may be omitted. However, in any of the cases, employing the felt of the present invention allows achieving a superior performance in dewatering, surface smoothing and so forth.

[EXAMPLES]

[0051] Hereunder, the present invention will be described in further detail based on several examples. In all the examples, another base material B (220, 230, 240, 250) respectively representing a feature of the present invention is layered on the base material A (210) so as to constitute an entirety of the base material 200.

[0052] The base material A 210 is constituted as follows, in all the examples in common.

Structure of the base material 210:

[0053]

(1) MD yarn and CD yarn
The twines specified below have been employed in common, as both of the MD yarn and the CD yarn.
(2) Twisting condition: "2/2/220" (the values respectively correspond to "the number of preliminarily twisted filaments for final twisting/the number of single filaments for preliminary twisting/fineness of the single filament = dtex")
(3) Preliminary twisting: S-twist, 250 times per meter
(4) Final twisting: Z-twist, 160 times per meter
Both the preliminary, twisting and the final twisting are more than 150 times per meter, by which the twines are defined as tightly twisted twines.
(5) Twisting ratio (preliminary/final): 1.56
(6) Weaving:

MD yarn: 120 rows/5 cm, CD yarn: 40 rows/5 cm
3/1 1/3 endless double woven

[EXAMPLE 1]

[0054] As shown in FIG. 2, a felt has been fabricated by layering the following woven fabric 220 as the base material B on the base material A (210) to constitute the base material 200, and further forming the staple fiber layer 300 (11 dtex, 600 g/m^2).

Structure of the woven fabric 220:

[0055]

(1) MD yarn: The twine specified below has been employed.

(a) Twisting condition: "2/2/220"
(b) Preliminary twisting: S-twist, 42 times per meter
(c) Final twisting: Z-twist, 30 times per meter

(d) Twisting ratio (preliminary/final): 1.40

(2) CD yarn: single yarn (fineness 330 dtex)
(3) Weaving:

MD yarn: 40 rows/5 cm, CD yarn: 34 rows/5 cm
3/1 plain endless single woven

[EXAMPLE 2]

[0056] A felt of a similar structure to that of the example 1 has been fabricated, except that the following woven fabric 230 has been employed as the base material B instead of the woven fabric 220. In other words, 230 is layered instead of 220 in Fig. 2.

Structure of the woven fabric 230:

[0057]

(1) MD yarn, CD yarn: The same as those of example 1.
(2) Weaving:

MD yarn: 40 rows/5 cm, CD yarn: 34 rows/5 cm
3/1 plain single woven with an end closed, wound twice

to constitute the layered woven fabric 230.

[EXAMPLE 3]

[0058] A felt of a similar structure to that of the example 2 has been fabricated, except that the woven fabric 240 in which the MD yarn and the CD yarn are replaced with each other has been employed as the base material B, instead of the woven fabric 230. In other words, 240 is layered instead of 220 in Fig. 2.

[EXAMPLE 4]

[0059] The base material 200 has been constituted by layering the woven fabric 250 serving as the base material B, in which a water-soluble PVA single yarn is employed as the CD yarn, on the base material 210 (250 is layered instead of 220 in Fig. 2). Then the staple fiber has been integrally entwined with the base material 200 by needle-punching so as to fabricate the papermaking press felt 1000, after which the CD yarn has been dissolved by hot water refining in a subsequent process, so that a layer 250 only including the MD yarn remains on the base material 210.

Structure of the woven fabric 250:

[0060]

(1) MD yarn: The same as the woven fabric 220 (example 1)
(2) CD yarn: Monofilament made of polyvinyl alcohol, 400 dtex
(3) Weaving: The same as example 2

[COMPARATIVE EXAMPLE 1]

[0061] As shown in Fig. 3, a woven cloth 260 constituted by layering the same base material 210 on the base material 210 has been employed, on which the staple fiber 300 has been layered as the examples, so as to fabricate the felt.
[0062] Staple fiber has been implanted by needle-punching on the woven fabrics prepared according to the above-mentioned examples 1 to 4 and the comparative example 1, and such needle-punched felts have been refined in hot water and dried by hot air, to thereby complete the papermaking press felt. Table 1 shows a structure of the base material B in the respective examples.

[Table 1]

	Structure of base material B				Staple fiber layer
	Number	MD yarn	CD yarn	Weaving structure	Basic weight (g/m^2)
Example 1	220	Twine of the present invention	Single yarn of the present invention	Plain endless single woven fabric	600 g/m^2
Example 2	230	Same	Same	Plain single woven fabric with an end closed, wound twice	Same
Example 3	240	Single yarn of the present invention	Twine of the present invention	Same	Same
Example 4	250	Twine of the present invention	Water soluble PVA single yarn according to the present invention	Same	Same
Comparative example	210	Conventional twine	Twine of the present invention	Endless double woven fabric	Same

[0063] All these felts have been made with the same amount (basic weight: g/m^2) of staple fiber, and paper smoothness index, compaction recovery and resistance against flattening of these papermaking press felts have been evaluated through the following steps.

(1) Paper smoothness index

[0064] An inverse of a value obtained based on distribution of a distance between a peak and a trough of a surface unevenness of the papermaking press felt, according to JIS B061-1982 (surface roughness). The higher the index indicates, the smaller the distance distribution is, and therefore the smoothness is superior.

(2) Compaction recovery, resistance against flattening

[0065] The felts have been passed through an experimental apparatus as shown in Fig. 6, and a thickness of the felts have been measured by a sensor at an initial unpressed state, during compression by press rolls and after release from the pressure, and the compaction rate and recovery rate have been calculated by the following formula, thus to evaluate the compaction recovery performance and durability.

$$\text{Compaction rate (\%)} = t_1/t_0 \times 100$$

$$\text{Recovery rate (\%)} = (t_2 - t_1)/t_1 \times 100$$

(where t_0: felt thickness at an initial state

t_1: felt thickness when compressed

t_2: felt thickness immediately after release from pressure)

[0066] The experimental apparatus is provided with a pair of press rolls PR, PR, a plurality of guide rolls GR for supporting the felt applying a certain tension thereto, a sensor (not shown) for measuring a felt thickness when compressed by the press rolls, and a second sensor (not shown) for measuring the felt thickness immediately after being released from the pressure. The experimental apparatus has been operated so as to generate a pressure of 100 kg/cm and a felt driving speedof 1000 m/minute, and the experiments have been continued for 120 hours.

[0067] Based on the values of the compaction rate and the recovery rate obtained through the above measurement, an overall evaluation of the resistance against flattening has been carried out with respect to the examples and the comparative example, and the results are shown below in relative points. Here, the value of the example 1 is defined as 3 points, which is used as a reference such that a higher point in other examples is regarded as good and a lower point as poor, and that the higher the point is, the better performance is considered to be achieved.

(3) Evaluation of durability of water permeability (water permeability coefficient)

[0068] An experimental apparatus as shown in Fig. 7 has been employed to impose a load of 30 kg on the felt which has been dipped in water for an hour, and a time taken for passing 30 liters of water from a front face of the felt to a rear face thereof has been measured. Such measurement has been executed with respect to specimens not subjected to the above-mentioned evaluation of compaction recovery and resistance against flattening and the specimens that have gone through the 120 hour test, and a variation of water permeability (water permeability coefficient) has been worked out based on the respective measured values utilizing the following formula, so as to evaluate the durability of water permeability. The higher the coefficient is, the lower the durability of water permeability.

Water permeability coefficient (%) = (water passing time

of tested specimens) / (water passing time of untested specimens)

x 100

[0069] With respect to the felts fabricated according to the examples and the comparative example, the measured physical properties are shown in Table 2.

[Table 2]

	Evaluation				
	Paper smoothess index	Resistance against flattening			Water permeability coefficient
		Compact ion rate	Recovery rate	Total evaluation of resistance against flattening	
Example 1	0.012	34%	28%	3	137%
Example 2	0.015	37%	31%	5	121%
Example 3	0.014	37%	31%	5	119%
Example 4	0.020	35%	30%	4	123%
Comparative example	0.007	32%	26%	2	152%

[0070] As is apparent in view of the results shown in Table 2, all the papermaking press felts of the examples, provided with the layered woven fabric constituted of the MD yarn and the CD yarn such that either of the MD yarn or the CD yarn is a twine made from a filament of 50 to 250 dtex in fineness, and the other thereof is a single yarn of 50 to 600 dtex in fineness according to the present invention, have achieved good points in both the paper smoothness index and resistance against compaction, while the felt according to the comparative example, provided with the base material 210 in which the same twine is employed as the MD yarn and the CD yarn has only shown a poor performance in both

the paper smoothness index and resistance against compaction. Inaddition, regarding the felt of the example 4 in which the water-soluble single yarn is employed as the CD yarn, since the CD yarn is dissolved at an interlacing point of the MD yarn and the CD yarn and no longer remains in the woven fabric, the felt achieves a superior surface smoothness.

[0071] Based on such results, it is effective to employ the felt according to the examples 2 and 3 as the pick-up felt of a papermakingmachine, because of the superior resistance against flattening and durability in water permeability. By contrast, for the posterior stages (3P, 4P), where surface smoothness is particularly essential, it is effective to employ the felt according to the example 4 which has achieved an excellent result in paper smoothness index.

[Industrial Applicability]

[0072] The embodiment of the invention provides a felt having a superior surface smoothing capability for a wet paper web and resistance against flattening. In the case of employing such a felt as a papermaking press felt, the surface smoothing capability for a wet paper web can be maintained and flattening is restrained, because of the superior compaction rate and recovery rate against a pressure applied by a roll or a shoe during a papermaking process, and resultantly the superior dewatering performance can be maintained for a long period of time.

[0073] Also, employing a soluble filament yarn as either the machine direction (MD) yarn or the cross-machine direction (CD) yarn constituting the woven fabric results in producing a paper of a superior surface smoothness.

[0074] The felt of the embodiment may be applied to various types of papermaking machines, however, in the case where the felt is employed in a closed draw type papermaking press apparatus, the advantage in resistance against flattening and surface smoothing performance for a wet paper can be duly attained despite the high-speed operation.

[0075] Also, this type of press apparatus applies a higher pressure than a conventional papermaking machine, because of which the felt is prone to be flattened to thereby lose the dewatering capability, however, employing the felt of the present invention having a superior resistance against flattening allows maintaining a high-level dewatering performance. In addition, degradation in smoothness because of loss of direct contact between the wet paper and the roll surface can also be overcome by employing the felt according to the embodiment of the present invention. Thus, since the felt of the present invention provides various advantages, the felt can be appropriately employed as a high-performance felt, under the current harsh operational conditions such as high speed and high pressure.

Claims

1. A papermaking press felt (100), comprising:

a plurality of base materials (200; 260; 210; 220; 230; 240; 250) of an identical or a different type; and
a fiber web (300) layered on one or both faces of at least one of the base materials (210; 220) and integrally entwined therewith by needling;

wherein at least one of the base materials (210; 220; 230; 240; 250) is a woven fabric including a machine direction (MD) yarn (22; 212; 222) and a cross-machine direction (CD) yarn (21; 211; 221), such that one thereof is a twine made from a filament having a fineness of 50 to 250 dtex, and the other thereof is a single yarn having a fineness of 50 to 600 dtex.

2. The papermaking press felt as claimed in claim 1, wherein the woven fabric (210; 220; 230; 240; 250) is woven with an end portion thereof closed, and the woven fabric (210; 220; 230; 240; 250) is wound a plurality of times to thus form a plurality of fabric layers, such that the gap between the aligned twines is filled by the flattening effect of the twine.

3. The papermaking press felt as claimed in claim 1 or 2,
wherein the woven fabric (210; 220; 230; 240; 250) is a plain woven fabric.

4. The papermaking press felt as claimed in any one of claims 1-3,
wherein the woven fabric (210; 220; 230; 240; 250) is a multiwoven fabric including a double-woven or a thicker structure, and
the gap between the aligned twines forming the multiwoven fabric is filled by the flattening effect of the twine.

5. The papermaking press felt as claimed in any one of claims 1-4,
wherein the twine is a loosely twisted twine given a final twist of 30 to 100 times per meter, with a ratio of a preliminary twist against the final twist in a range of 1.2 to 1.4.

6. The papermaking press felt as claimed in any one of claims 1-5, wherein either of the machine direction (MD) yarn (22; 212; 222) or a cross-machine direction (CD) yarn (21; 211; 221) constituting the woven fabric (210; 220; 230; 240; 250) is a soluble filament.

7. A papermaking press apparatus (800; 810; 820) comprising:

a pressing section (810; 820) including a papermaking press felt (100; 101; 102; 105; 106);

wherein the paper making press felt includes:

a plurality of base materials (200; 260; 210; 220; 230; 240; 250) of an identical or a different type, and
a fiber web (300) layered on one or both faces of at least one of the base materials and integrally entwined therewith by needling; and
at least one of the base materials (210; 220; 230; 240; 250) is a woven fabric including a machine direction (MD) yarn (22; 212; 222) and a cross-machine direction (CD) yarn (21; 211; 221), such that one thereof is a twine made from a filament having a fineness of 50 to 250 dtex, and the other thereof is a single yarn having a fineness of 50 to 600 dtex.

8. The papermaking press apparatus as claimed in claim 7, wherein the papermaking press apparatus (800; 810; 820) includes two pieces of felts that hold a wet paper web therebetween to dewater from the wet paper web; and
at least one of the two pieces of felts includes the papermaking press felt.

9. The papermaking press apparatus as claimed in claim 8, further comprising:

a first press apparatus (810) which holds a wet paper web with two pieces of felts (101; 102) for dewatering therefrom; and
a second press apparatus (820) installed on a downstream side of the first press apparatus (820);

wherein at least one of a pick-up felt and a bottom felt (101; 102) of the first press apparatus (810) and a top felt and a bottom felt (105; 106) of the second press apparatus (820) includes the papermaking press felt.

10. The papermaking press apparatus as claimed in claim 8, further comprising:

a first press apparatus (810) which holds a wet paper web with two pieces of felts (101; 102) for dewatering therefrom; and
a second press apparatus (820) installed on a downstream side of the first press apparatus (810);

wherein each of a pick-up felt and a bottom felt (101; 102) of the first press apparatus (810) and a top felt and a bottom felt (105; 106) of the second press apparatus (820) includes the papermaking press felt.

11. The papermaking press apparatus as claimed in claim 8, further comprising: a first press apparatus (810) which holds a wet paper web with two pieces of felts (101; 102) for dewatering therefrom; wherein the papermaking press felts is installed in the first press apparatus (810).

Fig. 1

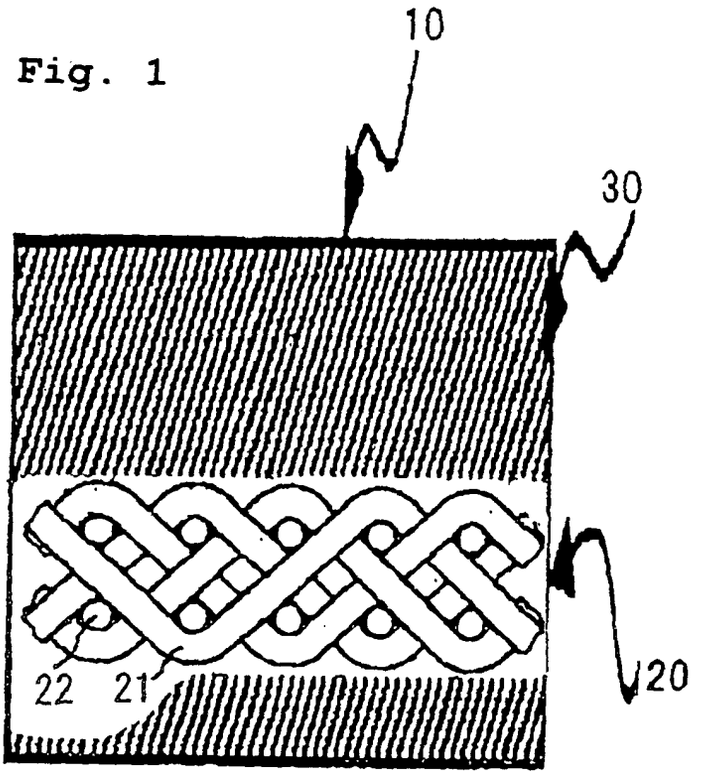

Fig. 2

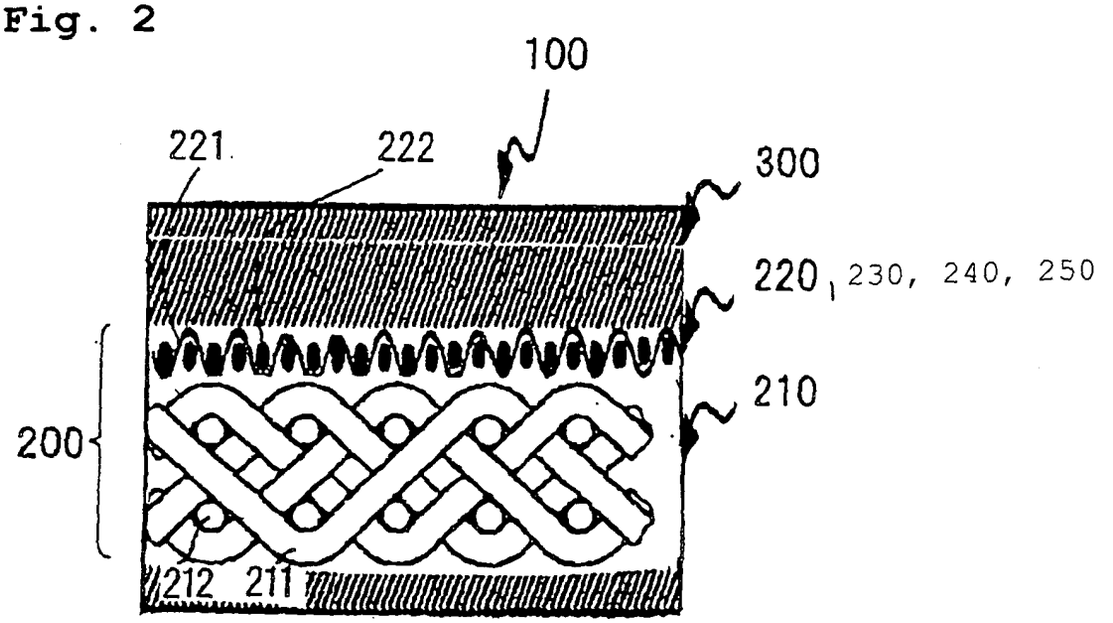

Fig. 3

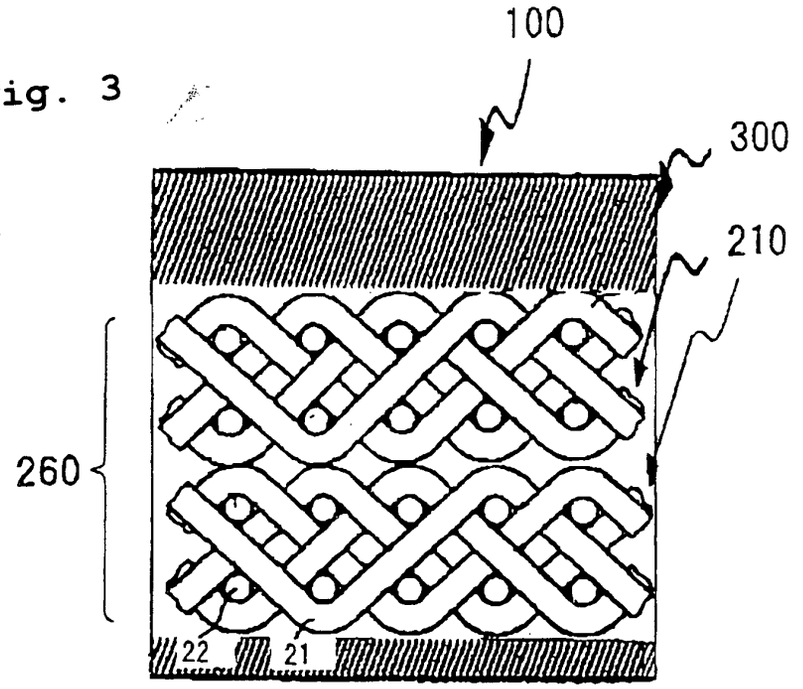

Fig. 4

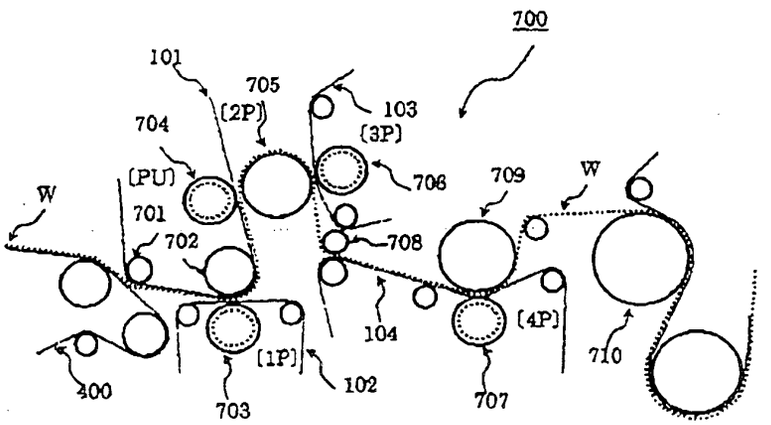

Fig. 5

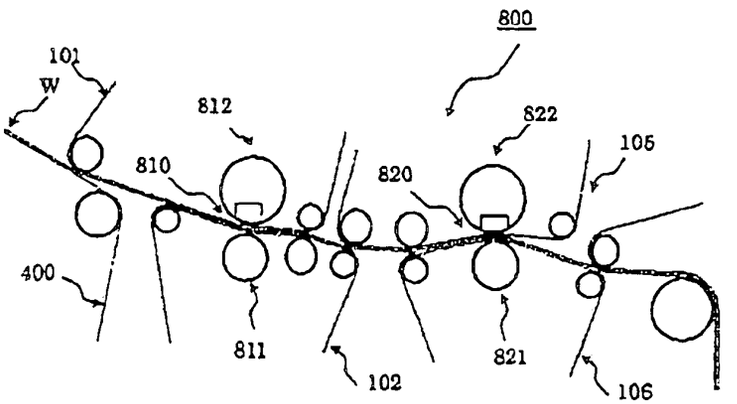

Fig. 6

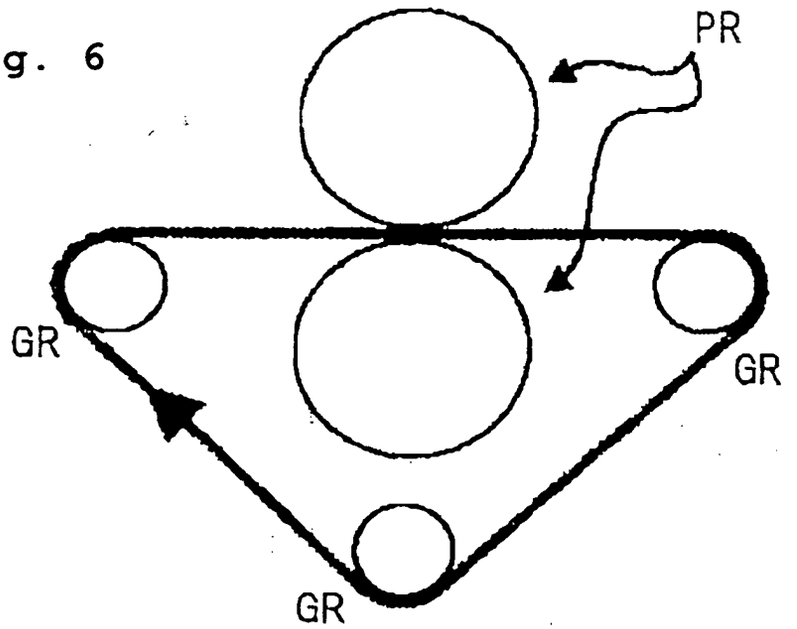

Fig. 7