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(54) Press roll for paper machines
Presswalze für Papiermaschinen
Rouleau presseur pour machines à fabriquer le papier

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(56) References cited:
EP-A- 0 207 921
DE-A- 2 914 308

• PAPIER, DAS. vol. 44, no. 10A, October 1990,
  DARMSTADT DE pages 143 - 155; K.
  HAIDENTHALER ET AL.: 'Ist der Naturstein
  Granit als Walzenbezug in der Papierindustrie
ewforderlich?'

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The present invention relates to a paper machine press roll according to the preamble of claim 1.

More particularly, the invention relates to a press roll for use in the press section of a paper machine for removing water from wet paper and making the paper smooth-surfaced.

The EP-A 207 921 discloses a paper machine press roll comprising a metal core, a ground layer formed over the outer periphery of the core and made of a metal material having a smaller coefficient of expansion than the metal material forming the core, and a ceramic layer formed over the outer periphery of the ground layer. The ceramic layer has a surface roughness of 0.1 to 3.0 \( \mu \text{m} \) (Rmax).

The JP-A 60-4616 of applicant describes a press roll of an artificial stone wherein hydrophilic coarse grains in average size of 200 \( \mu \text{m} \) or more and hydrophilic fine powders in average size of 100 \( \mu \text{m} \) or less are respectively combined with synthetic resin, and the content of these hydrophilic substances in the structure layer of the roll is arranged to a rate of 80% or more by weight. This roll has the disadvantage that the surface strength decreases. Moreover, abrasion resistance, doctor resistance and surface hardness decrease.

Roll presses are so adapted that wet paper supported on a felt is passed between two rotary rolls under pressure for the removal of water. In extended nip presses (ENP), the wet paper supported on a felt is dewatered by being passed between a rotary roll and a belt to which pressure is applied by a pressure shoe having a large nip width.

The rotary roll used in either of these systems has a hard surface in view of the pressing effect and surface smoothness. For example, the roll press comprises the combination of a rotary roll having a hard surface and serving as a top press roll and a rubber-covered roll or the like serving as a bottom press roll.

It is required that such hard-surfaced rotary rolls are usable over a prolonged period of time, withstanding a high load and high-speed rotation. To meet this requirement, stone rolls of natural granite (granite rolls) are widely used. Generally, the stone roll can be mirror-finished over the surface, has high surface hardness, is resistant to abrasion by the doctor blade which is usually provided for removing bits of extraneous stock, permits smooth release of wet paper and is less prone to the deposition of pitch or the like contained in the pulp even when used for a long period. Because of these characteristics, the stone roll has the advantage of being less likely to cause breaks of paper during pressing.

While stone rolls are prepared from natural stone, the stone material is expensive and requires a long period for delivery since the material is difficult to obtain owing to the recent trend toward depletion of resources. In fact, extreme difficulties are encountered in collecting, transporting and processing large stones for making stone rolls which become longer and must be larger than in the past.

Further, because the material is a polycrystalline natural stone, there is a substantial problem in that the rolls produced differ in the surface characteristics (such as porosity, surface hardness and water retentivity), even a single roll often differing in such surface characteristics from portion to portion.

The main object of the present invention is to provide a press roll which is free of the foregoing problems for use in paper machines.

The paper machine press roll of the present invention is characterized by the features of claim 1.

The water retentivity imparting particulate substance is at least one powder selected from the group consisting of mica powder, glass baloons, glass beads, glass powder, stone powder, sand and fluorine-containing resin powder.

The metal core for use in the present invention is made, for example, of iron, stainless steel, copper, brass or the like.

The metal core is formed with a ground layer made of a metal material which has a smaller coefficient of expansion than the surface material of the metal core but a greater coefficient of expansion than ceramics.

The ground layer serves to bond a ceramic layer to the metal core and to prevent the core from corrosion. The ground layer of metal material is smaller than iron-type metals and copper-type metals in coefficient of expansion. To be suitable, the ground layer is usually about \( 9 \times 10^{-6} \) to \( 14 \times 10^{-6} \) /\( \text{C} \) in coefficient of expansion. From the viewpoint of corrosion resistance, examples of suitable materials for the ground layer are molybdenum-type metals and nickel-type metals, among which nickel-chromium alloys and nickel-chromium-aluminum alloys are especially preferable.

The ground layer is formed, for example, by gas spray coating or gas plasma spray coating using the desired metal in the form of particles.

The ground layer has a thickness of about 100 to about 500 micrometers, and serves as a kind of buffer in the event of thermal expansion, preventing the separation between the core and the ceramic layer effectively due to thermal expansion.

When required, a corrosion inhibiting coating may be formed between the ground layer and the core to protect the core from corrosion.

Examples of materials for forming the corrosion inhibiting coating are nickel, nickel-aluminum alloys, copper, stainless steel, etc. Preferably, the coating is 100 to 500 micrometers in thickness.

The mixture layer comprising the ceramic and the water retentivity imparting particulate substance such as mica, contains 5 to 30 wt. % of the particulate substance as mixed with the ceramic.
If the amount of mica or like water retentivity imparting substance is less than 5 wt. %, the contemplated effect will not be available, whereas amounts exceeding 30 wt. % impair the surface roughness and give a lower strength to the mixture layer. The press roll obtained is therefore undesirable.

According to the invention, the mixture layer is formed from a powder of metal oxide for forming the ceramic and mica or like water retentivity imparting particulate substance, by covering the ground layer around the metal core with these materials by plasma spray coating (e.g. water-stabilized plasma spray coating or gas plasma spray coating). Thus, the mixture layer can be formed easily.

In this case, the ceramic and the particulate substance such as mica are mixed together and sprayed onto the ground layer at the same time, or the ceramic and the particulate substance are individually applied to the ground layer using separate powder feeders. In the latter case, it is desirable to feed the particulate substance to a low-temperature portion of the plasma used for spray coating, whereby the degradation of the particulate substance can be prevented.

Examples of typical metal oxides for forming the ceramic are gray alumina (94% Al₂O₃; 2.5% TiO₂), white alumina (99% Al₂O₃), titania (TiO₂), alumina-titania (Al₂O₃·TiO₂), mullite (Al₂O₃·SiO₂), zirconia-mullite (Al₂O₃·ZrO₂·SiO₂) and the like. These materials can be used singly or in admixture. Other metal oxide, low-melting alloy, metal carbide, metal nitride or the like which is applicable by spray coating can be admixed with such a material to form the ceramic.

The particle size of the material to be used for spray coating is 10 to 200 micrometers to be suitable.

Useful plasma spray coating apparatus are water-stabilized plasma spray coating apparatus wherein water is used as the plasma source, gas plasma spray coating apparatus wherein argon, helium, hydrogen or nitrogen is used as the plasma source, etc.

For spray coating, the core to be coated is rotated, whereby a layer can be formed which comprises a uniform mixture of ceramic and mica or like water retentivity imparting particulate substance. The thickness of the mixture layer to be formed is usually 1 to 30 mm although variable with the dimensions of the roll, pressure to be applied, etc.

Another feature of the present invention is that at least a surface layer portion of the mixture layer thus formed, at least one organic high polymer selected from the group consisting of synthetic resins and waxes is filled in the interstices between particles of the ceramic and particles of the water retentivity imparting particulate substance such as mica.

The organic high polymer is a substance selected from the group consisting of epoxy resin, phenol resin, polyurethane resin, silicone resin, fluorine-containing resin and waxes.

The synthetic resin, wax or like organic high polymer is applied, as it is or in the form of a solution, to the surface of the mixture layer by means such as coater, brush or spray, whereby the high polymer is caused to penetrate into or fill the interstices between the ceramic particles and particles of particulate substance.

The synthetic resin is thereafter hardened by a curing reaction, or the solvent of the synthetic resin or wax solution is evaporated off, whereby the interstices are fully filled with the resin or wax.

Since the organic high polymer penetrates into or fills the interstices or impregnates the surface layer portion of the mixture layer, the material or solution to be used preferably has a low viscosity.

For example, when epoxy resin is used as the organic high polymer, the resin per se is, for example, 0.05 to 0.5 Pa.s (50 to 500 cps) in viscosity.

When the epoxy resin to be used as it is is less than 0.05 Pa.s (50 cps) in viscosity, it is difficult to obtain the resin, whereas when exceeding 0.5 Pa.s (500 cps), the resin encounters difficulty in penetrating into the interstices between the ceramic particles and particles of water retentivity imparting substance such as mica.

Further when other organic high polymer, i.e., phenol resin, polyurethane resin, silicone resin, fluorine-containing resin or wax is to be used, such material or the solution thereof obtained by diluting the material with a suitable solvent needs to have the lowest possible viscosity.

The organic high polymer, such as synthetic resin or wax, fills up the interstices between the ceramic particles and particles of water retentive substance at least in the surface layer portion of the mixture layer. Preferably, the resin or wax fills the surface layer portion having 1/4 to 1/2 of the overall thickness of the mixture layer from the surface thereof since the paper machine press roll is raground during use.

The roll having the mixture layer of the ceramic and the particulate substance thus coated with the organic high polymer is ground over the surface to a surface roughness of 0.2 to 2.0 micrometers (Ra) (according to JIS B0601, except where mica or like water retentivity imparting substance is present), the ground surface being filled with the high polymer in the interstices, whereby a press roll is obtained for use in paper machines.

The roll of the invention comprises a metal core, a ground layer formed around the metal core and made of a metal material of small coefficient of expansion, and a mixture layer formed around the ground layer and comprising a ceramic and mica or like water retentivity imparting particular substance. The water retentivity given by the particulate substance such as mica renders wet paper smoothly releasable from the roll, obviating the trouble to be caused by the wet paper.

When an organic high polymer such as synthetic resin or wax is filled in the interstices between ceramic particles and particles of mica or like particulate substance at least in a surface layer portion of the mixture layer, the roll is given improved surface smoothness to release wet paper therefrom more effectively.
When the kind and particle size of mica or like water retentivity imparting substance are altered, the roll is selectively usable for pressing a particular kind of paper.

The paper machine press roll of the invention having either construction is usable in place of conventional stone rolls, has improved surface smoothness, releases wet paper effectively with good stability without permitting adhesion thereto since the ceramic layer surface has no voids, is less likely to permit adhesion of pitch even when used for a prolonged period of time, can be mirror-finished to give surface smoothness to wet paper pressed, has such surface hardness as to be resistant to abrasion by the doctor blade for removing bits of extraneous stock, has a strength to withstand a heavy load or high-speed rotation for a long period of time, is uniform in surface characteristics and can be easily produced with the specified surface characteristics.

The present invention will be described in greater detail with reference to the accompanying drawings.

FIG. 1 is a front view schematically showing a paper machine press roll of the invention;
FIG. 2 is an enlarged view in section showing the portion A in FIG. 1;
FIG. 3 is an enlarged view in section of the portion B in FIG. 2 to show a mixture layer of a ceramic and mica or like water retentivity imparting particulate substance; and
FIG. 4 is an enlarged view in section of the portion B in FIG. 2 to show an organic high polymer as filled in interstices between ceramic particles and particles of mica or like water retentivity imparting particulate substance.

**Comparative Example 1**

With reference to FIG. 1, a cast iron cylinder (14.0 x 10^-6/°C in coefficient of expansion) measuring 6000 mm in length, 5000 mm in surface length and 490 mm in diameter was used as the metal core 2 of a paper machine press roll 1. The surface of the core 2 was cleaned and degreased with an organic solvent (trichlene) and then sandblasted to remove rust and extraneous matter and form a rough surface. While rotating the core 2, a nickel-chromium alloy powder (10 to 44 micrometers in particle size) was applied to the outer periphery by a gas spray coating apparatus (using oxygenacetyleylene gas) to form a ground layer 4 having a thickness of 100 micrometers (see FIG. 2).

Next, while rotating the core 2 having the ground layer 4, a gray alumina powder, 50 micrometers in mean particle size, was applied to the layer 4 over a period of 6 hours by a water plasma spray coating apparatus to form a ceramic layer 3 of gray alumina powder having a thickness of 5.3 mm.

The water plasma spray coating was conducted under the following conditions.

| Input power:  | 400 V, 400 A (350 KVA) |
| Spray gun:    | 380 V, 420 A |
| Rate of feed of gray alumina: | 40 kg/hr (about 230 kg) |
| Distance between gun and core: | 300-400 mm |
| Traverse speed: | 10-20 mm/sec |
| Effective amount of deposition of gray alumina: | about 50% |

The press roll 1 thus prepared was used for pressing wood-free paper at a line pressure of 90 kg/cm and a speed of 800 m/min. The roll was usable for wet paper free of any trouble.

The wood-free paper had the following composition.

<table>
<thead>
<tr>
<th>Composition</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad-leaved tree kraft pulp (LBKP)</td>
<td>80 parts by weight</td>
</tr>
<tr>
<td>Coniferous tree kraft pulp (NBKP)</td>
<td>20 parts by weight</td>
</tr>
<tr>
<td>Aluminum sulfate</td>
<td>1 part by weight</td>
</tr>
<tr>
<td>Talc</td>
<td>5 parts by weight</td>
</tr>
<tr>
<td>Size agent</td>
<td>0.5 part by weight</td>
</tr>
<tr>
<td>Freeness</td>
<td>400 c.c.</td>
</tr>
</tbody>
</table>

It should be noted that the ceramic layer 3 was prepared only from gray alumina and was not coated with epoxy resin.

The roll became unusable owing to adhesion of paper.

The comparative roll was 3.0 to 5.0 micrometers (Ra) in surface roughness (according to JIS B0601).

**Example 1**

With reference to FIG. 1, a cast iron cylinder (14.0 x 10^-6/°C in coefficient of expansion) measuring 6300 mm in
length, 3850 mm in surface length and 1120 mm in diameter was used as the metal core 2 of a paper machine press roll 1. The surface of the core 2 was cleaned and degreased with an organic solvent (trichlone) and then sandblasted to remove rust and extraneous matter and form a rough surface. While rotating the core 2, a nickel-chromium alloy powder (10 to 44 micrometers in particle size) was applied to the outer periphery by a gas spray coating apparatus (using oxygensacetylene gas) to form a ground layer 4 having a thickness of 100 micrometers (see FIG. 2).

Next, while rotating the core 2 having the ground layer 4, a mixture of gray alumina powder and mica powder (4:1 in weight ratio), 50 micrometers in means particle size, was applied to the layer 4 over a period of 50 hours by a water plasma spray coating apparatus to form a mixture layer 3 of gray alumina powders 5 and mica powder 7 having a thickness of 5.3 mm (see FIG. 3). The water plasma spray coating was conducted under the following conditions.

<table>
<thead>
<tr>
<th>Input power:</th>
<th>400 V, 400 A (350 KVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray gun:</td>
<td>360 V, 420 A</td>
</tr>
<tr>
<td>Rate of feed of alumina-mica mixture:</td>
<td>38 kg/hr</td>
</tr>
<tr>
<td>Distance between gun and core:</td>
<td>300-400 mm</td>
</tr>
<tr>
<td>Traverse speed:</td>
<td>10-20 mm/sec</td>
</tr>
<tr>
<td>Effective amount of deposition of alumina-mica mixture:</td>
<td>about 50%</td>
</tr>
</tbody>
</table>

Subsequently, the surface of the roller was ground with a diamond abrasive stone for finishing. The paper machine press roll 1 thus formed, which is shown in FIGS. 1, 2 and 3, was 1130 mm in outside diameter and 1.5 micrometers in surface roughness (Ra) as determined according to JIS B6001 (except at the mica portions).

The press roll 1 thus prepared was used for pressing wood-free paper at a line pressure of 90 kg/cm and a speed of 800 m/min. The roll was usable for wet paper free of any trouble.

The wood-free paper had the following composition.

| Broad-leaved tree kraft pulp (LBKP) | 80 parts by weight |
| Coniferous tree kraft pulp (NBKP)  | 20 parts by weight |
| Aluminum sulfate                   | 1 part by weight   |
| Talc                               | 5 parts by weight  |
| Size agent                         | 0.5 part by weight |
| Freeness                           | 400 c.c.           |

**Example 2**

The surface of a roll having the same mixture layer 3 and prepared in the same manner as in Example 1 was preheated after the formation of the layer 3. A preheated epoxy resin having a viscosity of 0.1 to 0.2 Pa.s (100 to 200 cps), comprising 100 parts by weight of PELNOX 106 Japanese trademark as the main component, 80 parts by weight of PELCURVE HV 19 Japanese trademark as a curing agent and 4 parts by weight of an accelerator, product of NIPPON PELNOX Co., Ltd., was applied by a coater to the surface of the mixture layer 3 of ceramic and mica so as to fill the interstices between ceramic particles and mica particles. The coating was cured to form a resin layer 6 (see FIG. 4).

Subsequently, the surface of the roll coated with the epoxy resin was ground with a diamond abrasive stone for finishing. The paper machine press roll 1 thus formed, which is shown in FIGS. 1, 2 and 4, was 0.5 micrometer in surface roughness (Ra) as determined according to JIS B6001 (except at the mica portions).

The press roll 1 thus obtained was used for pressing the same wood-free paper under the same conditions as in Comparative Example 1. The roll was usable for wet paper free of any trouble.

**Comparative Example 2**

The same roll as obtained in the above example except that the mixture layer 3 of ceramic and mica was not coated with epoxy resin was prepared. This comparative roll was 3.0 to 5.0 micrometers in surface roughness (Ra) (according to JIS B6001). When the roll was used under the same conditions as in Example 1 for pressing the same wood-free paper as above, the roll became unusable owing to adhesion of paper.

**Claims**

1. A paper machine press roll comprising a metal core (2), a ground layer (4) formed over the outer periphery of the
core and made of a metal material having a smaller coefficient of expansion than the metal material forming the core (2), and a surface layer (3) comprising a ceramic formed over the outer periphery of the ground layer (4), characterized in that the surface layer (3) comprises a mixture of a ceramic and water retentivity imparting particulate substance, the mixture comprising 5 to 30 percent in weight of the water retentivity imparting particulate substance mixed with the ceramic and the surface of the surface layer (3) being treated to an Ra surface roughness of 0.2 to 2.0 μm except where the water retentivity imparting particulate substance is present.

2. A press roll as claimed in claim 1, characterized in that the water retentivity imparting particulate substance is at least one powder selected from the group consisting of mica powder, glass balloons, glass beads, glass powder, stone powder, sand and fluorine-containing resin powder.

3. A press roll as claimed in claim 1, characterized in that at least one organic high polymer selected from the group consisting of synthetic resins and waxes is filled in the interstices between particles of the ceramic and particles of the water retentivity imparting substance at least in a surface layer (3) portion of the surface layer (3).

4. A press roll as claimed in claim 3, characterized in that the organic high polymer filled in the interstices in the surface layer (3) is at least one substance selected from the group consisting of epoxy resin, phenol resin, polyurethane resin, silicone resin, fluorine-containing resin and waxes.

Patentansprüche

1. Preßwalze für Papiermaschinen mit einem Metallkern (2), einer geschliffenen Schicht (4), die auf dem äußeren Umfang des Metallkerns ausgebildet ist und aus einem metallischen Material mit kleinerem Ausdehnungskoeffizienten gegenüber dem Metall des Kerns (2) gebildet ist, und einer Oberflächenschicht (3), die ein Keramikmaterial umfaßt, das auf der äußeren Oberfläche der geschliffenen Schicht (4) angebracht ist, dadurch gekennzeichnet, daß die Oberflächenschicht (3) eine Mischung aus Keramikmaterial und einer die Fähigkeit zur Aufnahme von Wasser verleihende Teilchensubstanz ist, welche Mischung 5 bis 30 Gewichtsprozent der die Fähigkeit zur Aufnahme von Wasser verleihenden Teilchensubstanz ist, gemischt mit dem Keramikmaterial, und daß die Oberfläche der Oberflächenschicht (3) behandelt wird auf eine Oberflächenrauhigkeit Ra von 0,2 bis 2,0 μm, ausgenommen in den Bereichen, in denen die die Fähigkeit zur Aufnahme von Wasser verleihende Teilchensubstanz präsent ist.

2. Preßwalze nach Anspruch 1, dadurch gekennzeichnet, daß die die Fähigkeit zur Aufnahme von Wasser verleihende Teilchensubstanz wenigstens ein Pulver ist, ausgewählt aus der Gruppe Glimmer-Pulver, Glassballons, Glas- kugeln, Glaspulver, Steinpulver, Sand und Fluor enthaltendes Kunstharz pulver.

3. Preßwalze nach Anspruch 1, dadurch gekennzeichnet, daß wenigstens ein organisches Hochpolymer, ausgewählt aus der Gruppe synthetischer Harze und Wachse, in die Zwischenräume zwischen den Teilchen des Keramikmaterials und den Teilchen der die Fähigkeit zur Aufnahme von Wasser verleihende Teilchensubstanz wenigstens im Bereich der Oberflächenschicht (3) eingefüllt ist.

4. Preßwalze nach Anspruch 3, dadurch gekennzeichnet, daß das organische Hochpolymer, das in die Zwischenräume der Oberflächenschicht (3) eingefüllt ist, wenigstens eine Substanz aus der Gruppe Epoxyharz, Phenolharz, Polyurethanharz, Silikonharz, Fluor enthaltendes Harz und Wachse ist.

Revendications

1. Rouleau presseur pour machine à papier, comprenant une partie centrale métallique (2), une couche de base (4) formée sur la périphérie extérieure de la partie centrale et constituée d’un matériau métallique ayant un coefficient de dilatation inférieur à celui du matériau métallique formant la partie centrale (2), et une couche de surface (3) comprenant une céramique formée sur la périphérie extérieure de la couche de base (4), caractérisé en ce que la couche de surface (3) comprend un mélange d’une céramique et d’une substance particulaire assurant un pouvoir de rétention d’eau, le mélange contenant de 5 à 30 % en poids de la substance particulaire assurant un pouvoir de rétention d’eau, mélangée avec la céramique et la surface de la couche de surface (3) étant traitée pour avoir une rugosité de surface Ra de 0,2 à 2,0 μm sauf là où la substance particulaire assurant un pouvoir de rétention d’eau est présente.
2. Rouleau presseur selon la revendication 1, caractérisé en ce que la substance particulière assurant un pouvoir de rétention d'eau est au moins une poudre choisie dans le groupe constitué par la poudre de mica, les boules de verre, les perles de verre, la poudre de verre, la poudre de pierre, le sable et la poudre de résine contenant du fluor.

3. Rouleau presseur selon la revendication 1, caractérisé en ce qu'au moins un haut polymère organique choisi dans le groupe constitué par les résines synthétiques et les cires est introduit dans les interstices entre des particules de la céramique et des particules de la substance assurant un pouvoir de rétention d'eau au moins dans une partie de la couche de surface (3).

4. Rouleau presseur selon la revendication 3, caractérisé en ce que le haut polymère organique introduit dans les interstices de la couche de surface (3) est au moins une substance choisie dans le groupe constitué par les résines époxy, les résines phénoliques, les résines de polyuréthane, les résines de silicone, les résines contenant du fluor et les cires.