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(54) Elastic coating for a rotating press element of a fibre web machine

(57) The invention relates to an elastic coating (10) suitable for the rotating press element of a fibre web machine, which comprises a base layer (120) made of a polymer material suitable for being mounted on the body (130) of the press element and a surface layer (110) made of a polymer material as a wearing layer on top of the base layer, and where the surface layer (110) comprises an outer surface (100) as the outermost radial point. The radial modulus of elasticity of the surface layer (110) beneath the outer surface (100) of the coating (10) is adjusted to a level lower than the radial modulus of elasticity of the outer surface (100).

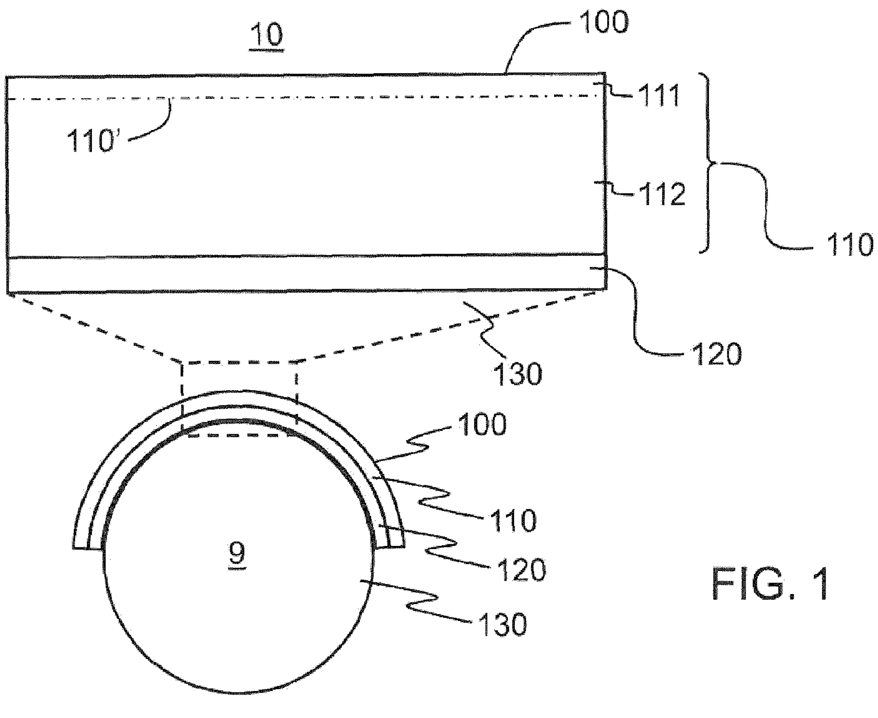

FIG. 1

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Description

FIELD OF INVENTION

[0001] The present invention relates to a method for the improvement of vibration resilience in a rotating press element of a fiber web machine, to a coating, to a press element, and to a method for the reconditioning of the coating or press element. In particular, but not limited to, the invention relates to a composite coating formed of layers for the roll of a fiber web machine and to a method for forming the composite coating of layers.

BACKGROUND OF INVENTION

[0002] Elastic and polymeric roll coatings are used in web-carrying machines, such as paper machines, for example on guide rolls or as press roll surfaces with a nip, used for removing water from webs, or in sizing and film transfer as well as in calendering to give the web the finished properties. Properties required from the composite roll coatings in paper machines typically include wear resistance and sufficient strength properties. In addition to these properties, one factor which limits performance especially in newer multinip calenders is the ability of the coating to resist the so-called barring phenomenon. The barring phenomenon can cause serious problems in terms of the runnability, production quality and maintenance of the paper machine, which is why the goal is to prevent its occurrence by every means possible. The barring phenomenon is generated by self-sustained vibration taking place in the calender. This vibration is influenced by many factors such as mechanical resonance, back feed from a previous load, and the properties of the composite coating used.

[0003] The goal is to prevent the barring phenomenon typically by suppressing the resonance by means of better design and materials, by using mass attenuators, or by adjusting the running parameters of the calender. In applications with a nip, a constant increase in speeds, loads and temperatures leads to an elevated likelihood of the barring phenomenon with elastic coatings. The barring phenomenon, in turn, gradually leads to such a vibration level that the coating needs to be replaced prematurely. Attempts have been made to improve the properties of the composite coating for better resilience against the barring phenomenon through means such as a high filler content, which reduces the deformation of the coating and improves its wear resistance.

[0004] The impulse for the barring phenomenon usually comes from a source other than the coating, but the proper coating properties can pre-empt barring. One variable present in the emergence of the barring phenomenon are the viscoelastic properties of the coating. It has been proven empirically that improved wear resistance also extends the running period. The impact of the adjustment of the viscoelastic properties is known relatively well when operating with a short measuring time within the natural frequency range environment of the nip, but there is less knowledge of the viscoelastic behaviour and of the changes in this behaviour in long-term operation.

[0005] The wear of the coating and the build-up of vibration can be significantly reduced by making a harder coating, which has a high modulus of elasticity. As is well known, this can be achieved by using a more rigid matrix raw material (there are a variety of rubber, PU, epoxy and thermoplast options with different moduli of elasticity), a higher filler content, or more rigid reinforcement fibers and on the other hand a higher reinforcement fiber content. However, there is an optimal coating hardness range for a particular application in view of the process, which is why it is not possible to infinitely increase the modulus of elasticity of the coating. As an example, in sizing it is advantageous to use soft coatings on the rolls, where the modulus of elasticity of the coatings cannot be too high. On the other hand, in calendering it is advantageous to use a sufficiently elastic roll coating so that the calender nip would not be too short, and, on the other hand, so that calendering would compact the paper in a sufficiently even manner. As is well known, deformations take place in the coating during calendering, primarily in the surface layer with a lower rigidity.

[0006] The elastic coatings used in the nips usually consist of two or more layers so that the hardness of a lower layer is typically greater than the hardness of the surface layer. Publication US 5887517 presents one example of such a layered coating constructed on a roll body, where the layers are softer than the adjacent layer when the distance from the metallic roll body increases; in other words, the hardness of the coating decreases gradually in the radial direction.

[0007] Publication US 5023985A presents a polymer-coated roll, where the outer surface is arranged of a coating which is several times thinner than the thickness of the soft polymer coating.

[0008] The prior art solutions cannot prevent the occurrence of the barring phenomenon sufficiently well in all cases, which means that barring becomes a major factor limiting the runnability of applications with a nip.

SUMMARY

[0009] According to a first aspect of the invention, the present invention provides a method for the improvement of vibration resilience in the rotating press element of a fibre web machine, in particular in a roll, where the press element has an elastic coating which comprises a base layer made of a polymer material on the body of the press element and a surface layer made of a polymer material as a wearing layer on top of the base layer, and where the surface layer comprises an outer surface as the outermost radial point and where the radial modulus of elasticity of the surface layer beneath the outer surface of the coating is adjusted to a level lower than the radial modulus of elasticity of the outer surface.

[0010] The radial modulus of elasticity of the base layer is preferably adjusted to a level lower than the radial modulus of elasticity of the outer surface.

[0011] An intermediate layer, which is softer in the radial direction than the surface layer, is preferably arranged between the surface layer and the base layer.

[0012] The radially outermost part of the surface layer, in other words its upper part which extends to a depth of 0.2 to 1 mm from the surface, is preferably arranged to be harder in the radial direction than the inner part of the surface layer, in other words its lower part, which is radially beneath the upper part. The upper part of the surface layer, where the upper part extends to a depth of 0.2 to 1 mm from the surface, is preferably arranged to be 15 to 20% harder in the radial direction than the lower part of the surface layer.

[0013] The upper part of the surface layer is preferably hardened by means of heat treatment directed at the upper part using a temperature which is preferably higher than the temperature used in the original heat treatment of the surface layer.

[0014] A component or additive which reacts to UV radiation is preferably added to the polymer material of the surface layer, and the upper part is allowed to harden by natural UV radiation or the upper part is hardened by means of UV treatment.

[0015] The outer surface of the surface layer is preferably hardened by means of sol-gel hardening.

[0016] The temperature in the lower part of the surface layer is preferably arranged to be higher than the temperature in the outer surface or in the upper part of the surface layer so that the temperature difference corresponds to the targeted difference in the modulus of elasticity required to make the lower part softer than the upper part.

[0017] The base layer is preferably arranged as a layered structure, where rigid layers reinforced with continuous fibers alternate with less rigid layers reinforced with discontinuous fibers.

[0018] The layer beneath the surface layer is preferably provided with a matrix polymer, which has a lower modulus of elasticity and a higher loss factor than the surface layer.

[0019] The thermal conductivity of the layer beneath the surface layer is preferably adjusted to be higher than the thermal conductivity of the surface layer.

[0020] An intermediate layer is preferably arranged between the surface layer and the base layer, where the intermediate layer has a higher thermal conductivity than the surface layer.

[0021] Carbon fiber or heat-conducting fillers are preferably used in the layer beneath the surface layer to achieve a better thermal conductivity.

[0022] The thermal conductivity of the base layer is preferably arranged to be higher than the thermal conductivity of the surface layer.

[0023] According to a second aspect of the invention, the present invention provides an elastic coating for the rotating press element of a fibre web, in particular for a roll, where the coating comprises a base layer made of a polymer material fastened on the body of the press element of a fibre web, and a surface layer made of a polymer material, where the surface layer is formed as a wear layer on top of the base layer and where the surface layer comprises an outer surface as the outermost radial point and where the radial modulus of elasticity of the surface layer beneath the outer surface of the coating is lower than the radial modulus of elasticity of the outer surface.

[0024] The polymer material in the surface layer is preferably polyurethane. The polymer material in the surface layer is preferably epoxy.

[0025] The radial modulus of elasticity of the base layer is preferably lower than the radial modulus of elasticity of the outer surface.

[0026] An intermediate layer, which is softer in the radial direction than the surface layer, is preferably arranged between the surface layer and the base layer.

[0027] The upper part of the surface layer, where the upper part extends to a depth of 0.2 to 1 mm from the surface, is preferably arranged to be harder in the radial direction than the lower part of the surface layer, where the lower part is radially beneath the upper part. The upper part, which extends to a depth of 0.2 to 1 mm from the surface, is preferably arranged to be 15 to 20% harder in the radial direction than the lower part of the surface layer.

[0028] The upper part of the surface layer is preferably hardened by means of heat treatment directed at the upper part.

[0029] A component or additive, such as a photoinitiator, which reacts to UV radiation is preferably added to the polymer material of the surface layer, and the surface layer is hardened by UV radiation.

[0030] The surface of the surface layer is preferably hardened by means of sol-gel hardening.

[0031] The outer surface of the surface layer is preferably treated with a material in sol-gel format, applied on the surface layer. The material can be of sol-gel which contains Si compounds. The material can be allowed to be absorbed, and the surface can be dried for example at an elevated temperature.

[0032] The base layer is preferably arranged as a layered structure, where rigid layers reinforced with continuous fibers alternate with less rigid layers reinforced with discontinuous fibers.

[0033] The layer beneath the surface layer is preferably provided with a matrix polymer, which has a lower modulus of elasticity and a higher loss factor than the surface layer.

[0034] The thermal conductivity of the layer beneath the surface layer is preferably higher than the thermal conductivity of the surface layer.

[0035] Carbon fiber or heat-conducting fillers can preferably be used in the layer beneath the surface layer to achieve a better thermal conductivity.

[0036] The polymer material used at least in the surface layer of the elastic coating is preferably of polyurethane, polyurea or epoxy.

[0037] According to a third aspect of the invention, the present invention provides a fiber web press element, in particular a roll, where the press element comprises a coating according to some aspect or embodiment of the invention.

[0038] According to a fourth aspect of the invention, the present invention provides a method for the reconditioning of the coating or fiber web press element according to some aspect or embodiment, in which method some of the outer surface of the surface layer is removed in the radial direction of the coating to below the deepest point of wear, and the exposed outer surface of the surface layer is hardened.

[0039] The wear of the coating and on the other hand the build-up of vibration can be significantly slowed down without having to essentially change the optimal hardness of the roll. The build-up of the barring phenomenon can be slowed down in demanding applications with a nip, such as in multinip calenders and in film transfer.

[0040] Solutions according to the aspects and embodiments described in this application can be used to achieve a composite coating structure which dampens vibrations and is hence better resilient to the barring phenomenon.

[0041] The removal of vibrations, which are relevant in terms of the barring phenomenon, from fiber web machine applications with a nip, such as from a calender, and hence the control of barring provide significant advantage in the improvement of current production processes and in the further development of fiber web manufacturing technologies.

[0042] According to some embodiments of the invention, it is possible to achieve a coating with an improved service life as compared to prior art coatings for the rolls of a fiber web machine. According to some embodiments, the wear resistance of the coating can be improved and hence a coating solution with a long maintenance interval can be achieved.

[0043] The wear of the coating and on the other hand the build-up of vibration can be significantly slowed down without having to essentially change the optimal hardness of the roll.

[0044] The embodiments of the present invention are described or have been described only in conjunction with some aspect or aspects of the invention. A professional in the field understands that any embodiment of any aspect of the invention can be applied in the same aspect and other aspects of the invention on its own or in combination with the other embodiments.

BRIEF DESCRIPTION OF FIGURES

[0045] The invention is described below in way of example by making reference to the enclosed figures, where:

FIGS. 1 - 3 present some preferred coatings formed around the body of the roll; and

FIGS. 4 - 6 present theoretical diagrammatic examples of the changes in the deformation of the surface layer and of the changes in the deformation energy as a function of the change in the modulus of elasticity of the surface layer.

DETAILED SPECIFICATION

[0046] In the below specification, similar reference numbers refer to similar parts. It is to be noted that the figures presented are not completely on scale and that they primarily only serve the purpose of illustrating some embodiments of the invention.

[0047] FIGS. 1 - 3 present some coatings 10 formed around the body 130 of the roll 9. The body 130 is preferably hollow, but the body can also be solid. The composite coating 10 can be used to improve the vibration damping capability of the coating and hence to reduce the occurrence of the barring phenomenon.

[0048] In FIG. 1, the coating 10 comprises a surface layer 110, whose outer surface is denoted with reference number 100, and a base layer 120, which is attached to the body 130. The surface layer is preferably formed as a single layer in a single coating manufacture stage. The surface layer is preferably formed around the base layer. The vibration-damping composite roll coating can be implemented according to the example in FIG. 1 so that the upper part 111 of the surface layer 110 of the coating 10, where the upper part extends to a depth of 0.2 to 1 mm from the outer surface 100, is arranged to be harder than the lower part 112 of the surface layer 110, which serves as the wear surface of the coating. The border zone between the hard upper part 111 and the softer lower part 112 has been denoted by the dash-and-dot line 110' extending across the surface layer. The surface layer 110 is preferably of a single material. The upper part 111 of the surface layer 110 is formed in the radial direction around the lower part 112. Up to a depth of 0.2 to 1 mm, the upper part 111 of the surface layer 110 of the coating 10 is preferably 15 to 20% harder than the lower part 112 of the surface layer 110. A preferred first modular gradation of the coating 10 is one where there is a hard upper part 111 of the surface layer 110, a lower part 112 of the surface layer where the lower part 112 is softer than the upper part 111, and a base layer 120 which is, if required (but not necessarily), harder than the lower part 112.

[0049] In FIG. 2, the coating 10 comprises a surface layer 110, whose outer surface is denoted with reference number 100, a base layer 120 which is attached to the body 130, and an intermediate layer 115. The intermediate layer 115 is formed between the surface layer and base layer. Several intermediate layers 115 can be arranged. A preferred second modular gradation of the coating 10 is one where there is, according to FIG. 2, a hard upper part 111 of the surface layer 110, a lower part 112 of the surface layer where the lower part 112 is softer than the upper part 111, an intermediate layer 115 which is, if required (but not necessarily), softer than the lower part 112, and a base layer 120 which is, if required (but not necessarily), harder than the lower part 112. The intermediate layer 115 is preferably of a material other than the material of the surface layer 110. According to one embodiment, the intermediate layer 115 is formed to be harder than the surface layer 110 arranged according to FIG. 1, where the modular make-up of the surface layer 110 is graded to become softer from the upper part 111 to the lower part 112. According to yet another embodiment, the modular make-up of the intermediate layer 115 is graded to be softer than the surface layer 110. According to yet another embodiment, the intermediate layer 115 is formed to have better thermal conductivity than the surface layer.

[0050] The impacts of the higher thermal conductivity of the inner layers of the coating 10 and the impacts of the potential heating of the internal layers on the vibration damping properties of the coating are described in more detail in what follows.

[0051] In FIG. 3, the coating 10 comprises a surface layer 110, whose outer surface is denoted with reference number 100, and a base layer 120, which is attached to the body 130. The surface layer is formed around/on top of the base layer. The base layer 120 is formed alternately of a layer 121 made up of a reinforcement comprising continuous fibers and of a layer 122 made up of a reinforcement comprising discontinuous fibers. The composite base layer 120 of the coating 10 can be used to improve the vibration damping of the coating and hence to reduce the occurrence of the barring phenomenon. The surface layer can be of uniform hardness. In some embodiments, the surface layer 110 can have a modular gradation as illustrated in FIG. 1.

[0052] The maintenance and grinding interval of polymer-coated rolls used in a nip contact is usually determined by the intensity of the uneven wear of the coating or/and by the intensity of the increase in the vibration level of the roll. It has been noticed that as far as vibration is concerned, the increase in the vibration level of a coated roll can be started from the beginning from a low vibration level, when a thin layer, typically 0.2 to 1 mm, is ground off the coating. It can be concluded from this that the intensification of the vibration is due to changes (fatigue) in the material properties of the surface of the coating and on the other hand due to changes in the surface shape. In terms of wear, the impact of grinding is trivial.

[0053] The total deformation of the coatings 10 illustrated in FIGS. 1 3 does not change essentially as compared to a prior art operating coating with equal modules when using FEM calculation to examine an operating coating where the deformation is the same (+/-2%) in the tangential direction and in the direction of the thickness of the coating (direction of thickness = direction of compression, radial direction), but the fatigue softening of the outer surface 100 of the coating 10, preferably the fatigue softening of the upper part 111 of the surface layer 110, can be given a significantly longer operating period due to the higher initial situation.

[0054] FIG. 4 shows on the vertical axis the change in the deformation in the surface layer in the tangential direction in percentages, and on the horizontal axis the change in the modulus of elasticity in percentages. FIG. 5 shows on the vertical axis the change in the deformation in the surface layer in the radial direction in percentages, and on the horizontal axis the change in the modulus of elasticity in percentages. FIG. 6 shows on the vertical axis the change in the deformation energy in the surface layer in percentages, and on the horizontal axis the change in the modulus of elasticity in percentages. FIGS. 4 - 6 present the first graph 20, the second graph 21, and the third graph 22, which are examples of three different operating coatings.

[0055] FIGS. 4 - 6 indicate that the deformation in the surface layer 100, 111, which has softened as little as 5%, and the deformation energy in the surface layer 100, 110 intensify rapidly. At the same time, the softening of the surface layer continues as a result of fatigue. The secondary benefit of the harder surface is the reduced deformation energy, which in itself reduces wear and vibration. However, at moduli of elasticity of the surface in excess of 20%, the deformation begins to focus more clearly on the lower part 112 of the surface layer 110 and on the inner parts 112; 115; 120 of the coating, in which case the disadvantage might be that when reconditioning the press element (coating) for example by grinding, it would be necessary to remove more coating than from prior art operating coatings with equal modules.

[0056] In terms of the damping of vibration and hence in terms of the prevention of the barring phenomenon, it is advantageous that deformation also takes place in the layer or layers beneath the outer surface 100.

[0057] Examples of layers beneath the outer surface 100 are the lower part 112 of the surface layer (FIGS. 1 and 2), intermediate layer 115 (FIG. 2), and base layer 120 (FIG. 3). In this case, a greater portion of the deformation energy of a nip under load is transmitted from the outer surface 100 of the surface layer 110 to the underlying layers, and the permanent deformation in the nip, which leads to barring, can be reduced. With a suitably selected modular gradation of the layers 110, 115, 120 of the coating 10, when the coating 10 becomes thinner during its service life as a result of grinding, the length variation of the nip can be reduced as compared to the use of a prior art structure where the modulus of elasticity of the coating material increases layer by layer when moving towards the body 130 of the roll.

[0058] A general guideline presented is that in the surface layer 110 of the coating 10, the radial (in the direction of compression) modulus of elasticity (hardness) of the layer beneath the outer surface 100 (or beneath the upper part 111) is adjusted to a level lower than the radial (in the direction of compression) modulus of elasticity (hardness) of the outer surface of the surface layer. The higher modulus of elasticity of the surface layer 110 of the coating 10, in other words the higher modulus of elasticity of the wear layer, can be arranged in different ways. Moreover and alternatively, the higher modulus of elasticity of the layers beneath the surface layer 110 can be arranged in different ways.

[0059] One simple way is the heat treatment of the coating 10 so that the upper part 111 immediately in conjunction with the outer surface 100 of the surface layer 110 (wear layer) is hardened by "tempering" using heat treatment directed at the outer surface 100, and the heat treatment is repeated in conjunction with grinding (for example FIGS. 1, 2). This "tempering" can employ a higher temperature directed only at the outer surface 100 and upper part 111 of the coating 10 than in the original heat treatment of the surface.

[0060] Another way is to use a coating material which reacts to UV radiation so that the upper part 111 of the surface layer 110 hardens by itself in normal light, and this can be intensified by means of separate UV treatment (for example FIGS. 1, 2).

[0061] A third way is to harden the outer surface 100 and the upper part 111 by means of sol-gel hardening, for example to a thickness of less than 10 μm (for example FIGS. 1, 2).

[0062] A fourth way is to manage the operating conditions of the roll so that the temperature in the lower part 112 of the surface layer 110 is higher than the temperature in the outer surface 100 and upper part 111, or the temperature in the inner part 115, 120 of the coating 10 is higher than the temperature in the outer surface 100 and upper part 111, so that the temperature difference corresponds to the targeted difference in the modulus of elasticity. As an example, the surface layer 110 of the roll can be cooled or/and the lower part 112 of the surface layer 110/inner part 115, 120 of the coating can be heated.

[0063] A fifth way to arrange the structure of the layer beneath the vibration-damping outer surface 100 is to use a layered structure in the base layer 120, where the layered structure comprises rigid layers 121 reinforced with continuous fibers alternating with less rigid layers 122 reinforced with discontinuous fibers (FIG. 3). Such a structure can retain the strength of the base layer 120 while at the same time increase the deformation capability of the structure and hence improve vibration damping. The structure of the vibration-damping composite coating 10 can be manufactured easily by winding the base layer 120 as a compound structure, where a woven reinforcement comprising continuous fibers alternates with a mat comprising discontinuous fibers.

[0064] A sixth way to arrange the structure of the layer beneath the vibration-damping outer surface 100, in addition to the above-described structures, is to use a matrix polymer, which is suitable in terms of the vibration damping properties, in the layer beneath the surface layer 110 (for example in the base layer 120, examples in FIGS. 1 and 3), where the matrix polymer can differ from the matrix polymer of the surface layer 110. The matrix polymer of the base layer 120 can have, for example, a lower modulus of elasticity, and the loss factor (tan d) can be higher than that of the surface layer 110, in which case the base layer can better absorb deformation energy and thus dampen vibration.

[0065] In the base layer 120, the conversion of deformation energy into heat is not as big a problem as in the surface layer 110, because there is better heat conduction in the base layer than in the surface layer due to the proximity of the metallic roll body. According to some embodiments, there is better heat conduction in the base layer than in the surface layer also due to the high fiber content of the layers reinforced with continuous fibers in the base layer 120 (FIG. 3). Unlike in a functional surface layer, carbon fiber or heat-conducting fillers can also be used in the base layer 120 to achieve better thermal conductivity. Carbon fiber and heat-conducting fillers can be used either as separate layers or in the entire base layer structure. The heat-conducting fillers used can be for example metal particles or aluminum nitride as powder, or fibers can be treated with metal. Aramid fiber can be used in the base layer 120 to achieve toughness. Aramid fiber and carbon fiber can be used as a compound structure. Fiberglass can be used at low cost. The fiberglass can be metallized, for example nickel-treated or silver-treated to improve thermal conductivity.

[0066] One option for the adjustment of the base layer module or intermediate layer module lower than the surface layer module is to use flexible particles, such as microspheres, in the base layer or in the intermediate layer. For example air-filled or gas-filled glass balls or phenol balls can be mixed into the fiber reinforcement or matrix polymer.

[0067] The above specification provides non-limiting examples of some embodiments of the invention. It is clear for a professional in the field that the invention is not limited to the details presented, but the invention can also be implemented using other equivalent methods. Some features of the presented embodiments can be utilized without the use of the other features.

[0068] The above specification as such must only be considered as a description of the principles of the invention, not as a description limiting the invention. The scope of protection of the invention is hence only limited by the enclosed patent claims.

Claims

1. An elastic coating (10) for the rotating press element of a fibre web, in particular for a roll (9), where the elastic coating comprises a base layer (120) made of a polymer material fastened on the body (130) of the press element of a fibre web, and a surface layer (110) made of a polymer material, where the surface layer is formed as a wear layer on top of the base layer and where the surface layer comprises an outer surface (100) as the outermost radial point, **charac-**

terized in that the radial modulus of elasticity of the surface layer (110) beneath the outer surface (100) of the coating (10) is lower than the radial modulus of elasticity of the outer surface (100).

2. A coating as claimed in claim 1, **characterized in that** the polymer material of the surface layer (110) is polyurethane.

3. A coating as claimed in claim 1, **characterized in that** the polymer material of the surface layer (110) is epoxy.

4. A coating as claimed in any of the claims 1 to 3, **characterized in that** the radial modulus of elasticity of the base layer (120) is lower than the radial modulus of elasticity of the outer surface (100).

5. A coating as claimed in any of the claims 1 to 4, **characterized in that** an intermediate layer (115), which is softer in the radial direction than the surface layer (110), is arranged between the surface layer (110) and the base layer (120).

6. A coating as claimed in any of the claims 1 to 5, **characterized in that** the upper part (111) of the surface layer (110), where the upper part (111) extends to a depth of 0.2 to 1 mm from the surface (100), is arranged to be harder in the radial direction than the lower part (112) of the surface layer (110), where the lower part (112) is radially beneath the upper part (111).

7. A coating as claimed in any of the claims 1 to 6, **characterized in that** the upper part (111) of the surface layer (110) is hardened by means of heat treatment directed at the upper part.

8. A coating as claimed in any of the claims 1 to 7, **characterized in that** a component or additive which reacts to UV radiation is added to the polymer material of the surface layer (110) and the surface layer is hardened by UV radiation.

9. A coating as claimed in any of the claims 1 to 8, **characterized in that** the surface (100) of the surface layer (110) is hardened by sol-gel hardening.

10. A coating as claimed in any of the claims 1 to 9, **characterized in that** the base layer (120) is arranged as a layered structure, where rigid layers (121) reinforced with continuous fibers alternate with less rigid layers (122) reinforced with discontinuous fibers.

11. A coating as claimed in any of the claims 1 to 10, **characterized in that** the layer (115, 120) beneath the surface layer (110) is provided with a matrix polymer, which has a lower modulus of elasticity and a higher loss factor than the surface layer.

12. A coating as claimed in any of the claims 1 to 11, **characterized in that** the thermal conductivity of the layer (115, 120) beneath the surface layer (110) is higher than the thermal conductivity of the surface layer.

13. A coating as claimed in any of the claims 1 to 12, **characterized in that** carbon fiber or heat-conducting fillers are used in the layer (115, 120) beneath the surface layer (110) to achieve a better thermal conductivity.

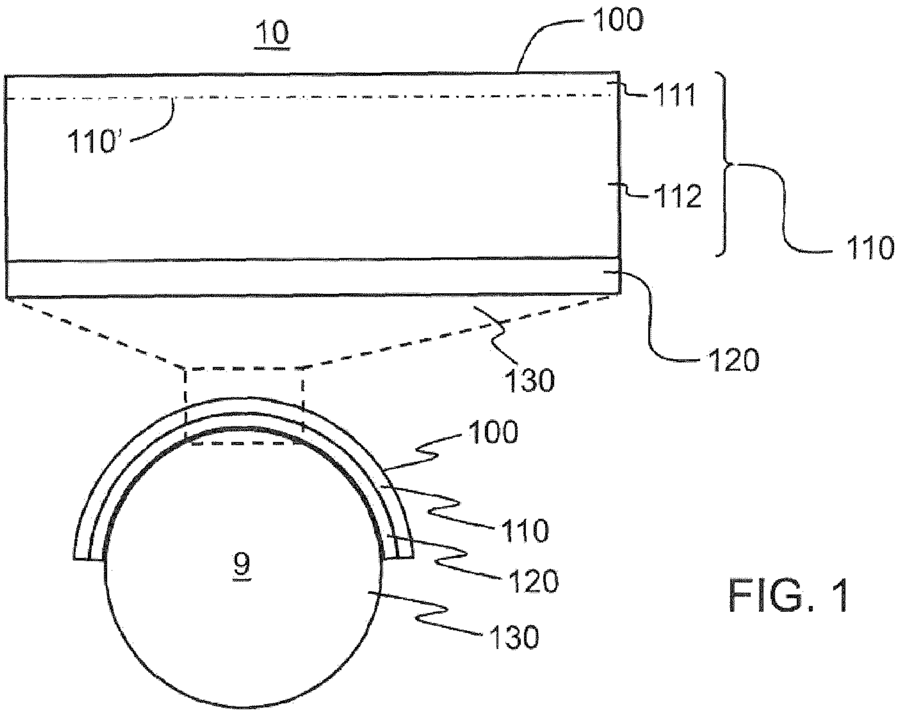
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FIG. 1

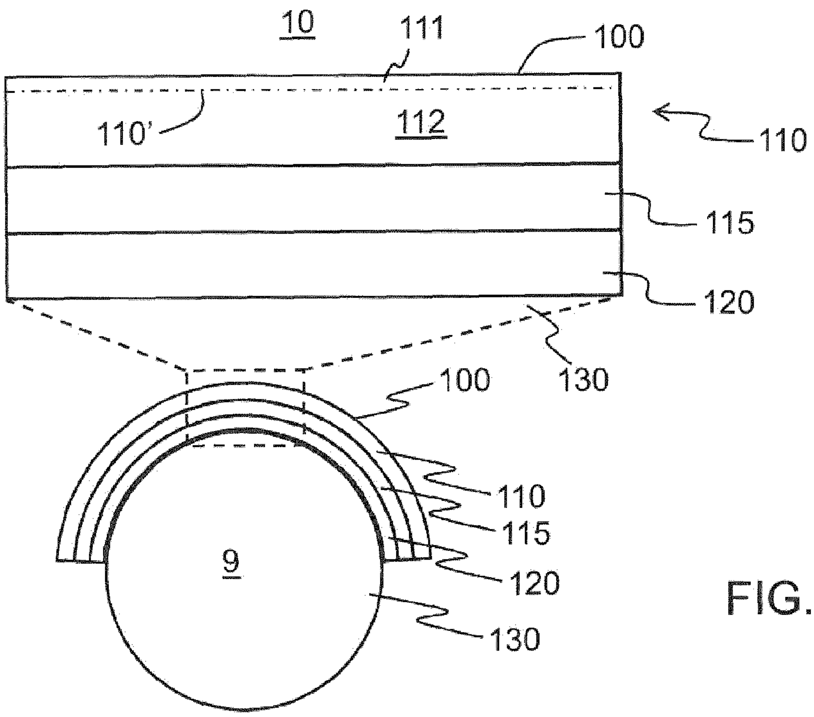
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FIG. 2

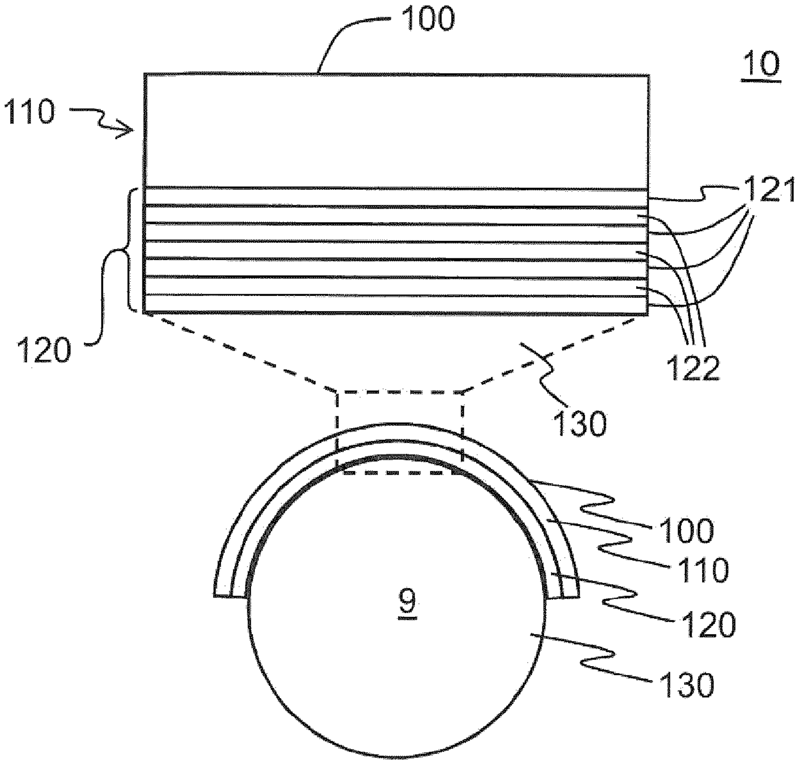

FIG. 3

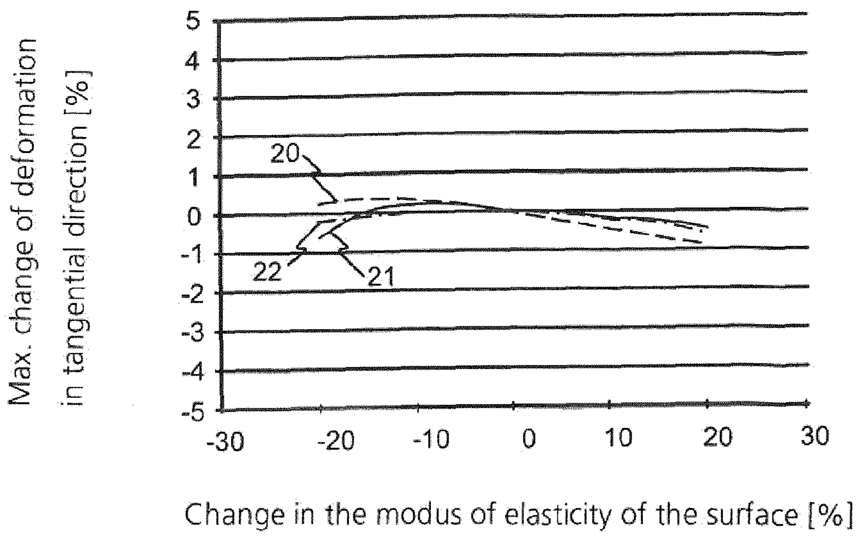

FIG. 4

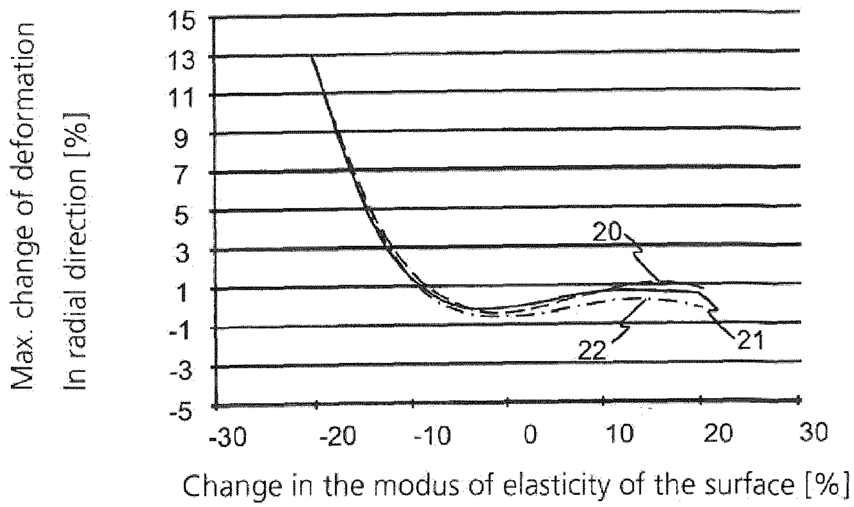

FIG. 5

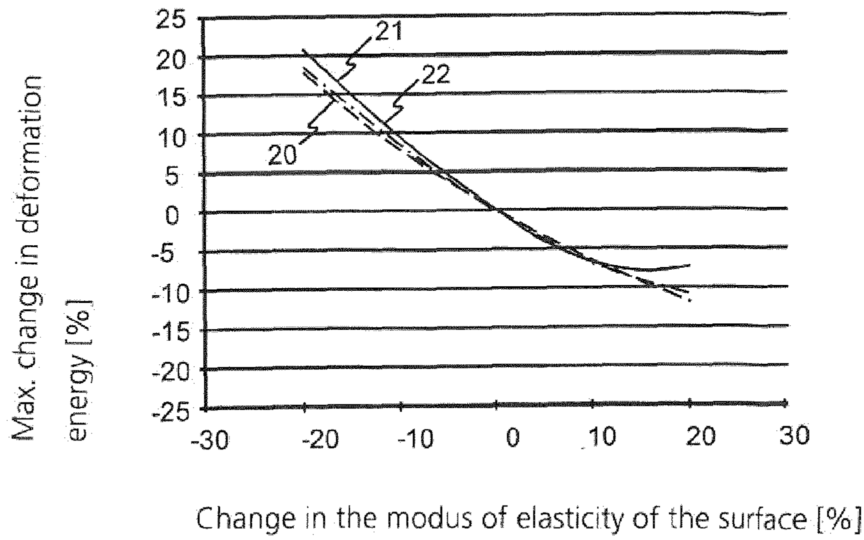

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 11 18 5417

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 5 023 985 A (SALO JUKKA [FI] ET AL) 18 June 1991 (1991-06-18) * column 1, line 6 - column 3, line 57; figure 1 *	1,2,4	INV. D21F3/08 D21G1/02
A	EP 1 659 216 A1 (SCHAEFER KG [DE]) 24 May 2006 (2006-05-24) * paragraph [0001] - paragraph [0015]; figure 1 * * paragraph [0020] - paragraph [0022] *	1,2,5	
A	EP 1 363 034 A1 (VOITH PAPER PATENT GMBH [DE] VOITH PATENT GMBH [DE]) 19 November 2003 (2003-11-19) * paragraph [0001] - paragraph [0019] * * paragraph [0032] - paragraph [0037]; figure 1 *	1,2,5, 11,12	
A	US 3 447 600 A (GREENE WILLIAM E) 3 June 1969 (1969-06-03) * column 1, line 13 - column 3, line 13; figures 2, 5 *	1	TECHNICAL FIELDS SEARCHED (IPC) D21F D21G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 February 2012	Sabatucci, Arianna

CATEGORY OF CITED DOCUMENTS

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

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 18 5417

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-02-2012

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

REFERENCES CITED IN THE DESCRIPTION

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- US 5887517 A **[0006]**
- US 5023985 A **[0007]**