METHOD OF PROVIDING A MANDREL WITH A COMPACT UNIFORM COVERING

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Fig. 1

Fig. 2

Fig. 3

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METHOD OF PROVIDING A MANDREL WITH A COMPACT UNIFORM COVERING

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The invention relates to improvements in the preparation of roll bodies, and more particularly to coverings for rolls adapted for the use as counter or backing rolls in roller embossing operations.

Such rolls have to combine a certain softness and resilience with resistance to deterioration under operating conditions. They may be made by placing discs of fibrous material, or discs of sheet materials cut at right angles to the axis of a metal shaft, compressing the discs together, and securing them in position by the use of rigid metal and supports connected to the shaft.

Roll bodies of this type have several drawbacks. For this reason, it has been proposed to use a plurality of discs in which alternate discs contain vegetable fibers, the remainder synthetic fibers. But even according to this mode of execution, the discs neither adhere firmly to the mandrel nor to one another. In consequence thereof, the surface of these roll coverings becomes uneven, thereby forming grooves. Once a groove has formed, other grooves quickly form, thus enlarging the unevenness of the roller surface. When pressing such grooved roll coverings against a counter roll, the elevated parts are subjected to a much higher pressure than the grooves. Since too strong a pressure causes a break-open of the material, such coverings become inoperable after short use. It is further obvious that squeezing rolls covered with grooved material cause serious damages to the articles to be squeezed.

It is a principal object of the invention to provide a roll covering made up of discs or bands of uniform composition in which the latter firmly stick to one another and to the mandrel, even after extended use.

Still another object of the invention is to provide a compact roll covering of uniform composition, the surface of which remains even and of equal Shore-hardness under the operating conditions of practice.

The above mentioned objects can be realized by converting the set of individual discs on the shaft into a uniform compact mass. For this reason, the discs which are impregnated with a curable or hardenable adhesive are assembled on the shaft and then compressed in axial direction. Instead of discs, bands may be wound edge-wise around the shaft so that the adjoining juxtaposed layers of the band coil extend at right angles to the axis of the roll. Simultaneously with the compression or immediate hardening of the discs or bands are hardened by placing the shaft with the thus positioned discs or layers into a steam atmosphere of about 120° C. for a period of about 5 to 8 hours.

In this way, a uniform integral covering is obtained which combines high Shore-hardness with good resilience, possesses good adhesion to the shaft of the roll, and has a surface hardness which is a balance of the stresses produced in the embossing and polishing operation.

As starting material, we use loose unwoven fibrous structures such as fleeces or webs, which preferably contain the fibers in superposed layers in intersecting directions. Suitable adhesives are vulcanizable compositions of natural and synthetic rubbers and other rubber-like substances and elastomers, such as silicone rubbers, polyurethans, modified epoxy resins; also chemically modified rubber types which contain functional groups like carboxyl, carbonyl, carbamide, amino, or hydroxyl groups, or saturated or unsaturated substitution products or homologues thereof such as chlorinated rubber. Also suitable are plastics, particularly rubber-like plastics, such as methacrylic acid esters. Such adhesives may be used alone or in mixture with each other.

It is of particular advantage to use impregnating compositions which contain, in addition to the adhesives, substances which improve the effect of the adhesive by cross-linking and/or effect otherwise a firm and reliable bond of the impregnating agent with part or all of the fibers. Such substances will be called heretofore reinforcing agents. Suitable reinforcing agents are reactive, not completely condensed precondensates of aldehydes and/or ketones, reactive amino- and/or phenol plastics or reactive precondensates of aldehydes and/or ketones with phenols or amino compounds such as formaldehyde, durene, triazines, and the like, and saturated or unsaturated substitution products and/or homologues thereof, and mixtures of such compounds. Other suitable reinforcing agents are, for instance, ethoxylin resins, polyester resins, polycarbonate resins of olefinic character such as vinyl resins and the like.

The reinforcing agents may be employed individually or in form of mixtures, they may be applied together with the vulcanizable adhesive composition, such as natural or synthetic rubbers, preferably in the form of dispersions or emulsions, which contain the adhesive and the reinforcing agent and may contain other components such as vulcanizing agents, antiaging agents, wetting agents, stabilizers, plasticizers, fillers, coloring pigments, and the like. The ratio of adhesive and reinforcing agent in the impregnating compositions may vary within relatively wide limits, depending on type of adhesive and reinforcing agents, on the fibers, and on the desired properties of the end products. Generally, the amount of reinforcing agents may be about 3 to 30 percent by weight, calculated on the dry content of the adhesive composition.

The fibrous webs or fleeces may consist entirely of natural, for instance vegetable, mineral or animal fibers and/or synthetic or semi-synthetic fibers. It is of advantage to use or to incorporate fibers of high tear strength, such as basalt, polyanide, or polyester fibers, particularly fibers having relatively low elongation such as fibers from basalt, polyvinylidene chloride, polyvinyl chloride, or highly stretched cellulose filaments. In an embodiment of the invention, blends are used which contain fibers of high tear strength and relatively low elongation, and fibers of relatively high elongation such as wool, staple fibers, regenerated cellulose fibers, whereby the ratio of the former fibers is about 30 to 60, preferably about 70 to 40 percent of the mixture.

A brightening procedure may strengthen the bond between the fibers and rubber adhesives. Sometimes, it may be of advantage to incorporate as a brightening agent. In such a case, the fiber fleece is subjected to a crimping treatment, for instance to a heat treatment, prior to, or after, the impregnation and/or curing. Such treatment favors the matting of the fibers.

The plastic or plastifiable intermediate product may be made by preparing first a loose fleece-like fiber sheet of the desired thickness by carding or puffing the fibers, for instance according to the random-web process. This may be done by superposing webs coming from the card in such a manner that alternate webs are crossofslied until a sheet of the desired thickness, for instance about 5 to 10 cm. is produced.

The sheet consisting of loose fibers is impregnated by known procedures, for instance by dipping into the impregnating liquid and then squeezing out the excess of the liquid. Generally, the impregnated sheet should con-
tain about 10 to 20 parts by weight of impregnating composition for 30 to 80 parts of the fibrous material. Sometimes, it is of advantage to apply the impregnating liquid in form of a foam.

The impregnated sheets are dried by gentle heating under conditions where the plastic or plastifiable properties are maintained. During the heat treatment, reactions like preCURing, precondensation, or prepolymerizations may be allowed to take place; care must be taken to avoid complete hardening because the discs or strips made from the sheet must be placed on the shaft of the rolls in still plastic or plastifiable state.

According to a modification of the invention, the reinforcing agents are not applied together with the film-forming adhesives but the impregnated crosslinked webs, or the discs and the like made therefrom, are subjected to an aftertreatment wherein said reinforcing agents are introduced. Such aftertreatment may be carried out by dipping the impregnated and gently dried sheet into solutions, dispersions or emulsions, which contain one or more of the reinforcing agents, squeezing out the excess liquid and subsequently drying gently while preserving the plastic or plastifiable properties; the dry substance of the introduced reinforcing agent may amount to about 5 to 20 percent by weight of the preimpregnated fleece.

If a sufficient hardness is not obtained by a one-bath impregnation with film-forming adhesives and reinforcing agents, the Shore-hardness of the finished product may be adjusted to the desired degree by an after-treatment with solutions or dispersions containing reinforcing agents; said Shore-hardness is maintained in continuous operation of the rolls. The concentration of the after-treating liquid depends on the desired result; generally, such after-treatment may be carried out by placing the impregnated structures into solutions or dispersions which contain about 3 to 20 percent of the reinforcing agent.

For the after-treatment, the same reinforcing agents may be used as recited hereinabove for the simultaneous application of adhesive and reinforcing agent.

The material prepared according to the described method is used for the production of roll bodies and particularly suitable for squeezing rolls and for rolls employed in embossing, printing and polishing operations. Such roll bodies have a high resistance against abrasion, pressure, and shearing forces; therefore, they are not subject to deformation even in continuous operation.

The thickness of the rolls may be selected at will. Connecting driving gears are not required. The roll bodies can be imparted a Shore-hardness of 80 to 90°, preferably to 85° to 90°, by said method. Said original Shore-hardness and elasticity are maintained also in continuous use of the rolls. The sheet material passed over such rolls, such as textiles, leather, synthetic leather, paper, foils, and the like, is not affected so that the good properties of such sheet material are maintained and inferior properties are improved. In using the roll for embossing operations, rough, deep, clear, angular design patterns and also very fine so-called damask patterns may be produced. The same roll can be used without difficulty first in the embossing of leather and then in metal foils. As the Shore-hardness of the roll coverings can be adjusted, the rolls are particularly suitable for producing embossing effects required an exactly defined Shore-hardness.

The invention is illustrated by the schematic isometric drawings.

FIG. 1 shows a plurality of plastic, respectively still plastifiable annular discs 1, 2, 3, 4, etc. being positioned on the shaft S and compressed between steel discs D.

FIG. 2 shows a roll covering according to the invention in which the individual annular discs 1, 2, 3, 4, etc., been converted into a compact mass M. Part of the roll covering is broken away in order to show the internal structure.

FIG. 3 shows a roll covering consisting of a band B placed radially edgewise onto the shaft S. The following examples are given to illustrate the preparation of rolls according to the invention. The description is not to be construed as limiting the invention to these embodiments.

Example 1

A web consisting of 40 parts by weight of highly cramped polyester fiber waste commercially available under the trademark "Treva," average titer 7 denier, 40 parts by weight of ramie sliver, 20 parts by weight of viscose staple fiber of 3 denier, was produced on 4 cards, and 20 layers of said web were continuously superposed in crosslapped relationship. The thus produced felt had a weight of 400 g./sq. m., and was subjected to a pretreatment by applying a small amount of a foamed adhesive to the surface and solidifying the same.

The mixture used for this purpose was dispersed in water and contained the same ingredients as the dispersion recited below used for through impregnation, with the difference that it contained the double concentration of the wetting agent and half the concentration of the other components.

After drying, the presolidified felt was impregnated with a foamed dispersion of the following composition, all parts being given by weight as dry substance.

100 parts of chloroprene latex (30% concentration)
1 part of colloidal sulfur
5 parts of active zinc oxide
2 parts of magnesium oxide
1 part of mercaptobenzimidazol (accelerator)
1 part of antiaging agent
3 parts of casein
5 parts of alkylarlylsulfonate (wetting agent)
382 parts of water

The impregnated assembly was pressed between rollers with adjustable nip to squeeze out the water. Then the assembly was gently dried so as to prevent curving, washed at 50° C. on an open width washing machine and again dried. With an adhesive content of 50 percent by weight, the felt produced weighed approximately 780 g./sq. m.

From the felt produced, bands of 30 mm. width were cut; said bands were placed radially edgewise on the shaft of a roll for a length of 1000 mm. and gradually compressed endwise by means of hydraulic pressure to one-fourth of the original length and then locked between backers and secured to the shaft.

The roll was then cured within 8 hours in a pressure vulcanizing vessel in steam at 120° C.

After the roll covering had been cured and after-compressed if necessary, the surface was subjected to an after-treatment as conventionally applied to paper or cotton rolls; such after-treatment comprised the usual steps of grinding, polishing, burning and the like. The surface had then a hardness of 90° according to Shore A. The roll may be used for squeezing out liquids from leather, textiles, and the like, or as counter or backing roll in the embossing of hard foils, paper and the like. Hereby it is not necessary to use the gears and chains frequently used to drive such rolls in embossing operations. The treated sheet material is not harmfully affected by the roll covering.

Example 2

According to the Random-web process, a web was blown which consisted of 20 parts by weight of polyamide fibers (as sold in commerce under the tradenname Parlon) of 1.5 denier, 30 parts by weight of polyamide fibers of 3 denier, and 30 parts of highly stressed polyacrylicnitile fiber waste of an average denier of 4.5 all having an average staple length of 60 mm., and 20 parts of cotton sliver; the fleece had a weight of about 250 g./sq. m. The fleece was passed on a conveyor belt through an impregnating
bath of the following composition, all parts of the ingredients being given by weight calculated on the dry substance.

<table>
<thead>
<tr>
<th>3,069,304</th>
<th>5 bath of the following composition, all parts of the ingredients being given by weight calculated on the dry substance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revertex (73% natural rubber latex concentrate)</td>
<td>55</td>
</tr>
<tr>
<td>Buna S latex (30% copolymer of 70 parts of butadiene and 30 parts of styrene)</td>
<td>30</td>
</tr>
<tr>
<td>Water-soluble phenol-formaldehyde condensation product (reinforcing agent)</td>
<td>15</td>
</tr>
<tr>
<td>Colloidal sulfur</td>
<td>10</td>
</tr>
<tr>
<td>Active zinc oxide</td>
<td>5</td>
</tr>
<tr>
<td>Mercaptobenzothiazole (vulcanization accelerator)</td>
<td>2</td>
</tr>
<tr>
<td>Antiaging agent</td>
<td>1</td>
</tr>
<tr>
<td>Casein</td>
<td>3</td>
</tr>
<tr>
<td>Alkylarylsulfonate (wetting agent)</td>
<td>8</td>
</tr>
<tr>
<td>Water</td>
<td>380</td>
</tr>
</tbody>
</table>

The wetted out bath was squeezed out and gently dried at 100° C. The dried material, which contain about 40 percent by weight of bonding agent, was sufficiently solidified to withstand washing. It was washed on an open width washing machine at 50° C. to dissolve out the wetting agent and then again carefully dried.

Annular discs having a diameter of 400 mm. were punched out of the dried material, placed on a 1000 mm. long metallic shaft of a roll, and compressed at room temperature under a hydraulic pressure of 150 kg./sq. cm. to 1/4 of the original thickness, whereby the assembly was held together by locking discs.

The assembly was cured with simultaneous condensation of the reinforcing agent under constant hydraulic pressure at a temperature of 115° C. for a period of 5 hours. In this way a stable roll surface is obtained which does not require after compression.

The roll was then finished by turning and other conventional finishing operations. The use of the reinforcing agent increased the strength of the roll covering over that of Example 1 and produced an excellent resistance to the pressure, abrasion, and shear stresses to which such rolls are exposed when used as embossing bowls. The Shore-hardness of 96° remained constant also in prolonged use within a wide temperature range.

**Example 3**

Like in the manufacture of paper, a fibrous pulp was prepared in a beater, which pulp, calculated on dry content, consisted of 55 parts by weight of fibers and 45 parts by weight of impregnating composition comprising hardening adhesive and reinforcing agent.

The fibrous portion consisted of 50 parts by weight of polyamide fiber waste, average titer 5 denier, 25 parts by weight of 3 denier fibers made of polyvinylidene chloride-polyvinyl chloride copolymer, and 25 parts by weight of ramie fibers having an average staple length of 30 mm.

The adhesive composition consisted of:

| 3 parts by weight (solid) alkylarylsulfonate (wetting agent) | 6 |
| 388 parts by weight water |

The pulp was diluted with water to about 2.5 parts by weight of solids, homogenized and made up in a continuous procedure by means of sieves. The sheet was lifted from the sieve support and carefully dried by means of rollers in a paper drying machine. The thus obtained sheet was after-impregnated with a 30% aqueous colloidal melamine-formaldehyde precondensate in aqueous medium at a temperature of 20° C., freed from excess water by squeezing and then dried without stretch at 90° C. The after-impregnating solution had the following composition:

| 30 parts by weight (solid) water soluble melamine-formaldehyde condensation product |
| 2 parts by weight (solid) zinc chloride |
| 7 parts by weight (solid) dicyanodiamide |
| 961 parts by weight water |

If desired, the after-treatment may also be carried out as set forth in Examples 1 and 2.

Subsequently, the sheet was gently pre-compressed between pressure rolls having a temperature of 90° C. From the thus obtained sheet material annular discs are punched, superposed on the shaft of a roll, and compressed, cured, hardened, and finished as set forth in Example 2. The obtained roll had a permanent Shore-hardness of 97°. It had a particularly smooth surface and was suitable for hard foil and fine paper embossing.

This application is a continuation-in-part of our patent applications Ser. No. 611,746, filed September 24, 1956, and Ser. No. 717,432, filed February 25, 1958.

What we claim is:

The method of providing a mandrel with a compact uniform covering firmly sticking to said mandrel, comprising the steps of impregnating a fiber batt consisting of 30 to 60 percent by weight of fibers of high tear-strength and low elongation and 70 to 40 percent by weight of fibers of high elongation with an aqueous natural or synthetic latex composition in such amounts until 20 to 70 percent by weight of said latex, based upon the weight of the total fiber weight, are incorporated into the batt, drying the thus impregnated batt substantially without curing, cutting discs from said dry impregnated batt, superimposing a plurality of the thus obtained discs on a mandrel, pressing said discs on a mandrel between two metal discs until the thickness of each disc has been reduced to about 1/4 to 1/5 of the original thickness, subjecting the thus compressed discs in the compressed condition in a steam chamber for about 4 to 8 hours to a temperature of about 120° C.

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