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PAPER-MACHINE FELT

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This invention pertains to woven textile fabrics, in particular to fabrics useful as a paper-machine felt such as is employed in the manufacture of pulp, paper, board, asbestos-cement sheets, pipes and similar or related products. The material, in accordance with the present invention, may be woven flat and then made into an endless band such as a paper-machine felt by joining the ends of a predetermined length of the woven fabric, or it may be initially woven as an endless band in accordance with well known weaving processes.

According to customary, prior practice, these "felts" were manufactured entirely from wool yarns, or, particularly in the case of the felts used in the production of asbestos-cement products, from a combination of wool and cotton. With the advent of nylon, polyester and similar synthetic fibres, it was found that by manufacturing the felt from yarns composed of blends of wool fibres and synthetic fibres, the abrasion-resistance of the felts was greatly improved and the felts exhibited a longer service life.

Whenever a paper-machine felt is composed entirely of wool or of a mixture of wool and synthetic fibres, milling or fulling is an essential operation in the manufacture of the felt. Thereby, the weave structure of the felt, which otherwise would mark the paper, is masked at the surface by the matted or felted wool fibres and yet its permeability to water remains of a high order.

Until recently, it was thought essential that the proportion of synthetic fibres incorporated in the felt must be less than that which would prevent appreciable milling or fulling of the felt. However, it has been discovered recently that if such a "felt," made wholly or predominantly of synthetic fibres, has one or both of its surfaces raised, as by napping or gigging, and the raised fabric is subjected to a process of needling, the resultant fabric simulates closely enough a milled felt made wholly or predominantly of wool to be used as a paper-machine felt. The operation of needling is effected in any known manner, as by passing the woven fabric through a machine wherein the surface of the fabric is frequently pierced by barbed needles, the result being to force the nap fibres consituting the raised surface into the body of the fabric.

Unfortunately, in many instances, prolonged needling is required effectively to entangle the raised fiibres into the woven body of the fabric. Two major defects are liable to arise as a result of the prolonged needling operation. Firstly, serious reduction in the water permeability of the felt is possible, and it is not unusual for the water permeability of the felt after extensive needling to be only one-half of its initial value. This reduction in permeability has an adverse effect on the rate of drainage of water from the paper sheet through the felt when the latter is in operation on the paper-machine. Secondly, the process of prolonged needling the raised, woven fabric breaks many of the fibres both of the raised surface and of the yarns in the body of the felt. This weakens the fabric and makes it more susceptible to degradation by mechanical abrasion.

The expression, "endless woven fabric," as used herein, is intended to include not only fabric which is woven

endless, initially (the weft in the loom becoming the warp in the finished fabric), but also a length of fabric, woven flat, whose ends have been joined, and wherein the warps and wefts of the fabric are the loom warps and wefts. In this specification by the term "warp" is, therefore, meant those yarns arranged in the longitudinal direction of the endless finished product (regardless of how produced), such as a papermarker's dryer felt and by the term "weft" is meant those yarns arranged in a direction which is transverse of the length of the finished product. The synthetic content of the yarns may be in the form of a plurality of continuous filaments, or staple fibres thereof, and general references to "synthetic fibres" or "fibres" when they occur herein and in the claims hereof are inteded to include, within their scope, both forms.

Broadly stated, the object of the present invention is to simulate in a predominantly synthetic felt, the effect obtained when wool is felted. In the latter case, adjacent fibres become entangled one with another, and not only do fibres within the same yarn become entangled, but the surface fibres of one yarn become entangled with the surface fibres of adjacent yarns running parallel and with the surface fibres of yarns crossing one another. Thus, in wool felting, adjacent fibres become attached to one another, and yarns are likewise attached to each other at their crossing points. In accordance with the present invention, synthetic fibres which contact at crossing points are joined together by integral bonds of the material of which they are composed.

One object of the present invention is to provide an adequately water-pervious woven fabric, for use as a paper-machine felt, which is wholly or predominantly of synthetic fibre and which has not been subjected to a needling or equivalent operation. A further object is to provide a woven textile fabric sufficiently pervious to the passage of water and sufficiently flexible to function satisfactorily as a paper-machine felt and which consists, at least predominantly, of synthetic fibres and wherein, whereever constituent synthetic fibres, in crossing, touch one another, they are integrally joined together at their mutual points of contact. Claims to a method of producing a fabric of the type herein claimed are made in applicants' copending application Serial No. 289,381, filed June 20, 1963.

Briefly stated the invention provides a novel woven fabric, adequately water-pervious and sufficiently flexible for use as a paper-machine felt and which is predominantly of synthetic fibrous material and having at least one outer surface acceptably smooth for such use and wherein adjacent, crossing synthetic fibres are integrally bonded together at their mutual points of contact. The fabric may be produced by interweaving warps and wefts, predominantly of synthetic fibrous material to form a woven structure acceptable for use as a paper-machine felt, and thereafter subjecting the fabric to the action of a reagent which causes some, at least, of the constituent synthetic fibres to coalesce where one fibre contacts another in crossing, whereby said contacting fibres are integrally and permanently bonded together. More specifically, the preferred reagent is an aqueous solution of an inorganic salt which, in concentrated form, is effective to gel synthetic fibres employed.

In the case of fabrics made wholly or predominantly of nylon and/or acrylic fibres, such as Orlon (a registered trademark, the property of E. I. lu Pont de Nemours & Co.) or Courtelle (a regisered trademark, the property of Courtaulds Ltd.), (both being acrylic fibres such as those made of polyacrylonitrile and copolymers thereof) suitable salts are calcium and lithium bromides and calcium and magnesium thiocyanates. In the case of fabrics made wholly or predominantly of polyester fibres, such as Terylene (a registered trademark, the property of Im-

perial Chemical Industries Ltd.) or Dacron (a registered trademark, the property of E. I. du Pont de Nemours & Co.), or containing a material proportion of such fibres in addition to acrylic and/or polyamide fibres, suitable salts are calcium and magnesium thiocyanates.

In accordance with a preferred procedure in the manufacture of the fabric herein claimed, there is first provided a woven fabric of a structure acceptable for use as a base fabric of a papermaker's felt and consisting, at least in major proportion, of synthetic fibre; impregnating the fabric with an aqueous solution of inorganic salt, said solution in response to natural forces tending to accumulate predominantly at points where fibres contact in crossing one another, the solution being too weak, when first applied, effectively to act upon the synthetic material but being such that it can be so concentrated in situ and without determent to the fabric that it will act upon some at least of the synthetic fibres to gel them; progressively concentrating the salt solution thereby intensifying the tendency of the solution to migrate toward and accumulate at the points at which fibres cross and contact one another until eventually the salt reacts with the fibres at said crossing points causing them to gel and coalesce and ultimately to form permanent bonds predominantly at the crossing points rather than over the entire area of the fabric whereby the felt retains substantially the same degree of permeability to water as when woven, then washing the fabric to remove the salt, and drying the fabric so that the completed fabric is devoid of any substance other than that of the yarns from which it was woven. Thereafter, the inorganic salt is washed out of the fabric with water.

Since, according to the herein described method, the application of heat and pressure is not essential for bonding the fibres together, the constituent yarns of the woven fabric are of substantially the same degree of roundness as when the fabric was woven and the interstices between the yarns are not reduced in area, as would result from the flattening of the yarns by the application of heat and pressure.

If a woven fabric for use as a paper-machine felt is composed of a mixture of two synthetic fibrous materials, then a salt capable of swelling and dissolving or gelatinising the surface of both fibres is employed. For example, if the fabric is composed of nylon and Terylene, then calcium or magnesium thiocyanate is employed as the reactant.

The concentration of inorganic salt in the impregnating liquor can be as low as 0.5% by weight, although for good fibre-to-fibre bonding, it is preferred that a 2% to 5% solution is used, and the solution can, in fact, have a concentration of inorganic reactant as high as 10% by weight.

One example of the processing according to the invention is as follows:

An endless woven fabric of a structure suitable for use as a paper-machine felt has warp and weft yarns spun from crimped nylon staple fibres. The fabric is treated at ambient temperature for 15 minutes in a 5% by weight solution of lithium bromide, 4 gallons of solution being used for every 10 lb. of synthetic fiibre. The impregnated fabric is hydro-extracted and then dried on a felt-stretching machine, at least one cylinder of which is heated. As the water evaporates from the felt, thus concentrating the lithium bromide, the latter tends to migrate toward and collect at points where crossing fibres contact, gelatinisation of which results in fibre-to-fibre bonding. When the fabric is completely dry, it is washed in water until free from lithium bromide, hydro-extracted, and redried on the felt-stretching machine.

The above is only one method of carrying out the invention. Any conventional method of impregnation and drying can be used and the concentration and amount of reactant salt can be varied without departing from the invention.

Furthermore, the fabric need not necessarily be woven wholly from spun synthetic yarns and, as has been pointed out hereinbefore, the general references to "synthetic fibres" and "fibres" herein and in the claims, are not intended to be limited to the fibres of such yarns. For example, the warp yarns may be spun from crimped synthetic fibres, or from straight synthetic staple fibres, or may be continuous filament synthetic yarns, or continuous filament bulked synthetic yarns of the non-stretch type, such as Taslan-textured yarns, or yarns composed of a core of continuous filament synthetic yarns around which is wrapped a finer Taslan-textured yarn. ("Taslan" is a trademark registered by E. I. du Pont de Nemours & Co.). The weft yarns are preferably spun from synthetic staple fibres, but these staple fibres may be the commercially-produced crimped synthetic fibres, or they may be prepared by cutting into staple fibre lengths those commercially-produced continuous filament yarns which are known as "bulked yarns" and "stretch yarns" and "bulked and stretch yarns."

In accordance with the present invention, many of the synthetic fibres are integrally joined by bonds which occur predominantly at points at which fibres contact where they cross one another. It should be remembered that it is extremely rare to find two fibres in a spun yarn which make a line contact of appreciable length, although they may repeatedly cross each other. Since the migration of the liquid toward fibre-crossing points is at the expense of liquid which coats fibres at other places, the probability of forming bonds between fibres which are generally parallel, although closely adjacent, is very much reduced, so that the present process does not result in stiffening or reducing the normal flexibility of the felt to a degree such as to impair its utility for the intended purpose and does not substantially decrease the initial permeability of the original woven fabric.

Moreover, the present fibre-bonding process can be applied with advantage to the wholly or predominantly synthetic paper-machine felts, described in our copending United States application Serial No. 47,955, filed August 9, 1960, now U.S. Patent No. 3,063,127, in which the weft yarns are spun from blends which contain shrinkable fibres.

With felts for use on certain types of paper-machines it is preferred to raise, as by napping, one or both surfaces of the woven fabric before impregnation with the reactant solution. In other instances, it is preferred first to bond the fibres by impregnation, evaporation of the entrained water and rewashing and thereafter to raise one or both surfaces. In this latter case, although the operation of raising breaks some of the bonds on the surface fibres, these fibres are still bonded below the raised surface, and the fibres of the yarns unaffected by raising are, of course, still bonded to one another. In either case, the nap fibres collectively mask the weave pattern and provide a smooth surface.

I claim:

1. A papermaker's felt consisting of material wherein uncoated warp and weft yarns are so intercalated as to provide a water-absorbent structure acceptable to constitute the base fabric of a conventional papermaker's felt, and wherein the warp and weft yarns are of substantially the same degree of roundness, in transverse section, as when freshly woven, the warp and weft yarns being in major proportions, at least, of synthetic fibres; the felt possessing desirable characteristics of a conventional wool felt including tensile strength, flexibility and permeability to water but possessing greater abrasive resistance and having a longer service life than an all-wool felt, one face, at least, of the felt comprising nap fibres which mask the weave pattern and collectively provide a smooth surface of the kind desirable in paper making, the felt bing substantially devoid of any substance other than that comprised in the original warp and weft yarns, as woven, and being further characterized in that, pre-

dominantly at points at which constituent fibres cross and contact one another, they are so coalesced from a gel state as to form permanent bonds thereby connecting the yarns of which the united fibres are constituent elements whereby, although the material retains substantially the same degree of flexibility and permeability which is possessed when first woven, it is comparable to a fulled wool felt as respects the permanent union of constituent fibres.

2. A woven papermaker's felt according to claim **1**, further characterized in that the fibres which coalesce at their crossing points are predominantly polyamide fibres.

3. A woven papermaker's felt according to claim **1**, further characterized in that the fibres which coalesce at their crossing points are predominantly acrylic fibres.

4. A woven papermaker's felt according to claim **1**, further characterized in that the fibres which coalesce at their crossing points are predominantly polyester fibres.

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