March 30, 1971 N. D. FRIEDBERG ET AL 3,573,164

FABRICS WITH IMPROVED WEB TRANSFER CHARACTERISTICS

Filed Aug. 22, 1967 2 Sheets-Sheet 1

Fig. 1

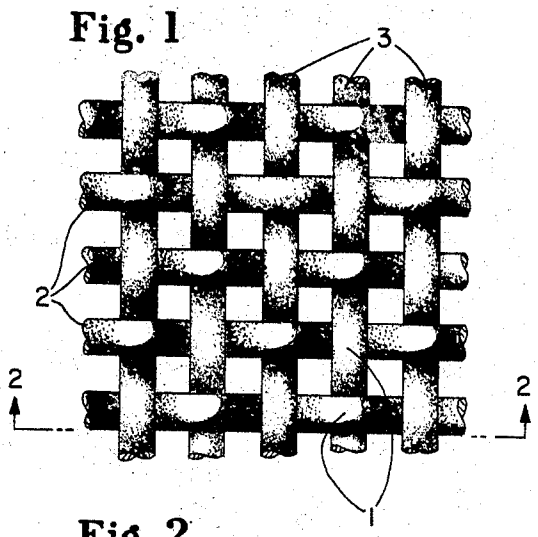


Fig. 3

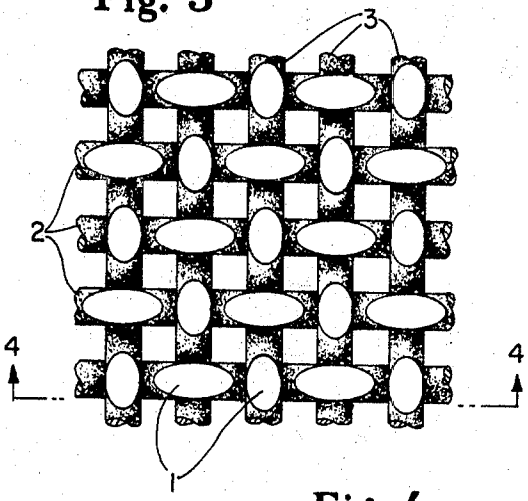


Fig. 2

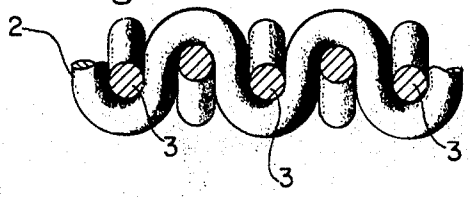


Fig. 4

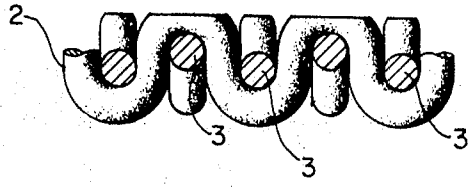


Fig. 5

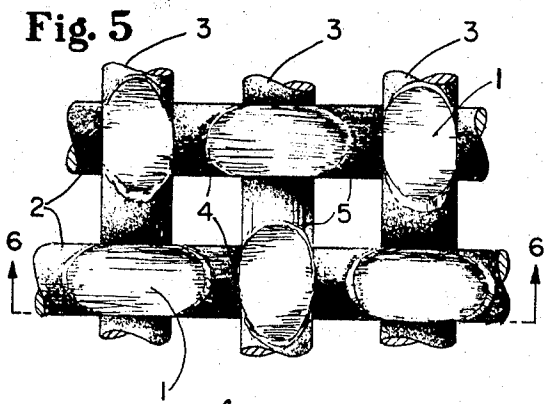
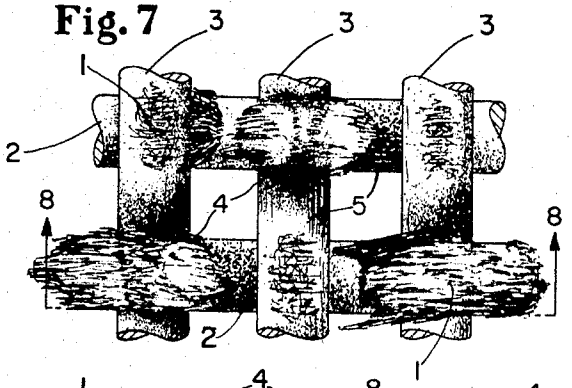


Fig. 7



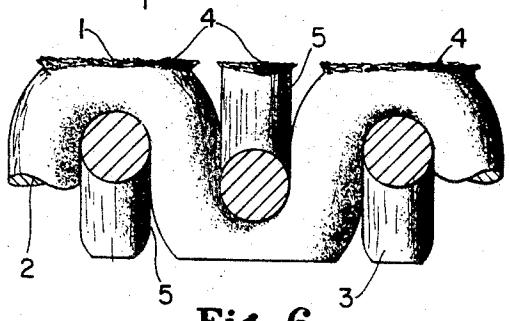


Fig. 6

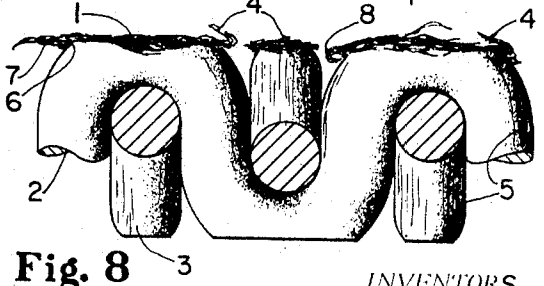


Fig. 8

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March 30, 1971 N. D. FRIEDBERG ET AL 3,573,164

FABRICS WITH IMPROVED WEB TRANSFER CHARACTERISTICS

Filed Aug. 22, 1967 2 Sheets-Sheet 2

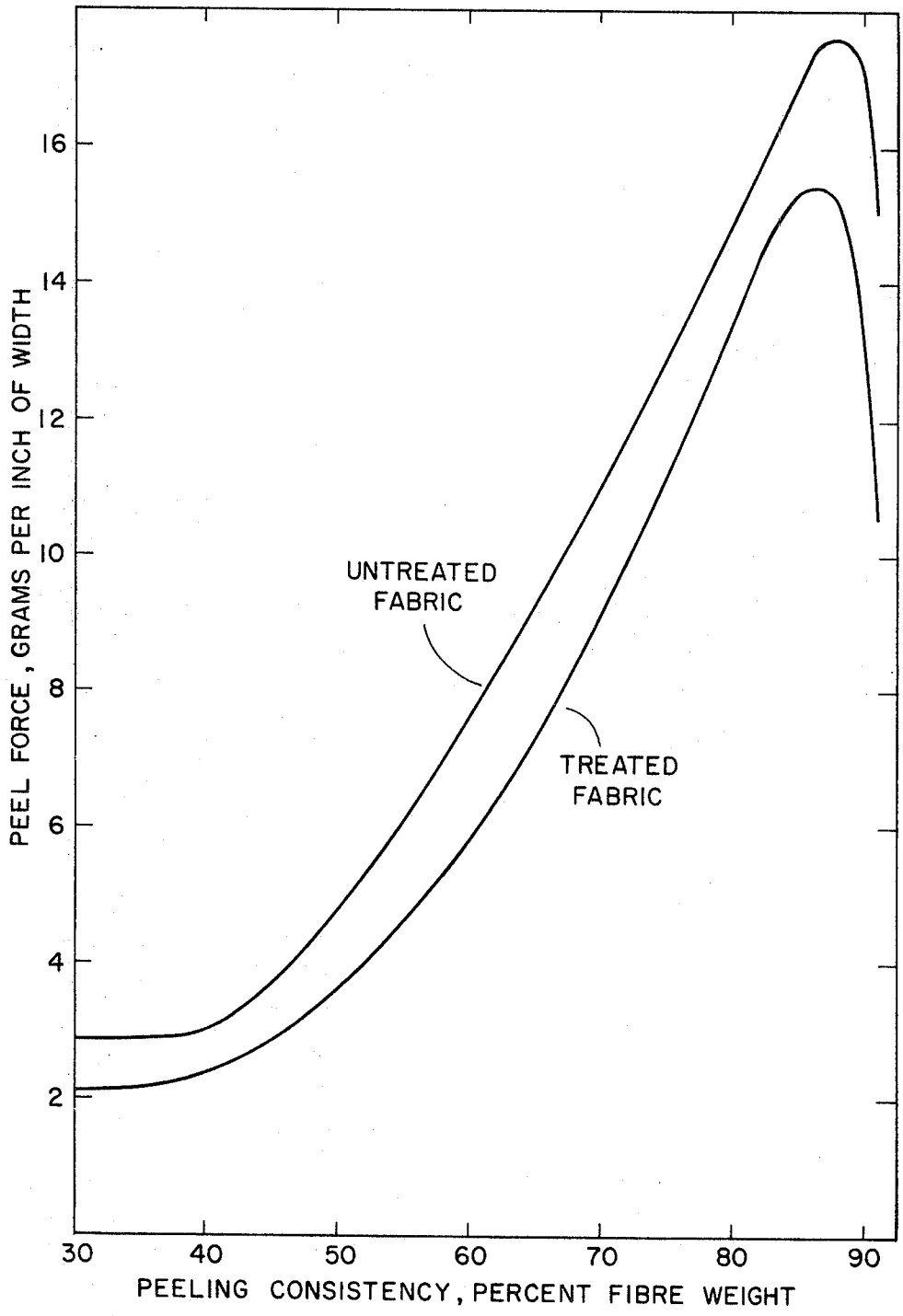

Fig. 9

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3,573,164

FABRICS WITH IMPROVED WEB TRANSFER CHARACTERISTICS

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U.S. Cl. 162—348 8 Claims

ABSTRACT OF THE DISCLOSURE

A process for improving the parting or transfer characteristics of monofilament polymeric fabrics in supporting and transferring moist webs from one step to another in papermaking and non-woven web manufacturing operations. Improved transfer characteristics in the monofilament polymeric fabrics are achieved by abrading away the knuckle surfaces thereof with a fine abrasive medium to increase the knuckle imprint area of the fabric. The improved parting characteristics engendered in the monofilament polymeric fabric by the abrasive treatment improve web transfer, web drying, web product characteristics and general machine operation.

BACKGROUND OF THE INVENTION

This invention relates to improvements in papermaking and non-woven web manufacturing operations and to the provision of formation and carrier fabrics which contribute to the efficiency of such operations. More particularly, the invention provides an improved monofilament polymeric fabric for use in papermaking and non-woven web manufacturing operations wherein the surface characteristics of such fabrics are of operational and product characteristic importance.

Specifically, the invention in one important embodiment consists of an improved monofilament polymeric fabric of the type used for transporting a moist web through the press and drying sections of a papermaking machine, which monofilament polymeric fabric has been improved by abrading its surface with a fine abrasive medium to increase its knuckle imprint area.

In referring to monofilament polymeric fabrics herein, applicants intend reference to moist web carrier fabics woven, for example, from the polyamide fibers, vinyl fibers, acrylic fibers and polyester fibers sold under the respective trademarks of "nylon," "Saran," "Orlon" and "Dacron." While both warp and woof filaments in fabrics can be made up of a multiplicity of fibers, the present invention is concerned with warp and woof filaments comprised of one fiber, i.e., monofilaments. The warp and woof monofilaments have a diameter of about 0.008 inch to about 0.20 inch, and the carrier fabrics can be of any specific construction; for example, plain weave, single or double crimped, twilled and semi-twilled fabrics can be utilized. The term knuckle imprint area refers to the area imprinted on an adjacent plane surface by the knuckle cross-over points of the warp and woof filaments of a monofilament fabric. It is noted that the warp filaments of the fabric run parallel to the machine direction of papermaking and non-woven web manufacturing machines to form a continuous carrier belt; woof filaments run in the cross-machine direction.

In the formation, pressing and drying of a moist web in Fourdrinier or other papermaking operations as well as in the manufacture of non-woven webs, persons skilled in the art will recognize that several transfers of a partially formed or bonded and/or partially dried web with little mechanical strength occur. These transfers, assuming the initial formation of a desirable web structure, are

of importance in that they can only disrupt bonds, entanglements and other mechanical and chemical features which contribute to the desirable structure of the web. To avoid the foregoing transfer problems and to satisfy other criteria, an ideal monofilament polymeric fabric for web manufacturing, and particularly papermaking operations, should possess characteristics which allow said fabric to adhere sufficiently to a web structure at its various stages of formation, pressing and drying to act as a carrier. At the same time, the monofilament polymeric fabric should not interfere with the web structure or impart undesirable characteristics to its structure during transfer.

Papermakers, for example, have long known that paper webs in their initial stages of formation, pressing and drying will naturally transfer from a rough to a smooth surface, i.e., papermakers have depended on the natural tendency of an initially formed paper web to transfer from a Fourdrinier wire to the felt conventionally used in the press section of a papermaking machine. Modern papermaking practice has, however, in several instances departed from the normal sequence of Fourdrinier of similar formation wire to pressing and drying felts. In these operations, for example in the operation of a paper machine according to the teaching of U.S. 3,301,746, improved transferability is desired, and the monofilament polymeric fabrics used should not contribute factors to the final paper product other than those desired by the papermaker and designed into the paper product.

In particular, it has been learned through experience that the use of monofilament polymeric fabrics in the press and drying sections of a paper machine introduces problems in the transfer of a moist paper web to a drying surface. Although it might be expected that continued use would polish the knuckle surfaces of such a monofilament polymeric fabric to make release of a moist paper web easier in late fabric life, such did not prove to be the case. Wear-induced fibrils on the knuckle surfaces of such used fabrics interfered with the release and transfer of moist paper webs and reduced the tensile strength of the resulting paper products.

SUMMARY OF THE INVENTION

Inasmuch as a means of reducing or preventing fiber bond rupture was desired as a means of increasing product tensile strength as were other improvements in papermaking and non-woven web manufacturing operations, the monofilament polymeric fabric and process for its preparation which comprise this invention were developed. In general, the present monofilament polymeric fabric is prepared by abrading the knuckle surfaces of a monofilament polymeric fabric to increase knuckle imprint area and polish knuckle surfaces. The preparation or pre-treatment is continued with a fine abrasive medium until the knuckle imprint area of said fabric is about 20% to about 50% of the fabric surface area. The knuckle imprint area of a monofilament polymeric fabric before pre-treatment is about 6% to about 15% of the fabric surface area.

Contrary to normal expectation, continued use on a paper machine does not polish the knuckle surfaces of a monofilament polymeric fabric not accorded the abrasion treatment of the present invention; but rather wears these knuckle surfaces in such a way that a fine fuzz or fibril tuft is developed at various points thereon. Such fibril tufts entangle themselves in the fibers of paper and non-woven webs and thereby interfere with web release and transfer. It has been unexpectedly discovered, however, that the presently disclosed abrasion pre-treatment using an abrading medium having an effective abrasive grain size of less than about 300 mesh, i.e. an abrading medium the use of which results in a surface smoothness at least equivalent to that obtained with sandpaper loaded

with grit number 300 aluminum oxide abrasive grains as defined by the Abrasive Grain Association and Grinding Wheel Manufacturing Association, will pre-prepare monofilament polymeric fabrics in such a way that the aforesaid wear fibrils are substantially prevented from developing. Accordingly, fiber bond disruption during transfer of a moist paper web carried and/or formed and carried thereon is greatly reduced, and increased intimate drying contact results when pre-prepared monofilament polymeric fabric is used to press a moist web onto a drying surface. It is, accordingly, the principal object of this invention to improve the foregoing features and to overcome other associated problems and disadvantages.

Another object of this invention is to provide a monofilament polymeric fabric for use in papermaking and non-woven web manufacturing operations, which fabric has a total knuckle imprint area of about 20% to about 50% of its area and which knuckle imprint area has a surface finish at least equal in smoothness to the surface finish induced by abrasion with an abrasive medium having an effective abrasive grain size of less than about 300 mesh.

It is another object of this invention to provide a process for the improvement of monofilament polymeric fabrics for use in papermaking and non-woven web manufacturing operations wherein such fabrics are abraded prior to such use with an abrasive medium having an effective abrasive grain size smaller than about 300 mesh, whereby a smooth knuckle imprint area which will persist during said fabrics' life in a papermaking machine and which is conducive to moist web transfer is produced.

It is yet another object of this invention to provide a monofilament polymeric fabric for use in the press and drying sections of a papermaking machine, which fabric presents an increased knuckle imprint area for use in pressing a moist paper web onto the surface of a Yankee dryer while it contributes materially to the final tensile strength of the dried paper product by avoiding the rupture of fiber bonds.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of this invention will become apparent as the description thereof proceeds in accordance with, and as illustrated by, the drawings wherein a monofilament polymeric fabric accorded the treatment of this invention is illustrated together with a conventional and untreated monofilament polymeric fabric for comparison. A graph illustrating the improvement in one measurable indicator of fiber bond rupture improvement gained by such treatment is also illustrated. In the drawings the direction of worn travel is left to right; the fibrillated side of the worn fabric is the fabric side in moist web contact while the opposite side runs against pulleys and suction boxes and like numbers refer to like monofilament polymeric fabric features.

FIG. 1 is a plan view of an enlarged portion of a conventional monofilament polymeric fabric. The monofilament polymeric fabric illustrated has not been accorded the abrasive treatment of the present invention and has not been run as an endless or continuous fabric belt in papermaking or non-woven web manufacturing operations.

FIG. 2 is an enlarged cross-sectional view of the monofilament polymeric fabric illustrated in FIG. 1, which cross-sectional view further illustrates the smooth knuckle surfaces of the warp and woof filaments and is taken in the cross-machine direction along the line **2—2** in FIG. 1.

FIG. 3 is an enlarged plan view of a monofilament polymeric fabric which has been accorded the abrading pre-treatment of this invention, but has not been run on a papermaking machine.

FIG. 4 is an enlarged cross-sectional view of the monofilament polymeric fabric illustrated in FIG. 3, which cross-sectional view illustrates the increased knuckle imprint area of sum of the knuckle surfaces developed by the present abrasive pre-treatment and is taken along the line **4—4** in FIG. 3.

FIG. 5 is an enlarged plan view of a monofilament polymeric fabric like that illustrated in FIG. 3 after a service life of about 400 hours as a continuous moist web carrier belt in the press section of a papermaking machine.

FIG. 6 is an enlarged cross-sectional view of the fabric illustrated in FIG. 5, which cross-sectional view illustrates the unusual lack of wear discovered in the present pre-treated monofilament polymeric fabrics and is taken along the line **6—6** of FIG. 5.

FIG. 7 is an enlarged plan view of a monofilament polymeric fabric like that illustrated in FIG. 1, i.e., given no abrasive pre-treatment, after a service life of about 300 hours as continuous moist web carrier belt in the press section of a papermaking machine.

FIG. 8 is an enlarged cross-sectional view of the fabric illustrated in FIG. 7, which cross-sectional view illustrates very well the surface roughness, fibrillation and other indications of incipient filament breakage and poor moist web transferability which were developed in an untreated monofilament polymeric fabric under comparable conditions of service at only three-quarters of the service life obtained by the fabric illustrated in FIGS. 5 and 6. The cross-sectional view of FIG. 8 is taken along the line **8—8** in FIG. 7.

FIG. 9 is a graph illustrating the improvement in force necessary to transfer a moist paper web from a monofilament polymeric fabric before and after pre-treatment according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In describing the preferred embodiment of the invention illustrated in FIGS. 3, 4, 5 and 6 of the drawings, specific terminology will be adhered to for the sake of clarity in referring to the features of the monofilament polymeric fabrics for use in papermaking and non-woven web manufacturing of this invention. Transfer refers to parting a moist web from a monofilament polymeric fabric for deposit on another fabric or surface.

FIGS. 1 and 7 and 2 and 8 are, respectivey, enlarged plan and enlarged cross-sectional views of comparative monofilament polymeric fabrics which have not received the abrasive pre-treatment of the present invention. FIGS. 1 and 7 are enlarged plan views of the comparative monofilament polymeric fabrics which illustrate the before and after appearance of such fabrics in continuous moist web carrier belt use. FIGS. 2 and 8 are enlarged cross-sectional views which further illustrate the before and after appearance of untreated monofilament polymeric fabrics.

Referring now to FIGS. 3, 4, 5 and 6 of the drawings, FIGS. 3 and 4 illustrate a monofilament polymeric fabric treated according to the present invention but not worn, and FIGS. 5 and 6 are enlarged plan and cross-sectional views of the same fabric after about 400 hours of papermaking machine wear as a continuous moist web carrier belt. FIGS. 5 and 6 illustrate the greatly reduced wear on the fabric attributable to the pre-treatment of this invention. In particular, comparison between FIGS. 3 and 4 and 5 and 6 show that fabrics accorded the treatment of this invention prior to use as a continuous moist web carrier belt in a papermaking machine show very little wear of knuckle surfaces **1** after 400 hours of papermaking machine use.

This is surprising since it would appear that wear by deliberate abrasion prior to service would decrease service life. As shown in FIGS. 5 and 6, however, the knuckle surfaces **1** of the treated monofilament polymeric fabric, enlarged as they are in FIGS. 5 and 6, show the development of very little fibrillation **4**, striation **5**, fibril tufts **7**, fibril masses **8** or other characteristics which result in poor moist web transferability, fiber bond rupture and decreased drying efficiency in transfer to a Yankee drying drum or other drying surface.

For comparison, FIGS. 1 and 2 show a monofilament

polymeric fabric as it issues from the weaving process; this fabric has not been accorded the abrasive pre-treatment of this invention and has seen no service life. It is apparent from the enlarged plan and cross-section views, shown in FIGS. 1 and 2 respectively, that both the warp filaments 2 and the woof filaments 3 of this fabric are smooth surfaced and in their enlarged view appear almost as woven glass rods. FIGS. 1 and 2 are included in the drawings to illustrate the appearance of an unworn monofilament polymeric fabric with no pre-treatment for contrast with the worn fabric illustrated in FIGS. 7 and 8 of the drawings. FIGS. 1 and 2 also can be compared with FIGS. 3 and 4 to show the physical effect of the present abrasive pre-treatment in flattening and enlarging the knuckle surfaces 1 of the fabrics.

FIGS. 7 and 8 of the drawings illustrate enlarged plan and cross-sectional views of a monofilament polymeric fabric, which views are comparable, respectively, with FIGS. 1 and 2, FIGS. 3 and 4 and FIGS. 5 and 6. In FIGS. 7 and 8, however, the fabric shown in FIGS. 1 and 2 is illustrated after about 300 hours of service as a continuous moist web carrier belt on a papermaking machine. Note that the individual warp filaments 2 and woof filaments 3 of the worn monofilament polymeric fabric illustrated in FIGS. 7 and 8 have developed striations 5, and that these striations 5 further develop to rupture and appear as fibril tufts 7. The striations 5 appear to rupture at the shoulder of the filament knuckles 6 to form fibril tufts 7 or turned back fibril masses 8. Either the fibril tufts 7 or the turned back fibril masses 8 are detrimental to the release of a moist paper web. Furthermore, fibril tufts 7 do not present a flat pressing surface conducive to the development of contact for drying on a Yankee surface. In some instances it can be seen in FIGS. 7 and 8 that the filament breakdown at the knuckle surfaces 1 is so pronounced that some of the fibril tufts 7 have torn back to the adjacent woof filaments 3, and the woof filaments 3 are seen to be preventing them from further tearing. In other instances, where there has been an initial breakdown in the warp filaments 2 to form striations 5 which parted to form fibril tufts 7, the initial rupture point is seen to be the site of yet another incipient filament breakdown. It is assumable that successive filament breakdowns of this type would eventually cause rupture of a warp filament 2 or a woof filament 3.

The graph shown in FIG. 9 illustrates one measure of the moist web fabric transfer characteristics engendered by the pre-treatment of a monofilament polymeric fabric according to the process of the present invention. The graph shown in FIG. 9 has as its ordinate the peel force in grams per inch of web width necessary to part a moist paper web from a monofilament polymeric fabric. The abscissa of the graph has as its units the fiber consistency at which the peeling was conducted. A monofilament polymeric fabric pre-treated according to the process of the present invention is seen to require a lower peel force at any fiber consistency, as a measure of moisture content, than does an untreated monofilament polymeric fabric. Although the peel force reduction brought about by pre-treatment is shown by the graph of FIG. 9 to be only about 12% to about 27% of the peel force necessary, the effect of this peel force reduction in the tensile strength of a moist web is relatively large; this is because the peel force is applied to a moist and relatively weak web, and slight reductions in peel force produce relatively large gains in ultimate tensile strength. Increases in paper web tensile strength of about 40% to about 90% have been realized from the present monofilament polymeric fabric pre-treatment. In requiring a lesser peel force to separate a moist web and carrier fabric, the treated fabric has a lesser tendency to disrupt fiber bonds when transfers are made in papermaking and non-woven web manufacturing operations.

In obtaining the results shown in the graph of FIG. 9, the peel force was taken as the average instantaneous pull necessary to peel back a one-inch wide strip of moist web at various fiber consistencies in a 180° reversal from its position on a monofilament polymeric fabric. The numerical results from which FIG. 9 was plotted were obtained by using an Instron tester (Model TM, Serial No. 261) to apply the peel force.

FIGS. 3 and 4 of the drawings illustrate the about 20% to about 50% knuckle surface area developed in monofilament polymeric fabrics by the present treatment. FIGS. 5 and 6 show that this increased knuckle surface area persists after service as a continuous moist web carrier. The greater knuckle surface area serves to increase contact between moist webs and drying surfaces for more efficient drying.

Applicants point out that the initial abrading treatment given the monofilament polymeric fabric prior to use, as illustrated in FIGS. 3 and 4, might be expected to shorten fabric life. The present pre-treatment, however, not only results in a monofilament polymeric fabric life as long if not longer than untreated monofilament polymeric fabrics, but also results in the aforementioned advantage of dryer surface contact and avoidance of fiber bond disruption. Comparison between FIGS. 5, 6, 7 and 8 shows that a pre-treated monofilament polymeric fabric with a service life of about 400 hours as a continuous moist web carrier belt is clearly superior in surface condition to a 300 hour untreated monofilament polymeric fabric illustrated in FIGS. 7 and 8.

As stated above, the pre-treatment of the present invention consists of abrading the knuckle surfaces of an original monofilament polymeric fabric, as illustrated in FIGS. 1 and 2, with a suitable abrasive media wherein the abrasive grains have a smaller or finer effective abrasive grain size than about 300 mesh. Applicants have found that the present pre-treatment performed with an abrasive medium having an effective abrasive grain size larger than about 300 mesh will engender an ultimate fabric condition much like that illustrated in FIGS. 7 and 8. When the pre-treatment is carried out with an abrasive medium having an effective abrasive grain size of about 300 mesh to about 600 mesh, the ultimate monofilament polymeric fabric appearance after lengthy periods of service as a continuous moist web carrier belt will be found to approximate the fabric appearance illustrated in FIGS. 5 and 6. A total knuckle imprint area of about 20% to about 50%, preferably about 30%, of the monofilament polymeric fabric area is developed on the pre-treated fabrics.

Applicants prefer to carry out the present treatment by abrading the surface of the original monofilament polymeric fabric using a wet sandpaper having an effective abrasive grain size of about 300 mesh to about 500 mesh as an abrasive medium. Dry sandpapers can also be used, and the abrasive media can be mounted on drums for rotative application to fabric knuckle surfaces. The abrading can be performed while continuously showering the fabric with water or other cleansing and lubricating fluid, for example light oil, to remove abraded particles and facilitate the polishing operation.

Applicants find it necessary to form a smooth and polished surface on the knuckle imprint area of the monofilament polymeric fabric. To this end, the present abrading operation can be conducted in several stages. For example, the initial abrasion can be carried out with with an abrasive medium having an effective abrasive grain size of about 300 mesh, and this initial abrading operation can be followed by an abrasive polishing treatment using a water lubricated wet sandpaper having an effective abrasive grain size of about 500 mesh. Polishing abrasives such as talc, rouge and crocus cloth can be used to further polish the knuckle surfaces formed on the monofilament polymeric fabric. While applicants have specified wet and dry sandpapers having an effective abrasive grain size of about 300 mesh to about 600 mesh as abrasive media for use in carrying out the present pre-

treatment, other abrasive means, for example pierced metal and grinding wheel abrasive media having an equivalent abrasive action can be used to develop the type of knuckle surfaces 1 shown in FIGS. 3 and 4.

It is to be understood, therefore, that the form of the invention herein illustrated and described is to be taken as a preferred embodiment. Various changes may be made in the abrading process without departure from the invention, and various abrasive media and means of using same to achieve a pre-treatment for monofilament polymeric fabric as disclosed herein can be utilized without departing from the spirit or scope of the invention as defined in the attached claims.

The method of monofilament polymeric fabric pretreatment and the resultant monofilament polymeric fabric with increased knuckle imprint area of this invention has been found to be advantageous in that the abrasion pre-treatment practically eliminates further meaningful fibrillation wear during the life of a so-treated monofilament polymeric fabric as a continuous moist web carrier belt. The additional knuckle imprint area engendered on the pre-treated fabrics is also advantageous in that better contact on a Yankee dryer or other drying surface results when the pre-treated fabric is used to effect a pressing transfer; the better contact is found to increase drying capacity. This latter advantage is in part due to the knuckle surface height evenness engendered by abrasion.

Since the pre-treated monofilament polymeric fabrics have improved transfer characteristics, which improved transfer characteristics result in higher product tensile strength, use of the pretreated fabrics allows higher machine speeds during startup and decreases the likelihood of web breakage and resultant machine down-time. Further improvement in transfer capability can be obtained by coating the pre-treated fabrics with resin and other release agents.

The enhanced web transfer engendered by abrasive fabric pre-treatment also leads to less fiber residue remaining on the treated fabric after web transfer. The reduced fiber residue results in a fabric which remains clean and retains the improved transfer capability. Resultant paper and non-woven web products are more uniform as regards web characteristics such as surface pattern, creping and other physical characteristics. As another important feature of the pre-treatment disclosed herein, the monofilament polymeric fabrics of this invention, as a result of their substantially unchanging surface condition, tend to exhibit substantially the same operating conditions and produce substantially the same products from the time of their first use until the time of their replacement.

Having thus defined and described the invention, what is claimed is:

1. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations, whereby the parting characteristics of said fabric for moist papers and non-woven webs supported thereon are substantially improved, which process comprises the steps of:

(1) increasing the knuckle imprint area of said fabric on the web supporting surfaces of said fabric by abrading away the knuckle surfaces thereof with at least one abrasive medium having an effective abrasive grain size of about 300 mesh to about 600 mesh, and

(2) supporting said papers and non-woven webs by said fabric on its abraded surface.

2. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claimed in claim 1 wherein the abrasive medium is wet sandpaper and the knuckle surfaces are lubricated with water while increasing the knuckle imprint area.

3. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claimed in claim 1 wherein the abrasive medium is drum mounted dry sandpaper having an effective abrasive grain size of about 300 mesh.

4. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claim in claim 1 wherein the abrasive medium is first wet sandpaper having an effective abrasive grain size of about 300 mesh and second wet sandpaper having an effective abrasive grain size of about 500 mesh.

5. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claim in claim 1 wherein the abrasive medium is wet sandpaper having an effective abrasive grain size of about 300 mesh and the abraded knuckle surfaces are thereafter polished with crocus cloth.

6. A process for pre-treating a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claimed in claim 1 wherein the abrasive media is first wet sandpaper having an effective abrasive grain size of about 300 mesh and second wet sandpaper having an effective abrasive grain size of about 500 mesh and the abraded knuckle surfaces are thereafter polished with rouge.

7. The combination of a monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations with a web supported by said fabrics, which monofilament polymeric fabric has a knuckle imprint area, supporting said web, of about 20% to about 50% of the surface area of said fabric, and the knuckle surfaces comprising said knuckle imprint area have surface finishes which are at least equal in smoothness to the surface finish induced by abrasion with an abrasive medium having an effective abrasive grain size of about 300 to about 600 mesh, said web being supported by the abraded knuckle surfaces of said fabric.

8. A monofilament polymeric fabric for use as a formation and carrier fabric in papermaking and non-woven web manufacturing operations as claimed in claim 7 wherein monofilament polymeric fabric has a knuckle imprint area equal to about 30% of the surface area of said fabric.

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U.S. Cl. X.R.

139—383, 425.5; 161—75