

- [54] **FIBROUS PRODUCT**
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Related U.S. Application Data

- [60] Division of Ser. No. 264,302, June 19, 1972, , which is a continuation-in-part of Ser. No. 850,747, Aug. 18, 1969.
[52] **U.S. Cl.**..... **210/497.1, 210/508**
[51] **Int. Cl.**..... **B01d 27/00**
[58] **Field of Search** 161/88, 170, 172, 176; 28/74, 75; 210/491, 496, 508, 497, 497.1, 494

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[57] **ABSTRACT**

An improved roving capable of being mechanically worked without first forming a yarn is disclosed. The improved roving is in the form of a strand of staple fibers prepared in accordance with customary textile carding process. The formed roving is treated with a resin binder and, when cured, the fibers resemble a reticulated network. The fibers are disoriented and cross over one another at a multiplicity of points to form bonding sites at the cross-over point when the resin is cured, while maintaining the fibers spacially separated between the bonding sites. The thus treated roving is found to have good flexibility and abrasion resistance while providing the roving with unexpected tensile strength, increased elasticity, permeability, void volume and porosity even when the roving is subjected to compressive forces as compared with untreated roving subjected to the same forces.

6 Claims, 8 Drawing Figures

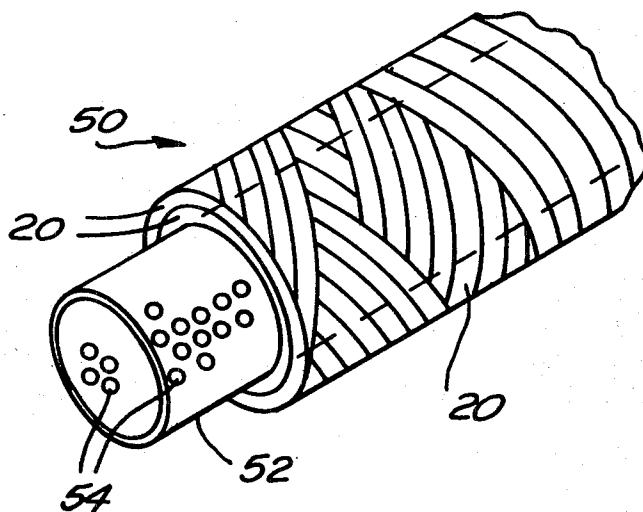


FIG. 1

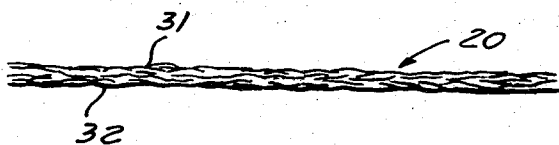
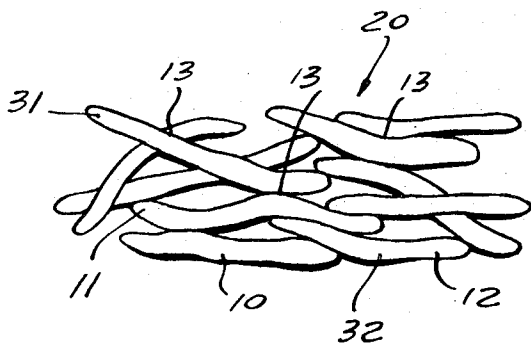


FIG. 2

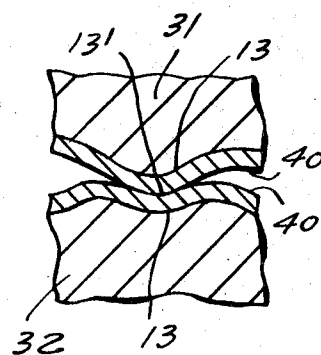


FIG. 3

FIG. 4

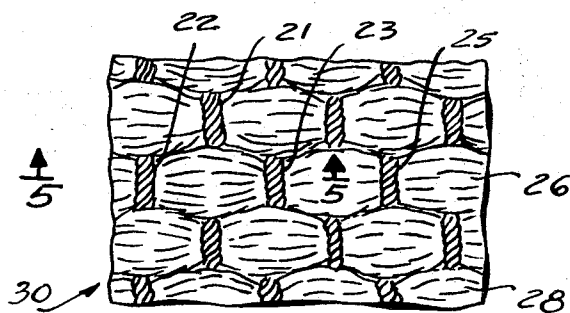
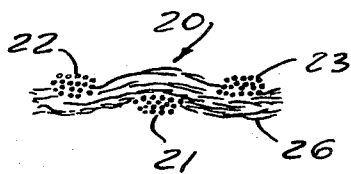


FIG. 5

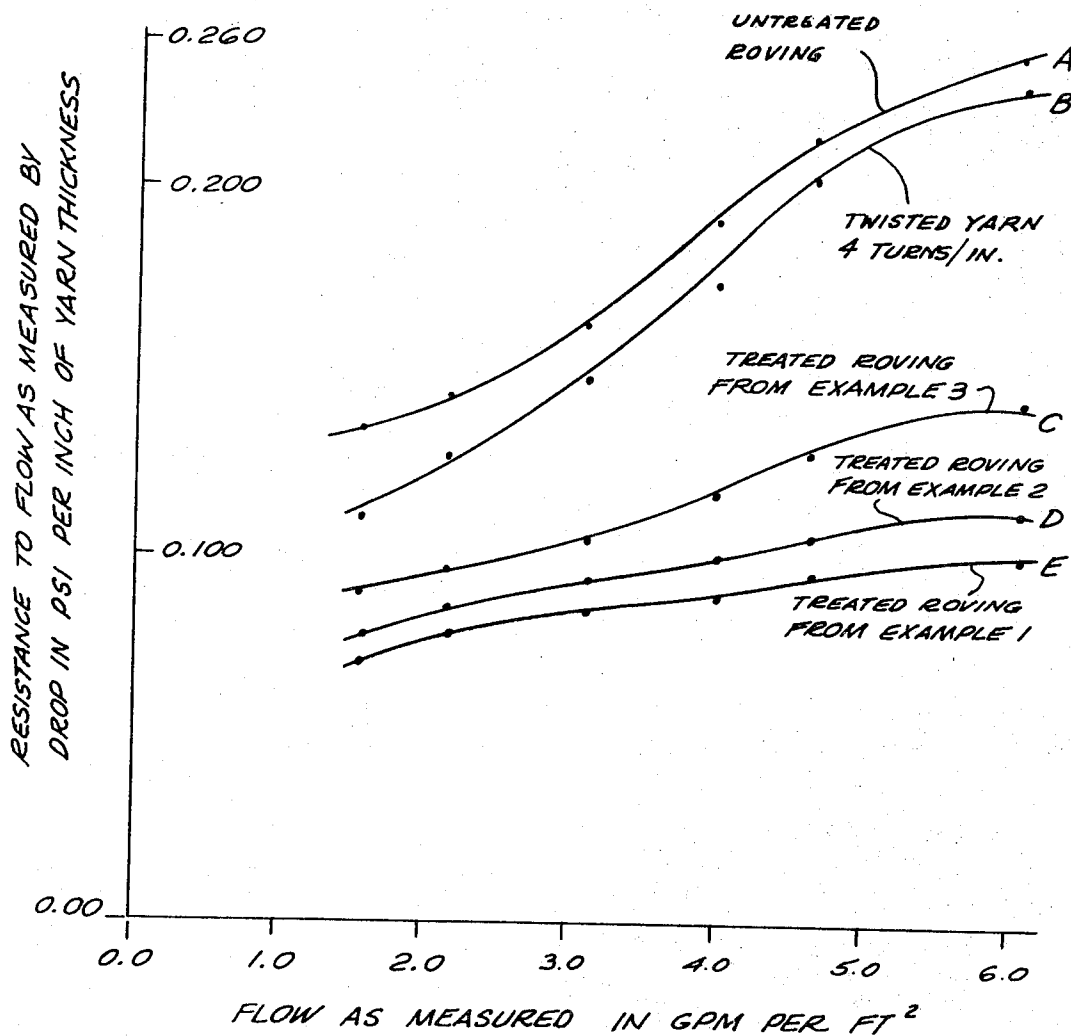


FIG. 6

AT 50 PSI STATIC COMPRESSIVE LOAD PRESSURE ON YARNS

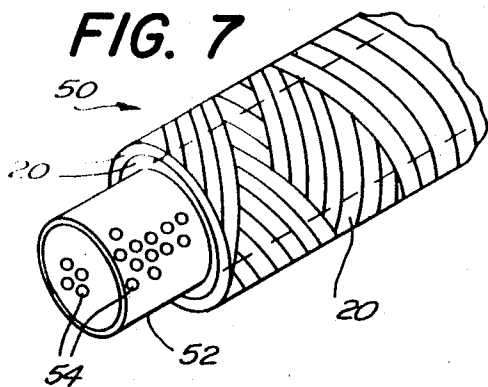
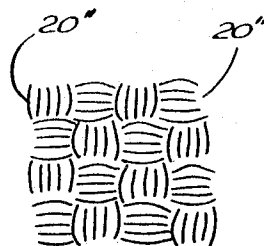


FIG. 8



FIBROUS PRODUCT

CROSS REFERENCE TO RELATED APPLICATION

This application is a division of U.S. application Ser. No. 264,302, filed June 19, 1972 which in turn is a continuation-in-part of U.S. application Ser. No. 850,747, filed Aug. 18, 1969.

BACKGROUND OF THE INVENTION

This invention relates to fibrous products and, more particularly, to roving having improved strength which is adaptable to be woven into fabric without first being processed into yarn.

The conventional method of producing yarn in the textile industry is by carding a blend of textile fibers into a web. The web is then broken or cut by a grooved roll into a number of flat ribbon-like web ends. These webs are then carried by means of tapes or narrow straps to a series of rubbing aprons where the rubbing action entangles and condenses the fibers in the flat ribboned web into a round strand. By so entangling the fibers the number of cross-over points are multiplied, resulting in an increase in strength of the fiber bundle. The resulting product is termed "roving" or "roping" and does not have enough strength to be woven although it is stronger than the web ribbons from which it is formed due to further entanglement of the fibers. As used herein, the term "roving" means a loose assemblage of fibers drawn or rubbed into a single strand with very little twist. It is a product in the stage between sliver and yarn.

The roving is then wound on a spool for further processing into yarn. The yarn is formed on a spinning frame by applying draft and twist to the roving before winding on bobbins. The drafting and spinning operation performed on the roving produces yarn with enough strength, abrasion resistance and flexibility for weaving into fabric. The fibers in the yarn are closely packed and spirally oriented due to the twisting action in the spinning operation on the fiber bundles. The greater the twist given to the fibers, the closer the fiber packing in the yarn and the stronger the resulting yarn. However, when roving is twisted each turn of twist increases the density but decreases the void volume per unit length with an attendant reduction in diameter and length which reduces its efficiency as a filter media.

Roving or roping cannot normally be woven into fabric before being processed into yarn because the roving does not have sufficient strength without the twist imparted in the yarn-making step to withstand weaving stresses such, for example, as the winding tension on the warp beam, tension resulting from harness motion encountered in the weave pattern, etc. In addition, roving does not have sufficient filling strength for winding or insertion of picks. Moreover, roving does not have the external abrasion resistance necessary to withstand weaving, the chafing of metal parts, e.g., the rolls, etc., nor does it have resistance to withstand strand against strand chafing.

In U.S. Pat. No. 2,689,813 a method is disclosed for making a bonded yarn from a roving. The yarn is initially in the form of a strand of staple fibers which are aligned into an extremely thin ribbon such that it cannot sustain its own weight when suspended across a gap during processing. The ribbon is coated with an adhesive

and is then subjected to pressure which compacts the fibers and causes the adhesive to completely coat the fibers so that when the adhesive is dried and cured the compacted fibers forming the strand are coated and bonded over substantially their entire length.

In another U.S. Pat. No. 2,834,704 staple fibers are coated with an adhesive and bonded to form a twistless filamentary body. The fibers are coated with an adhesive and are gathered into a bundle by forming rolls which compact the fibers and while compacted the adhesive is dried and cured and a compacted bonded yarn is formed.

SUMMARY OF THE INVENTION

With the foregoing in mind, it is an object of the invention to provide a roving having increased strength, abrasion resistance, flexibility and other properties to permit it to be woven into fabric without first being processed into yarn.

Another object of this invention is to provide an improved, high-strength roving.

A further object of this invention is to provide a roving having high strength, permeability and which is capable of being manufactured into filter media either woven or non-woven, or woven in combination with mono or multifilament yarns.

A still further object of this invention is to provide roving having a combination of high strength, permeability, and increased void volume even when subjected to compressive forces.

Also another object of the invention is to provide a roping which is suitable for manufacture into articles of commerce such as woven fabrics, as filter media in filtration devices, and as filler material useful as batting for shaping stuffed furniture.

The invention generally relates to an improved roping or roving capable of being mechanically worked without first forming the roving into a yarn. The roving, which is made in accordance with customary carding process, comprises a strand of staple fibers having applied thereto a resin binder. The strand is in the form of a bundle of disoriented fibers which cross over one another in a multiplicity of points so that the resin binder carried on the surfaces of the fibers will form bonding sites at the crossover points when the resin binder is cured while maintaining the fibers spatially separated. The treated roving is found to have high tensile strength while unexpectedly providing a roving with increased bulk density, permeability and porosity even when the roving is subjected to compressive forces.

A further object of the invention is to provide a treated roving or roping of high strength and improved resiliency which is resistant to compressive forces.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings.

It is another object of the invention to provide a treated roving or roping in which the fibers forming the treated roving are spatially separated intermediate the fiber crossover points. These crossover points form the bonding sites which maintain the treated roving in a bulky non-compacted state thus providing greater permeability, loft, resiliency and, consequently, results in a roving or roping which is less dense than conventional bonded yarns of the prior art. A further object of the invention is to provide a treated roving in which the di-

ameter of the treated roving is substantially equal to or greater than the original roving in the untreated form and which has greater strength, is compressible and will return to its original diameter upon release of the compressive forces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of roving composed of a strand of condensed fibers;

FIG. 2 is a close-up view of the roving of FIG. 1 showing the entangled fibers and numerous points of crossover or overlap between adjacent fibers;

FIG. 3 is a close-up view of a pair of fibers at a point of crossover or overlap showing a bonding of the fibers at the point of crossover;

FIG. 4 is a top plan view of a section of fabric woven in the filling direction with roving processed in accordance with this invention;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 4;

FIG. 6 illustrates diagrammatically the resistance to flow of fluids through filter media made in accordance with the invention herein as compared with untreated roving and/or yarn as a function of varying flow rates;

FIG. 7 is a fragmentary perspective view illustrating treated roving of the invention herein wound about a perforated core which is useful as a filter cartridge; and

FIG. 8 is a top plan view of a section of fabric woven with treated roving of the invention herein both in the warp and filling directions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with this invention an improved roving is formed having a strand of condensed fibers which cross over at a multiplicity of points throughout the strand. An adhesive material is applied to the fibers to provide adhesive at the points of crossover to form bonding sites to produce a roving having improved physical and chemical characteristics of increased high strength of draft and which is adaptable for weaving into fabric without first being formed into yarn; has good flexibility, elasticity, resiliency, abrasion resistance, permeability and unexpected high filtration efficiency of fluids such as liquid and gas.

FIG. 1 is a schematic view of roving 20 which includes a strand of entangled staple fibers such as 31 and 32 which form a condensed fiber reticulated network. These fibers cross over one another at numerous points 13 throughout roving 20. FIG. 2 is a close-up view of condensed fibers 31 and 32 having points of crossover or overlap 13. FIG. 3 is a greatly enlarged view of a bonding site at a point of crossover 13 showing condensed fibers 31 and 32 having adhesive coating 40 applied over their surfaces.

FIG. 4 is a top plan view of fabric 30 woven from yarn 21, 22, 23 and 25 in the warp direction and roving 26 and 28 in the filling direction. FIG. 5 is a sectional view of fabric 30 showing yarn 21, 22 and 23 in the warp direction and roving 26 in the filling direction.

The fibers within roving 20 are bonded at points of crossover due to the adhesive applied to the staple fibers 31 and 32 forming treated roving 20 which is not twisted, as is yarn 21, 22, 23 and 25 and is adaptable for weaving into fabric as shown in FIG. 4. It is to be

noted, however, that adhesive 40 is applied to fibers 31 and 32 respectively along the fiber lengths as well as at the point of crossover 13. The adhesive improves the strength of roving 20 due to formation of bonding sites 13' at points of crossover 13.

FIG. 7 illustrates one form of a filtration device 50 in which a continuous strand of treated roving 20 is wound about a perforated core member 52 having perforations 54 uniformly distributed over substantially its entire surface. In operation filtration device 50 is inserted into a filter cartridge housing in which the fluid to be filtered is introduced through core 52. The fluid passes through perforations 54 and is filtered by the treated roving 20 by passing through the voids formed in the treated roving as illustrated in FIG. 2. The filtered fluid is then carried away after passage through roving 20.

In FIG. 8 a fabric is illustrated which is useful as a filtration medium, the fabric being formed of roving 20' and 20''. Roving 20' is woven in the warp direction while roving 20'' is woven in the filling direction. Fabrics of the type illustrated in FIG. 8 are useful as filter pads or other filter aids in removing particles from a fluid medium.

The term adhesive in accordance with this invention is used to cover many types of thermoplastic and thermosetting resins or mixtures of both, that are capable of being applied to the fibers forming a roving of high strength which will form bonding sites at a point of crossover thereby providing a roving of improved physical characteristics. The adhesive resin should be able to be diluted either in water as a dispersion or in a low boiling solvent as a solution to an extent sufficient to enable application of the resin to the roving. Advantageously, the resin should be capable of dilution to at least about 5 percent solids by weight. This facilitates the handling of a weak strand of roving through a non-viscous solution of an adhesive. The minimal amounts of adhesive thus deposited on the fiber crossover points will have sufficient bonding strength to allow for the weaving of the strengthened roving.

Many adhesives can be employed in accordance with this invention to produce roving adaptable for weaving into fabric or winding onto filter cartridges without the necessity of first forming a yarn. Some suitable adhesives which may be employed are listed in Table 1 although many other adhesive formulations may be used for practicing the invention herein.

Classes of resins which are particularly adapted to make improved roving are for example:

- a. epoxy resin adhesives
- b. polyurethane adhesives
- c. polyamide (soluble in solvents)
- d. polyester (soluble in solvents)
- e. acrylic and vinyl acrylic or acrylonitrile adhesives
- f. rubber based adhesives such as natural and synthetic rubber or mixtures thereof

Also, water soluble polymeric adhesives such as polyvinyl alcohol, polyethylene oxide or polyvinyl pyrrolidone may be used to treat roving in accordance with this invention.

Although fabric can be woven from the high strength roving in both the warp and filling directions, it is not necessary for the woven fabric to consist entirely of roving formed in accordance with this invention. For example, an acceptable fabric can be woven conven-

tional yarn, mono or multifilament yarn in combination with high strength roving prepared in accordance with this invention in the filling direction as illustrated in FIG. 4. Such a fabric has been found to have improved strength, abrasion resistance, flexibility resiliency and permeability to gas and liquid when used as a filter media.

Adhesive can be applied to roving in amounts between about 1 and 100 percent or more by weight of the dried fibers. In this connection, when the roving is not required to undergo severe stress, such as, for example, when the roving is used in the filling direction of a fabric while conventional yarn is employed in the warp direction, polyurethane or polyamide epoxide resin adhesives in amounts of about 2 to 25 percent by weight of the dried fibers are sufficient to impart weavable and other improved physical characteristics to the roving. It has been found that the physical characteristics which are imparted to the fibers of the roving may be varied by the proportion of adhesive material applied thereto and particularly for the end use required. For example, 2 to 5 percent by weight of dried fibers is advantageous for using roving in the filling direction of fabrics as seen in FIG. 4. Higher levels of adhesive may be desirable in fabric where increased strength is desired and where abrasion resistance is important, i.e., 10-50 percent.

The fibers to which the adhesives can be applied in accordance with this invention may be natural or synthetic or mixtures thereof. Natural fibers may include wool or cotton, while the synthetic fibers are numerous and may include polyamide, polyester, polypropylene, viscose rayon, acrylic fibers or mixtures thereof. In general, any synthetic or natural fiber that is capable of being formed into roving can be treated in accordance with this invention.

For the purpose of giving those skilled in the art a better understanding of the invention and a better appreciation of the advantages of the invention, there is given herein examples illustrative of the improved roving in accordance with this invention.

EXAMPLE 1

Roving made in accordance with any customary textile carding process is wound on a spool forming a plurality of concentric layers of roving commonly referred to as a "cheese." When a sufficient weight of roving has been wound about the spool, for example, 300 grams, a new spool is prepared and the wound roving is then ready for further processing in accordance with the invention herein.

An adhesive material, for example, 5 parts of DuPont's Elvamide 8061, a nylon that is soluble in lower alcohols, is dissolved in 80 parts of ethyl alcohol and 15 parts water. The solid nylon resin is dissolved by mixing, using moderate heat to facilitate solution of the solid resin. After the resin is in solution the temperature is maintained at room temperature but below the boiling point of the solvent in the resin solution to avoid distillation of the solvent.

The formed "cheese" is lowered into the resin solution and allowed to become impregnated therewith. After complete impregnation the "cheese" is removed from the resin solution and the excess adhesive resin is removed, for example, by centrifugation techniques, squeezing or any other known means. After removal of excess adhesive solution the remaining solvent is re-

moved as by air drying or by placing the "cheese" in a controlled temperature oven. After drying has been completed the roving which initially weighed 300 grams increased in weight by 21 grams or 7 percent adhesive on dry weight basis. The adhesive carried by the fibers in the strand forming the roving is cured generally at the same time the solvent is removed. The fibers are bonded at their crossover points to form bonding sites so that the fibers remain spacially separated.

The roving made in accordance with Example 1 is then adapted to be made into various products such as a fabric of FIG. 4 without the necessity of first forming the roving into a yarn. In FIG. 6 treated roving of the invention herein was compared with untreated roving as a filtration medium. All tests were made at a static compressive load of 50 lbs. per sq. inch on yarns and roving. All of the roving and yarns were formed into pads having the same configuration, each pad being identical except for the treated roving which was made in accordance with the invention herein. Each pad consisted of four layers of roving or yarn with each layer positioned at 90° with respect to the adjacent layer.

In the curves of FIG. 6 the resistance to flow as measured by a drop in pounds per sq. inch gauge (psig) per inch of yarn of roving thickness is shown graphically as a function of flow as measured in gallons per minute per unit area (FT²).

The results show that all yarns or roving exhibit an increase in resistance to flow as the rate of fluid being filtered increases. However, the resistance to flow increases at a greater rate for untreated roving and yarn (see curves A and B) than for treated roving (see curves C, D and E).

The untreated roving and the untreated but twisted yarn of curves A and B respectively exhibit a greater resistance to flow, that is, an increased pressure drop than the treated roving of curves C, D and E. Thus, it is apparent that the untreated roving and the untreated twisted yarn require greater work to be exerted on the fluid medium being filtered thus decreased force is required to filter a like volume of fluid through the treated roving of the invention herein illustrated in curves C, D and E.

The roving of the invention herein is capable of being employed as improved filter media for example by winding the roving about a perforated core (see FIG. 7) and encasing the wound core into a housing fitted with an inlet and outlet opening. Thus, fluids such as liquids or gases may be filtered through the treated roving uniformly with high removal efficiency of particles entrained in the fluid while maintaining a relatively low pressure drop across the filter unit. Also, increased flow rates of the fluid medium is obtained without loss of filtration efficiency (see FIG. 6). Further, no adverse filtration effects occur with the increase in temperature of the fluid medium being filtered. The roving made in accordance with the invention herein is of high strength and does not require twisting. Also, the treated roving has improved physical characteristics of increased bulk density which maintains the relatively high percentage of voids, resistance to compression, increased abrasion resistance, permeability and flexibility.

EXAMPLE 2

Roving weighing 488 grams per 100 yards composed of condensed, high tenacity nylon fiber (6 denier, 3 inch staple) is immersed in a bath of 10 percent by

weight aqueous polyurethane solution maintained at room temperature. The roving is then passed through a pair of driven squeeze rolls to remove excess polyurethane adhesive solution and thereafter wound on a spool. The spool containing the roving saturated with polyurethane solution is then placed in an oven at 300°F. for about 24 hours to dry and cure the polyurethane on the roving. The spool is then removed from the oven and the roving unwound from the spool and placed on weaving bobbins. After curing, it is noticed that only an insignificant amount of sticking of the individual nylon strands results. This illustrates the nature of the roving wherein most of the fiber crossover points are within the roving and very few crossover points are between the packed or wound strands of nylon fibers. The amount of polyurethane on the roving is 2.29 percent by weight of the dried fibers, the density is 2.43 pounds per cubic foot, and the breaking strength is 4.00 pounds. Since the untreated nylon roving has a

10 parts Versamide 125 a polyamide resin sold by General Mills

1 part hydroxyacetic acid

79 parts isopropyl alcohol

Roving taken from the same spool was divided into two equal samples for testing. The first sample was divided into two portions, the first portion remained untreated and untwisted, the second portion of the sample remained untreated but was subjected to four twists per inch. The second sample was treated with the resin mixture described above and required two applications of the resin to obtain a 34 percent add on a dry weight basis. After curing, this treated sample was also divided into two portions, the first portion remained untwisted, the second portion was twisted four twists per inch.

The above samples were tested for percent void volume, compressibility, strength, i.e., the number of pounds force required to break a section of the roving by pulling. The following are the results:

Sample	Strength	Diameter at 0 PSI mm	Percent Voids	Thickness at 20 PSI mm	Percent Voids at 20 PSI
Untreated Untwisted	.15 lbs.	4.56	97.7%	.254	5.45
Treated Untwisted	8.5 lbs.	5.58	98.1%	.711	12.4
Untreated Twisted	6.3 lbs.	1.02	51.1%	.457	2.28
Treated Twisted	12.1 lbs.	1.27	59.5%	.552	2.58

break strength of only 0.05 pound, the adhesive treatment in accordance with this invention results in an increase in strength of the roving of 80 times the untreated nylon roving. A fabric similar to that shown in FIG. 4 is then woven from the aforesaid roving.

The water permeability of the fabric is then tested by clamping the fabric over a $\frac{1}{8}$ inch diameter opening positioned in the base of a cylinder 27 inches high with an inside diameter of 2- $\frac{3}{4}$ inches. The cylinder is filled with water which is allowed to drain through the fabric under the force of gravity. Water permeability of the fabric is found to be 9.2 gallons per minute per square inch of fabric.

The roving containing the polyurethane adhesive is wound into a ball and is found to have considerable bounce and resilience making the ball suitable for use in childrens' games. Such a ball can also be used as the core of a baseball.

EXAMPLE 3

Roving was treated as in Example 2 but an epoxyamide resin adhesive was substituted for the polyurethane resin. The epoxyamide resin is dissolved in isopropyl alcohol and consists of the following ingredients:

10 parts Eponite 100, an epoxy resin sold by the Shell Chemical Company

The above data indicates the unexpected increase in strength of the treated roving made in accordance with the invention herein. Even when untreated twisted is compared to simply treated and untwisted roving the strength is considerably higher. Further, when comparing the treated twisted roving with the other samples it is apparent that the treated twisted roving strength of 12.1 lbs. where only four turns per inch are used is approximately 800 times greater in strength than the untreated and untwisted roving and is approximately two times as strong as the untreated and twisted yarn. Also, the percent voids is approximately 8 percent greater in the treated and twisted yarn as compared to the untreated and twisted. This illustrates graphically the resistance to compression obtained when the roving is treated in accordance with the invention herein. It should be noted that where the roving is treated and untwisted the percent voids is substantially equal to the percent voids of the untreated untwisted roving.

Table I below shows Examples 4 and 13 in which various adhesives are applied in the same manner to nylon roving as described in Example 2. The bath temperature at which the adhesive is applied to the yarn is room temperature. Following application of the adhesive to the roving, it is dried and cured at 200°F. to 250°F. for Examples 4 and 5, 300°F. for Examples 6 to 12 and room temperature for Example 13.

Table I

Example	Adhesive	Commercial Form	Amount of Adhesive on Roving (weight %)	Density of Adhesive-Treated Roving (lbs./ft ³)	Break Strength of Adhesive Treated Roving (lbs.)	Increase in Strength Above Untreated Roving Strength (break strength of treated roving/break strength of untreated roving)
4	epoxy resin with polyamide hardener (10% solids in aqueous medium)	Epon 815 from Shell Chemical Co. with Versamide 125 harder added	5.49	n.d.*	6.44	129

Table I—Continued

Example	Adhesive	Commercial Form	Amount of Adhesive on Roving (weight %)	Density of Adhesive-Treated Roving (lbs./ft ³)	Break Strength of Adhesive Treated Roving (lbs.)	Increase in Strength Above Untreated Roving Strength (break strength of treated roving/break strength of untreated roving)
5	epoxy resin with polyamide hardener (10% solids in aqueous medium)	Epon 815 from Shell Chemical Co. with Versamide 125 harder added	2.62	2.35	2.88	57
6	acrylic latex (10% solids in aqueous medium)	Chem U car 893 from Union carbide Corp.	2.40	2.18	3.09	62
7	polyurethane (10% solids in toluene solvent)	Clear Synthetic 60-204, and Clear Activator 62-105 from Chemical Coating Co.	2.29	2.43	4.00	80
8	polyurethane (10% solids in aqueous medium)	X-1033 from Wyandotte Chemical Corp.	2.33	3.03	2.07	42
9	polyurethane (10% solids in aqueous medium)	X-1033 from Wyandotte Chemical Corp.	5.00	n.d.	5.50	110
	polyurethane (10% solids in aqueous medium)	X-1033 from Wyandotte Chemical Corp.	10.30	n.d.	6.55	131
11	polyurethane (10% solids in aqueous medium)	X-1033 from Wyandotte Chemical Corp.	28.00	n.d.	7.30	146
12	neoprene rubber latex (10% solids in aqueous medium)	Vulcanol 7724 from Alco Chemical Corp.	2.15	2.89	1.46	29
13	polyvinyl alcohol (1% alcohol by weight in aqueous medium)	laboratory grade	2.50	2.93	3.18	64

*n.d. means not determined.

As can be seen from the data presented in Table I, Examples 4 to 13 each displayed a substantial increase in strength above that of the untreated roving. Example 4 shows a strength increase of 129 times that of the untreated nylon fiber having a break strength of 0.05 pound. Examples 9, 10 and 11 show the increase in strength of the treated roving having increasing amounts of additive applied thereto. The adhesive-treated rovings described in Examples 2 to 13 are suitable in strength, permeability, abrasion resistance and resiliency to be adaptable for weaving into fabric.

The strength of such rovings ranges from 10 to 200 times the strength of untreated roving. The maximum strength, however, will not ordinarily exceed the strength of the sum total of individual fibers comprising the bundle.

Untreated roving has practically no elasticity or resistance to distortion. When a force equal to between 25 percent and 75 percent of its breaking strength is applied to untreated roving, having a breaking strength between 0.05 and 0.25 lbs., the roving will substantially maintain its distorted length after removal of the force. Adhesive treated roving, subjected to a force between 25 percent and 75 percent of its breaking strength will return within 10 percent, and generally within 3 percent of its original length upon removal of the force.

Roving treated in accordance with this invention is tested on the Gurley Stiffness Tester. To bend the treated roving on the Gurley Tester requires an average of 0.02 grams per strand to 2 grams per strand compared to 0.01 grams per strand to 0.5 grams per strand to bend untreated roving. This is indicative of the body or stiffness of the treated roving.

Strands of roving having no adhesive treatment are compressed laterally with $\frac{1}{4}$ inch foot of a compres-

someter (manufactured by American Instrument Company, Silver Springs, Md.), to 175 psi. Upon release of the compressometer foot, the untreated roving will not return to its original diameter when this stress is released. Strands regained only 30 to 50 percent of the original diameter thickness. However, roving with an adhesive at the fiber-fiber contact points will return to as much as 99 percent of its original diameter thickness.

Roving strands with and without adhesive treatment were abraded wet on a roll wrapped with 300X Behr Manning Emery Cloth. The strands were wrapped at 45° on the surface of this roll and made to oscillate with their ends clamped at moderate tension over this abrasive roll. The roving strands which were not treated with adhesive broke after the first cycle of oscillation. All strands with adhesive were more resistant to abrasion than untreated strands. Adhesive treated roving, especially that treated with polyamide-epoxy resins and polyurethane resins, lasted for at least 50 cycles. Thereafter, these strands were removed and tested for remaining strength. Roving strands with the aforesaid adhesives maintained as much as 50 percent of their original strength after 50 cycles of abrasion.

Yarn is made from 200 grains/100 yards of 6 denier Dacron fiber. This yarn is woven into Fabric A in which the yarn is present in both the warp and filling directions. Fabric A has 35 strands per inch while the yarn has a twist of seven turns per inch in the warp direction with 36 strands per inch and six turns per inch in the filling direction. Fabric B is woven with the same warp yarn as Fabric A but includes roving made in accordance with this invention and having 35 strands per inch in the filling direction. The yarn in Fabric B has seven turns per inch in the warp direction without any turns in the filling direction. Fabrics A and B are of

about equal weight, i.e., about 1.4 ounces per square foot and have a weave pattern of 2x2 twill.

Fabrics A and B are then tested for air and water permeability with the following results shown in Table II:

TABLE II

Test	Fabric A	Fabric B
air permeability under ½ inch water pressure	40 cubic feet per minute per square foot of fabric surface	55 cubic feet per minute per square foot of fabric surface
water permeability	5.4 pounds per minute per square inch of fabric surface	25.2 pounds per minute per square foot of fabric surface

The water permeability test utilizes the gravity flow of water as previously described. The data presented in Table II clearly shows that Fabric B utilizing the roving of this invention has substantially improved air and water permeability when compared to Fabric A.

The present invention is particularly applicable to the production of papermakers' felt. In this connection, papermakers' felt can be woven from roving having an adhesive applied thereto in accordance with this invention in both the warp or filling directions (or merely in one direction with conventional yarn in the other direction). A papermaker's felt woven from roving in accordance with this invention has excellent water drainage because of the roving's improved permeability to water. The rapid absorption of the water by the felt due to the porosity of the roving eliminates channeling the water along the felt in the longitudinal direction of travel, a problem inherent in most papermakers's felts.

In addition, roving processed in accordance with this invention can be used to weave filters. If the roving is woven only in the filling direction with the yarn woven in the warp direction, the roving due to its fluffy characteristics, will close the voids left by the yarn resulting in a fabric particularly suitable for use as a filter.

It is to be noted that the present invention is not to be confused with White U.S. Pat. No. 3,102,835 which discloses a fibrous material saturated with a urethane polymer. The White patent discloses a process for treating fibers with polyurethane prior to carding. The fibers are first saturated with polyurethane and then carded or garnetted. Thereafter, the fibers are positioned over screen aprons in layers, and then cured to form a pad useful for insulation and sound absorption. Since the disclosure in the White patent is directed to the treatment of a web with polyurethane before carding, it would be virtually impossible to produce roving from the carded product since the fibers cannot be made to entangle by condensing to form numerous crossover points in the fiber bundle. Any roving which might be formed after treatment of the web with polyurethane in this manner would cause the fibers to completely stick together to form a dense cable which would not have the necessary permeability to air and water and would not be adaptable for weaving into fab-

ric. The compacting step disclosed in the White patent is not equivalent to condensing since it does not entangle the fibers and increase the points of fiber crossover but merely compresses the fibers to make a more dense product. Other prior art patents, such as Kuemmerer U.S. Pat. No. 3,189,578, are directed to the treatment of yarn with polyurethane and do not consider nor appreciate the problem presented in improving the strength of roving to make the roving adaptable for weaving into fabric without first being processed into yarn. Yarns such as those disclosed in the Kuemmerer patent do not have the permeability necessary to make the roving useful in accordance with this invention since the twist imparted in making yarn substantially decreases fabric porosity and permeability. This is probably a direct result of the effect of twist in compacting the fiber bundle which results in higher yarn densities with higher twist.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention as those skilled in the art will readily understand.

What is claimed is:

1. A filtration device adapted for use for filtering fluid media comprising a tubular core member having perforations therein; treated roving being wound about and covering the openings in said core member; said treated roving forming a plurality of layers around said core member; said treated roving comprising a strand of staple fibers in the form of a bundle of disoriented fibers which cross over one another at a multiplicity of points, said fibers carrying on their surfaces a resin adhesive binder, said fibers being bonded together by said resin binder at respective crossover points with the resin binder being cured to maintain said fibers in spatial separation between the crossover points thereby providing a roving which is permeable and substantially of the same density throughout.

2. The filtration device of claim 1 wherein the treated roving is formed having a diameter substantially equal to or greater than the diameter of untreated roving.

3. The filtration device of claim 1 wherein the adhesive is carried on the fibers in amounts between about 1 percent and 100 percent by weight of the dried fibers.

4. The filtration device of claim 1 wherein the adhesive is carried on the fibers in amounts between about 2 percent and 25 percent by weight of the dried fibers.

5. The filtration device of claim 1 wherein the adhesive comprises at least one material selected from the group consisting of polyethylene, polypropylene, polyamide, polyester, epoxy resin, polyurethane, polyvinyl resin, acrylic resin, polyvinyl alcohol and rubber based adhesives.

6. The filtration device of claim 1 wherein the roving has a break strength of at least about 0.5 pound and the adhesive has a tensile strength of at least about 1,500 psi.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,834,547

Dated September 10, 1974

Inventor(s) Armen Renjilian

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

At Col. 9 and 10, in Table I, after Example 9 and before Example 11, insert:

-- polyurethane X-1033 from 10.30 n.d. 6.55 131--
(10% solids in Wyandotte Chem-
aqueous medium) ical Corp.

Signed and sealed this 19th day of November 1974.

(SEAL)

Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents