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METHOD OF MAKING PAPER YARN

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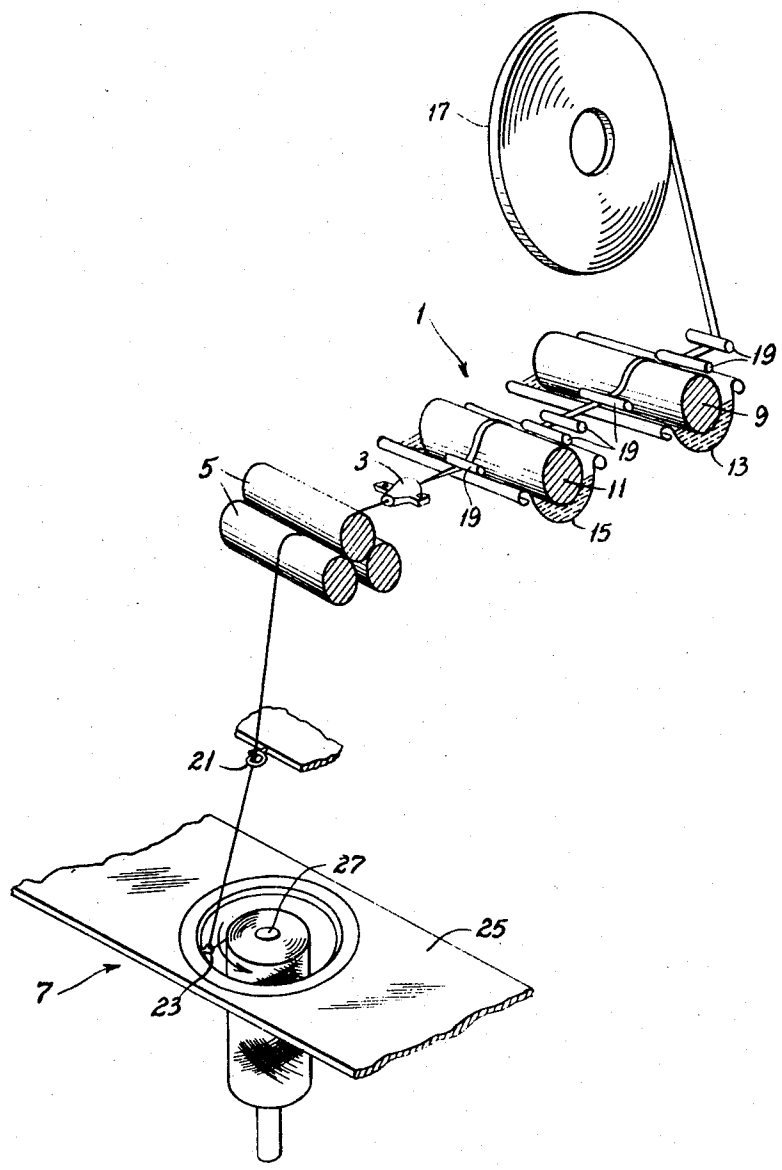

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METHOD OF MAKING PAPER YARN

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This invention relates to a method of making paper yarn and, more particularly, to a method of making so-called "wet strength" paper yarn.

Among the several objects of the invention may be noted the provision of a method of making paper yarn having superior wet strength and abrasion-resistance characteristics; the provision of such a method whereby not only the wet strength of the yarn but also its dry strength is improved; and the provision of such a method that may be carried out on existing spinning or twisting apparatus without alteration thereof. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the steps and sequence of steps, and features of manipulation, which will be exemplified in the methods hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which one of various possible embodiments of the invention is illustrated, the single figure of the drawing is a diagrammatic isometric view of apparatus by means of which the method of this invention is conveniently performed.

In general, the method of this invention involves the treatment of a paper strip in such a manner as to soften its fibers with water and simultaneously to impregnate and coat the strip with resin either of the thermosetting or thermoplastic type and to spin or twist the strip into yarn while the fibers are still soft. Resins of the thermosetting type in the uncured or partially cured stage are dissolved or dispersed in an aqueous moistening bath while resins of the thermoplastic type are contained in the moistening bath as dispersions or emulsions of the cured resin, or emulsions of the cured resin dissolved in, or softened by a water immiscible solvent, water being the outer phase in each case. The resin employed is of a type, which, when cured, coats the fibers of the yarn and resists the penetration of moisture thereinto, whereby the yarn has substantial strength even though subjected to moisture.

The drawing illustrates one unit of a spinning or twisting frame comprising a paper strip-impregnating means 1, a strip-folding or crimping die 3, drawing rolls 5, and a ring spinner or twister 7. The strip-impregnating means comprises two coating rollers 9 and 11 disposed in troughs 13 and 15 respectively. It will be understood that the spinning frame includes a multiplicity of spinners arranged side by side so as to

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spin a plurality of yarns simultaneously. The troughs extend the length of the frame. Only one operating section of the frame is illustrated, and consequently only short sections of the troughs and rollers are shown.

A strip of untreated paper of suitable type, such as kraft paper, is unwound from a supply roll 17 and travels over coating rollers 9 and 11, being guided around said rollers by suitable guide rollers 19. As the strip travels over the coating rollers, it is moistened with a spinning bath solution contained in the troughs into which the rollers 9 and 11 dip respectively. The composition of this spinning bath solution will be discussed in detail hereinafter. As the strip leaves the coating rollers, it travels through a conventional die 3, which constrictively folds and bunches the strip through its length preparatory to spinning. The treated folded strip travels through drawing rolls 5, thence through a guide 21, and through the eye 23 of a spinning ring on ring rail 25, and thence to the winding spindle 27 of the spinning frame.

The spinning bath is contained in one or both of the troughs. An example of the bath is an aqueous solution of an uncured, water-soluble, thermosetting resin which is adapted to cure to insoluble form upon evaporation of water. Examples of such resins are condensation products of urea and formaldehyde, or of melamine and formaldehyde, or modifications of these basic types, in an intermediate stage of polymerization in which they are soluble in water. Commercial products of the urea formaldehyde type which have been found to be satisfactory are "Uformite 467" and "Uformite 470," made by The Resinous Products and Chemical Company, Philadelphia, Pa. A 5% solution of either of these products in water has been successfully used. A commercial product of the melamine formaldehyde type which has been found to be satisfactory is "Parez 605," made by the American Cyanamid and Chemical Company of New York, the bath comprising a 2% solution of this product in water. Mixtures of urea formaldehyde and melamine formaldehyde resins may also be used.

As the paper strip travels over the coating rollers 9 and 11 it absorbs the resin solution. The absorbed moisture causes the fibers of the strip to swell and soften so that they may be more readily twisted and compacted in the spinning operation. The yarn is spun while wet with the resin and moisture, and the resultant better twist and compaction of the fibers imparts improved

dry strength to the paper yarn when it ultimately dries.

When the yarn dries, the resin from the spinning bath solution remains dispersed throughout the yarn and on the surface thereof. Such dispersed resin cures to insoluble form upon evaporation of the water from the yarn and provides a water-resistant coating not only on the surface of the yarn but upon the internal surfaces of the individual fibers thereof. The internal resin also provides a bond between the fibers. The coating, after drying, resists subsequent penetration of moisture into the fibers of the finished yarn and imparts superior wet strength thereto. The finished yarn may be subjected to wetting and still have considerable strength. The coating also is resistant to abrasion, hence the yarn has excellent abrasion-resisting characteristics. The yarn also has improved dry strength.

A catalyst may be added to the spinning bath to accelerate the curing of the resin to insoluble form upon evaporation of the water from the spun yarn. The catalyst may be any material which reduces the pH value of the bath, such as alum or ammonium sulfate. If desired, the spinning bath may be contained in one trough 9 or 11 and a solution of the catalyst in the other. It is not material whether the catalyst is applied to the yarn before or after the application of the resin solution. Or using only one trough, a solution of the catalyst may be continuously metered into the spinning bath containing the resin, which bath is also continuously being replenished from a reservoir. The proportion of catalyst used is determined by the pH of the water and paper. The amount of catalyst used is such as to obtain the maximum effect without excessive precipitation in the bath. If under given conditions precipitation is too much, the amount of catalyst is reduced.

Curing of the resin to insoluble form may also be accelerated by heating the web of fabric woven from the yarn. The fabric may be heated in an oven, or passed over heated drying cylinders, either in a separate operation or in connection with other finishing operations such as dyeing. The higher the temperature the faster the cure, the upper limit being the temperature at which the paper would begin to char. With the above-mentioned resins, heating the yarn for two minutes at 215° F. effects a substantial cure.

Curing may also be accelerated by subjecting the fabric woven from the yarn to an atmosphere composed in whole or in part (the other component being air) of an acid vapor, such as acetic acid, formic acid or hydrochloric acid. After the cure has been effected, the acid vapor is dissipated by displacement with pure air.

The spinning bath may comprise an aqueous emulsion or dispersion of thermoplastic resins instead of the above-described solution of thermosetting resin. An example of such a bath is the emulsion made as follows:

First mixture

	Parts
Polyvinyl acetate resin	25
Tricresyl phosphate	5
Toluene	50
Oleic acid	5

Second mixture

	Parts
Water	150
Ammonia water 28° Bé.	10

The stated first and second mixtures are stirred together to form the emulsion. The emulsion is then diluted with water to obtain a spinning bath containing 2% of resin.

An example of a suitable bath comprising a thermoplastic resin dispersion containing no organic solvent is a bath containing one of the acrylic resin dispersions commercially known as "Rhoplexes," products of the Rohm and Haas Company, Philadelphia. A siutable bath may be made up as follows:

	Parts
Rhoplex W–66	100
Ammonia 28%	1
Sodium lauryl sulfate or any compatible anion active wetting agent	2
Water	897

While the thermoplastic resins do not require curing but only drying, the strength of yarn or fabric woven from yarn treated therewith is improved by heating.

The spinning bath may also comprise compatible mixtures of aqueous thermoplastic resin emulsions or dispersions and soluble thermosetting resins. The thermosetting or thermoplastic resins may also be used in conjunction with other finishing or strengthening materials such as starch, casein or glue.

The simultaneous moistening and impregnation of the paper strip with partially condensed resin of the type above described and prompt spinning before setting is an important distinctive feature of the invention. If a dry paper strip which has been made from a resin-impregnated slurry, or which has been previously otherwise impregnated or coated with resin to impart wet strength thereto is moistened and spun into yarn, there results a yarn having inferior wet and dry strengths. This is because the paper, having been previously treated to make it water-resistant, does not readily absorb moisture a second time and its fibers do not swell and soften so that the ensuing spinning operation may readily twist and compact them. This adversely affects both the wet and dry strengths of the yarn. If a yarn is spun from an untreated paper strip without the resin impregnation during the spinning operation, and the yarn is subsequently treated with resin to impart wet strength thereto, a complete re-processing of the yarn is required. The method of this invention results in a paper yarn having superior wet and dry strengths and abrasion-resisting qualities. Not only are the internal fibers of the paper better bonded, but the paper surfaces which are brought together in the folder 3 are effectively bonded together. The invention employs inexpensive paper, and involves a minimum number of operations which may be carried out on existing spinning apparatus.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed resin adapted in its condensed

form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

2. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed thermosetting resin adapted in its condensed form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

3. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed thermoplastic resin adapted in its condensed form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

4. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed urea formaldehyde resin adapted in its condensed form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

5. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed melamine formaldehyde resin adapted in its condensed form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

6. The method of making twisted wet strength paper yarn, comprising moistening a flat paper strip so as to soften and swell the fibers thereof, dispersing throughout the moistened strip a partially condensed polyvinyl acetate resin adapted in its condensed form to waterproof the fibers of the strip, spinning the strip with the partially condensed resin and moisture therein to twist it into yarn before the evaporation of the moisture therein, removing moisture from the strip, and condensing the resin to its waterproof form so as to leave a coating of waterproofing resin on the fibers.

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