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NETTING TREATMENT PROCESS

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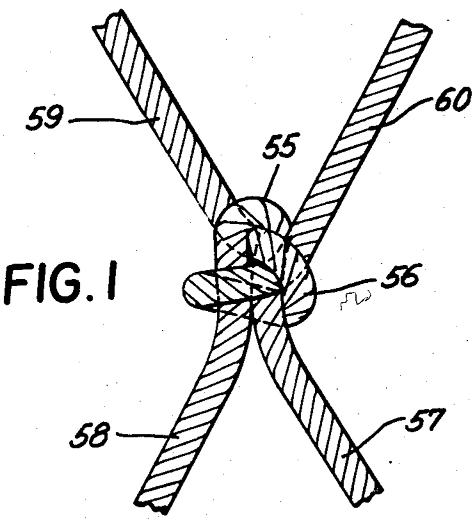

FIG. 1

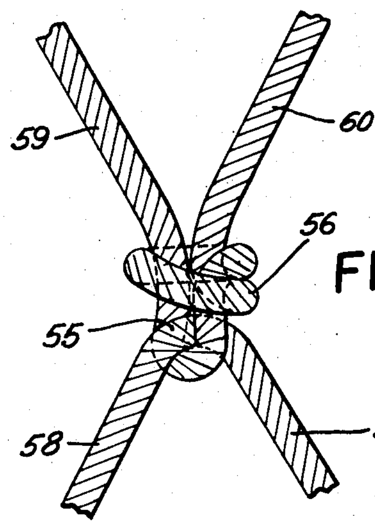

FIG. 2

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NETTING TREATMENT PROCESS

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The present invention relates to a novel process for conditioning or treating knotted netting, and particularly fishnetting, and to the novel netting produced thereby.

In very recent years it has become practical to manufacture fishnetting from twines and filaments of the thermo-sensitive synthetic resins, such as nylon. By employing the thermo-sensitive synthetic resins, it became possible to make fishnettings which overcame many of the deficiencies of the fishnettings woven from strands of vegetable fibers. These nettings of thermo-sensitive synthetic resins, while having great tensile strength and while being resistant to the weathering, micro-biological attack, etc., which characterized nettings of vegetable fibers, suffer from a very serious defect; the knots have a tendency to open up and slip or tip over during usage. This results in a variation in the size of the meshes of the netting making the netting substantially useless; particularly where used for gilling fish. Government agencies require stringent adherence to their regulations which define the minimum mesh size of netting to be used for particular purposes. Fishermen desire fishnets having the smallest size mesh which is permitted by law; for the smaller the mesh size, the greater will be the catch. Thus it becomes important that the dimensions of the mesh be as small as permissible and yet the knots of the netting must not slip to reduce the size of some of the meshes to a dimension below that permitted by law. It should also be appreciated that when one of the meshes is reduced in size due to slippage of a knot, there must be a corresponding enlargement of the adjacent mesh. This is equally undesirable for fish can escape through the enlarged mesh.

Various efforts have been made to overcome the knot slippage problem inherent with the use of twine or filaments made from the thermo-sensitive synthetic resins but these methods suffer from certain disadvantages. Either they are too costly to compete in a highly competitive industry or they require intricate handling of the netting which, in addition to adding to the cost of the final product, unduly complicate the manufacturing processes for producing a marketable netting.

The netting produced in accordance with the process of the present invention possesses all of the advantages of netting made from the thermo-sensitive synthetic resins, without the disadvantage of knot slippage, and yet is produced economically without the use of costly coatings, materials, equipment or manufacturing procedures. In addition, the netting of the present invention is significantly superior to netting made from a twine having a bonded coating in that it does not shrink nearly as much during normal usage and it is more resistant to slippage at the knots.

The process of this invention does not require heat setting of the thermo-sensitive synthetic resin from which the netting is constructed, nor is it necessary to materially modify the plastic memory of the internal portion of the resin filaments.

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It is an object of the present invention to provide a netting of a thermo-sensitive synthetic resin which will resist slippage at the knots.

It is also an object of the present invention to provide a novel and efficient process for providing knotted netting which will not slip at the knots and which requires only simple and readily available manufacturing equipment.

Other objects and advantages of the invention will be apparent to those skilled in the art from a reading of the disclosure which follows and from the appended drawings. The invention will be in part described by reference to the accompanying drawings.

In the drawings:

Fig. 1 is a view of the weaver's knot, which is a common knot used in the weaving of fishnetting.

Fig. 2 is a view of the weaver's knot (opposite side from that of Fig. 1) which has not been treated by the process of the invention and which has been "tipped" by pulling the ends of the bend of the knot.

The present invention comprises a novel process for conditioning or treating netting, and particularly fishnetting, having knotted meshes of a thermo-sensitive synthetic resin twine to make the knots more resistant to slippage, and the treated netting produced by said process. It is contemplated that the twine from which the netting is made and the final, conditioned netting of the invention shall not require any permanent coating or bonding. The woven netting having knotted meshes is treated with a chemical swelling agent which is capable of swelling the thermo-sensitive synthetic resin twine from which the netting is constructed to soften and swell the external portions of the twine. In the swollen and softened condition, the external portions of the twine become somewhat plastic and tend to conform to the configuration of the adjacent twines at the knots, particularly if the netting is subjected to tensioning while in the swollen and softened condition. Upon removal of the chemical swelling agent from the surface of the twines which form the knotted netting, the external portions resume their normal semi-rigid properties although they have now been distorted at the surfaces in contact with the adjacent twines which form the knots. These distortions in the surfaces of the twine help to anchor the twines in the knot and thereby make the knots more resistant to slippage or tipping.

More specifically, the novel process for conditioning knotted netting of thermo-sensitive synthetic resins comprises passing the netting, preferably while under slight tension, through a bath containing a chemical swelling agent for the thermo-sensitive synthetic resin for a sufficient time to produce swelling of only the external portions of the twine, and thereafter passing the netting through a wash bath, preferably of water, which will remove the chemical swelling agent from the surface of the twines forming the netting. Optionally, the netting may be coated with a temporary binding agent prior to its passage through the bath of chemical swelling agent. During the treatment of the filaments of the thermo-sensitive synthetic resin with the chemical swelling agents, only ambient temperatures need be employed although, as will be appreciated, the swelling rate is accelerated at elevated temperatures. However, it is not contemplated that temperatures in excess of 110° F. shall be employed during the swelling treatment.

The processing equipment required for the treatment of the netting is simple and readily available commercially. The only requirements of the equipment are that it comprise pulley and roller members which permit the travel of the knotted netting through a bath of a chemical swelling agent and thereafter through a wash bath. No more tension on the netting is required than is necessary to pull the woven netting through the baths.

It is contemplated that the netting which is subjected to the process of the present invention shall be that which is woven in the form of knots to hold the twines together. It is contemplated that the twines woven into the netting shall be of thermo-sensitive synthetic resin material. This is a well-defined class of materials with which the art is familiar. Certain types of thermo-sensitive synthetic resins are better known than others and this is particularly true of the (1) linear polyamide resins, also known generically as nylons, of which two important examples are polyhexamethylene adipamide and caprolactam polymer, a commercial form of which is marketed under the trade-mark "Perlon" or "Perlon L." Polyhexamethylene adipamide is usually known simply as nylon and is sold under this name, although, strictly speaking, the name "nylon" applies to the whole group of synthetic linear polyamide resins, (2) the acrylic resins, such as the polyacrylic esters and polyacrylonitrile, the latter class of which the well-known Orlon is representative, (3) the polyester type resins derived from the polyhydric alcohols and polybasic acids, such as the resins produced from the esters of ethylene glycol and terephthalic acid, of which an example is known as Terylene or Dacron, (4) the vinyl resins and their copolymers, such as the copolymer of vinylidene chloride and vinyl chloride, known commercially as Saran, and (5) copolymers of any of the various types of resins referred to above, such as the resins formed by the copolymerization of vinyl chloride and acrylonitrile, known commercially as Vinyon-N and Dynel, or the copolymer of vinyl acetate and acrylonitrile, known as Acrilan. As can be seen, the preferred resin materials are polymers of unsaturated compounds capable of forming resins. Nylon and Dacron (or Terylene) are the most desirable materials available at present. Nylon is preferred because of its greater commercial availability. In general, it might be said that any thermo-plastic resin, or synthetic thermo-sensitive material, may be employed in making the netting and be subject to the process for making said netting resistant to slippage at the knots.

The thermo-sensitive synthetic resins of the present invention are to be distinguished from the so-called thermo-setting resins. The latter class of resins become rigid or hard when subjected to heat. They become "set" or polymerize when heated and cannot be softened by subsequent reheating. The thermo-sensitive synthetic resins, on the other hand, once polymerized to a given state do not become hard or rigid upon heating. When subjected to heat, they soften or become pliable, and they harden upon cooling. While these thermo-sensitive synthetic resins may be hard when in bulk, they are, nevertheless, flexible and elastic when in the form of extruded filaments, or multifilament twines, yarns and threads. The alternate heating and cooling of the thermo-sensitive synthetic resins may be repeated again and again without altering the chemical structure, so long as the temperature upon heating is not unduly high.

The term "twine", as used in this specification, is intended to include twine, threads or filaments, etc., of the resin. The "twine" shall be made from continuous filaments and shall consist of what are known in the art as "mono-fils" or "multiple-fils." The "twine" may be produced by braiding, twisting, cabling, etc., the filaments in accordance with the general practice in the industry.

The chemical swelling agents contemplated for employment in the process of the present invention are those chemicals, or solutions of them, which will produce a swelling of filaments of a thermo-sensitive synthetic resin of at least 10%, measured in terms of the increase in diameter of the filaments produced when immersed in a bath of the chemical swelling agent at room temperature (about 75° F.) for a period of from about 3 to 5

minutes. These chemical swelling agents will, at room temperature, produce a minimum of 10% swelling without appreciably dissolving or chemically attacking the thermo-sensitive synthetic resin. These agents have no appreciable or permanent effect upon the strength or elongation properties of the thermo-sensitive synthetic resin. It is preferred to employ a chemical swelling agent which is water-soluble so that it can be washed from the surfaces of the twine after it has served its purpose in producing the swelling effect on the exterior portions of the filament.

As has been stated hereinabove, it is characteristic of these chemical swelling agents, when employed in accordance with the process of the invention, to produce the swelling phenomenon on only the external portions of the resin filaments. It is not contemplated that during the process of this invention the internal portions of the filament shall be subject to appreciable swelling. This is controlled, in part, by limiting the time period during which the netting is immersed in the chemical swelling agent. Consequently, the plastc memory of the internal portions of the filaments of the thermo-sensitive synthetic resin is not materially altered.

In Table I below are disclosed some of the chemical swelling agents suitable for employment in the process of the present invention. The degree of swelling given for each swelling agent is that produced on a 6 denier filament of nylon as measured in terms of the increase in diameter produced upon immersion of the nylon filament in the chemical swelling agent at room temperature (about 75° F.) for a period of from about 3 to 5 minutes.

TABLE I

Chemical Swelling Agent	Degree of Swelling, percent
20% Solution of formic acid in water	15
2% Solution of acetic acid in methanol	10
Benzoic acid dissolved in water (saturated solution)	20
2% Solution of benzoic acid in methanol	20
Boric acid dissolved in methanol (saturated solution)	10
20% Solution of phosphoric acid in water	10
20% Solution of phosphoric acid in methanol	10
2% Solution of phenol in water	25
Zinc chloride dissolved in water (saturated solution)	10

The twine used in the construction of the netting need have no pre-treatment. After the woven netting is treated in accordance with the process of the invention, the knots of the netting are set which makes them substantially immune to tipping or slippage. The process takes advantage of a swelling produced on only the external portions of the filaments comprising the twine. The thermo-sensitive synthetic resins, being somewhat elastic in nature, tend to be resilient and to resist distortion of their shape or configuration. By means of swelling only the external portions of the filaments of the twine, the surfaces of the filaments at the knots, which are in intimate contact with each other, become soft and pliable, thereby yielding to accommodate the adjacent filament. The resulting surface distortion is enhanced if the netting is under tension. The surface distortion or furrows produced in the exterior portions of the filaments at the points of contact with adjacent filaments act to resist slippage or tipping at the knots. The internal portions or centers of the filaments are relatively unaffected by the swelling agent in the course of the process of the present invention and consequently the plastic memory of the interior portions of the filament remains relatively unchanged. This, so far as I am presently advised, is a point of distinction between treated nets having knots resistant to slippage produced by the process of the present invention and those treated nets produced by prior art processes.

Since the internal sections or centers of the filaments remain substantially unaffected by the chemical swelling agents, the length of the filaments changes very little as a result of processing. Consequently, it is not necessary to weave the netting with meshes of different dimensions than desired in the final product to compensate for changes in size resulting from the processing. Nor is it necessary to carefully control the degree of tensioning to obtain proper elongation of the twines as is required with other processes for conditioning netting made from thermo-sensitive synthetic twines.

The process of the present invention is especially applicable to the treatement of fishing nets, but it will be understood that the nets may be produced or used for other purposes, particularly, those nets intended for use in water. Fishing nets, when produced in accordance with the process of the invention, have been found highly satisfactory.

Resistance of netting to slippage at the knots is in part indicated by the resistance of the knots to "tipping." The enhanced resistance to tipping and slippage of the knots treated in accordance with this invention may be shown by reference to the appended drawings. Fig. 1 illustrates a single knot taken from a woven netting showing the so-called weaver's knot which is often used in the weaving of fishnetting. The knot in Fig. 1 is shown in the "untipped" position. Fig. 2 shows the knot of Fig 1 (from the reverse side) which has been "tipped." This knot had not been treated in accordance with the process of the invention, which explains the reason for easily tipping the knot. The susceptibility of the knots to tipping is evidenced by the ease with which the bight **56** of the knot tips over, as shown in Fig. 2, when the ends **57** and **58** of the bend **55** of the knot are pulled apart. When the bight of the knot tips over, there is less compression brought to bear on the bend of the knot and it is most likely that slippage will occur.

In comparing the resistance of various nettings to knot slippage, the "critical test" is, of course, the stability under long-term conditions of service. Long-term service tests, however, suffer from two disadvantages. First, they are time-consuming since a long period of time is often required before proof of stability is obtained. Secondly, service stability tests provide neither a precise comparison nor an absolute comparison between nettings. To overcome these undesirable shortcomings of relying solely upon service tests, a more precise analytical method has been developed.

This analytical method involves a comparison of the tension necessary to produce tipping of the knot with the tension necessary to break the twine from which the net is constructed. In conducting the test a single mesh is cut from the netting which has been soaked in water overnight and hooks are inserted at the opposite sides of the wet mesh about midway between the knots. The hooks are attached to the jaws of a tensile testing machine and tension is applied gradually. The machine has attached a recording device which will record the tension and elongation which are required to produce the sudden but slight increase in the dimensions of the mesh, which indicates that a knot has been tipped, and to subsequently break the twines constituting the mesh. When a knot tips over, one loop of twine straightens out, increasing the dimensions of the mesh by a small amount. This appears as a sudden sharp and distinctive displacement in the elongation curve. By dividing the tension necessary to produce knot tipping by the tension required to break the mesh it is possible to calculate a ratio which is indicative of resistance to slippage. The higher the ratio, the greater is the resistance to slippage of the knot. In order to obtain results which are less subject to the experimental error, it is advisable to take an average of the results obtained from testing at least 10 meshes of each type of netting. So that the results

may be comparative, the weight and composition of the twine constituting the netting should be identical.

In accordance with the above described analytical method, wet meshes of nylon twines of 1260 total denier made by twisting two 210 denier filaments, then cabling three of these to produce the finished twine, were tested to determine their resistance to knot slippage. Meshes of nets produced in accordance with the process of the present invention employing various swelling agents at room temperature were compared with those of nets which were untreated and which therefore constituted a control. In Table II below are given the results obtained with meshes of various nets (the tension required to produce knot tipping and mesh break are given in terms of pounds):

TABLE II

Treatment of Netting	Tension Required to Produce Tipping of Knot	Tension Required to Break Mesh	Ratio of Tension Required to Tip Knot Divided by That Which Broke Mesh
	Lbs.	*Lbs.*	*Percent*
Untreated Control	3.5	21.9	16.0
2% Solution of phenol in water	11.9	22.7	52.5
20% Solution of phosphoric acid in water	7.5	20.5	36.5

Examination of the data given in Table II shows that treatment with a 2% solution of phenol in water produces a netting having the greatest resistance to slippage at the knot as indicated by the high ratio of 52.5% of the tension required to produce tipping of the knot as compared with that required to produce breakage of the mesh. This is more than three times the ratio obtained with untreated netting meshes. When this ratio is compared with the percent of swelling produced on a nylon netting it will be seen that the resistance to slippage at the knot imparted to the netting is directly proportional to the swelling power of the chemical swelling agent. This is shown in Table III below:

TABLE III

Treatment of Netting	Percent Swelling	Ratio, percent
Untreated control		16.0
2% Solution of phenol in water	25	52.5
20% Solution of phosphoric acid in water	10	36.5

It is believed apparent from the above results that netting produced according to the present invention is far superior to that of untreated netting in the resistance of the netting to slippage at the knots. This has also been confirmed by tests under conditions of service.

In its broadest aspect, the novel process of the present invention comprises passing a woven netting made of knotted meshes from a thermo-sensitive synthetic resin twine through a bath of a chemical swelling agent for thermo-sensitive synthetic resin. Desirably the netting is subject to slight tensioning during the passage through the chemical swelling agent, as this enhances the distortion produced on those swollen and softened external portions of the twines where they are in contact with an adjacent twine at the knots. The period of time during which the netting is passed through the chemical swelling agent need be of short duration and periods of ½ to 5 minutes, with the swelling agent bath at room temperature, have been found, in general, to be satisfactory. Two minutes is preferable in most cases. The rate of swelling may be enhanced by heating the bath of the chemical swelling agent moderately. It is not contemplated that the temperature of the bath shall exceed 110° F. After passing through the chemical swelling agent, the netting (desirably still under slight tensioning) is passed through a bath of ordinary water to wash off the swelling agent. The removal of the chemical swelling agent may be effected by passing sprays of ordinary water over the netting. If desired, the netting is then air dried.

It has been found highly desirable to gather the woven netting as it comes from the weaving machine into a ribbon-like or rope-like form before treating it with the chemical swelling agent. By gathering the finished net into a rope-like member, it is possible to use smaller equipment, handle more easily widths of widely varying depths, and it also facilitates the tensioning of the netting lengthwise while passing through the conditioning apparatus.

Optionally, the twine of thermo-sensitive synthetic resin material may advantageously be coated before or just after weaving with a temporary binding agent or one adapted to increase the coefficient of friction of the twine. This temporary binding agent acts to resist any tendency of the knots to loosen. In this manner the net can be left untensioned until such time as it is convenient to treat it in accordance with the present invention. Thus, there is no necessity for the net to be passed immediately in a tensioned state from the weaving machine to the bath of chemical swelling agent, but the nets, when formed, can be left stacked until a suitable number have accumulated and they can then be passed in succession through the chemical swelling agent. It will therefore be clear that one machine or a comparatively small number of machines are sufficient to treat in accordance with this invention the total output of a netting factory, thus resulting in a considerable saving in space, expense and the number of operators required. The nature of the temporary binding agent should desirably be such that it is rinsed from the netting while passing through the chemical swelling agent bath or by passing the netting through a tank of water which may or may not contain a detergent to wash off the temporary binding agent.

The nature of the temporary binding agent used is not critical as long as it minimizes any tendency for the knots to loosen before they have been rendered slip-resistant and does not cause any undue difficulty in the weaving of the net. Suitable examples of temporary binding agents are as follows:

(1) A solution made up of:

10 gals. water
2 lbs. textile (bar) soap
10 lbs. Syton (a colloidal dispersion of about 14% silica in an aqueous medium)

or

(2) A rosin dip made up of:

1½ lbs. rosin soap
2 ozs. powdered rosin
3 gals. water

In order more clearly to disclose the nature of the process of the present invention, the following example is intended to illustrate the preferred embodiment of the process. It should be understood, however, that this is solely in the nature of an example and is intended neither to delineate the scope of the invention nor limit the ambit of the appended claims:

Example

Nylon fishnetting was passed directly from the weaving machine into a bath tank equipped with rollers and containing a 2% solution of phenol in water having a temperature which was substantially that of the room (about 75° F.) The netting was passed over the rollers which were so positioned that at the speed at which the netting traveled through the treatment tank each section

of netting remained immersed in the aqueous phenol solution for about 2 minutes. During its travel through the tank containing the aqueous phenol solution, the netting was under just sufficient tension to pull it over the rollers and out of the tank. Upon emerging from the aqueous solution of phenol, the netting was then passed over rollers through a tank of ordinary water which was also at substantially room temperature. After the phenol had been washed from the surfaces of the netting, the netting was removed from the water wash bath and subsequently air dried by blowing a stream of air over the netting. As a result of the treatment there was produced a nylon fishnetting which was resistant to slippage at the knots.

The above example describes the process of the invention with respect to nylon fishnetting and a 2% aqueous solution of phenol. It should be appreciated that other types of knotted netting, thermo-sensitive synthetic resins and chemical swelling agents may be employed.

While the speed at which the net is passed through the machine is not normally critical, there is a maximum speed at which the net may be subjected to the swelling treatment. This will depend primarily upon the weight of the twine of the netting, the type of thermo-sensitive synthetic resin and upon the temperature of the chemical swelling agent bath. The heavier the twine and the lower the temperature, the longer is the period required to treat the nets. However, it has been found that a period from about ½ to 5 minutes is generally satisfactory.

With reference to the treatment with a temporary binding agent aforementioned, it is to be understood that this is not essential to the invention, but may be employed where desired. It is either rinsed off in the treatment tanks or washed off at a later stage if necessary. Also, the removal of the temporary binding agent is not essential, but again is preferable, so that the nylon, for example, in the finished net may retain its natural and attractive lustre.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A method of treating netting made of a thermo-sensitive synthetic resin twine knotted to form meshes, which treatment renders the netting substantially resistant to slippage at the knots; which method comprises treating the netting with a chemical swelling agent for the thermo-sensitive synthetic resin, the temperature of the swelling agent not exceeding 110° F., said netting being subjected to the action of the chemical swelling agent for a period of time sufficient to swell and soften only the external portions of the twine of the netting and permit the plastic memory of the internal portions of the twine to remain unchanged, the netting itself remaining in a substantially unshrunken condition, and thereafter removing the chemical swelling agent from the netting.

2. A method as defined by claim 1, wherein the chemical swelling agent is maintained at substantially room temperature.

3. A method as defined by claim 1, wherein the netting is under substantially only such slight tension as is necessary to pull the netting through the chemical swelling agent.

4. A method as defined by claim 1, wherein the chemical swelling agent is water-soluble.

5. A method as defined by claim 1, wherein the chemical swelling agent is removed from the twine by washing with water.

6. A method as defined by claim 1, wherein the net-

ting is coated with a temporary binding agent prior to being subjected to the action of the chemical swelling agent.

7. A method as defined by claim 1, wherein the chemical swelling agent is a dilute aqueous solution of phenol.

8. A method as defined by claim 1, wherein the chemical swelling agent is a concentrated solution of benzoic acid.

9. A method as defined by claim 1, wherein the chemical swelling agent is an aqueous solution of phosphoric acid.

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