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WARP SIZE COMPRISING HIGH MOLECULAR WEIGHT  
STYRENE/MALEIC ANHYDRIDE COPOLYMER  
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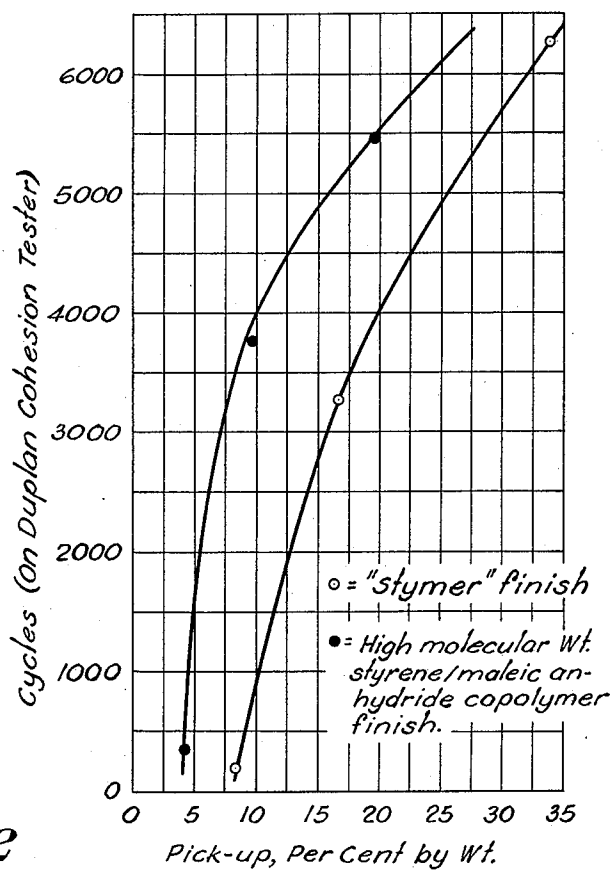
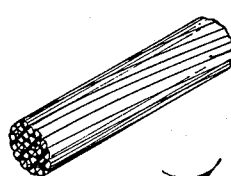


Fig. 2



Textile yarn finished with high molecular weight copolymer of styrene and maleic anhydride

Fig. 1

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## WARP SIZE COMPRISING HIGH MOLECULAR WEIGHT STYRENE/MALEIC ANHYDRIDE COPOLYMER

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This invention relates to the finishing with unusually high molecular weight copolymers of styrene and maleic anhydride of various natural and synthetic yarns, threads, cords, and the like filamentary structures and textile materials in order to facilitate their construction into cloth and fabric. The invention has particular reference to the sizing with the indicated finish of warp ends of various natural and synthetic fibers for subsequent weaving operations. It also relates to the finished yarns and the like that are obtainable through practice of the invention.

Copolymers of styrene and maleic anhydride are generally obtained in a relatively low molecular weight form. Ordinarily, for example, the molecular weight of such copolymers is in the neighborhood of 200,000 or so. Such low molecular weight styrene/maleic anhydride copolymers, particularly the alkali metal salts thereof, have been employed for various warp sizing operations, usually upon rayon and other cellulosic materials.

It would be an advantage to provide a much more efficient and effective styrene/maleic anhydride copolymer warp size or other finish for coating textile yarns comprised of various natural and synthetic materials. Such an improved finish would be especially desirable if it could adequately protect the yarn during the course of its construction and conversion into cloth and fabric without exerting any adverse effect upon its physical or chemical constitution while being employed in economical minimal quantities as a warp size or other finish. The achievement of these desiderations and corollary advantages and benefits are, therefore, amongst the principal objects and purposes of the present invention.

To the realization of these and related ends, yarn of natural or synthetic fibers may advantageously be finished for its construction into cloth and fabric by the application thereto or deposition thereon of an aqueous solution containing between about 2 and 25 percent by weight, based on the weight of the solution, advantageously up to about 10 percent by weight (especially at room temperature), of an alkali metal salt, preferably sodium, of styrene/maleic anhydride copolymer having a molecular weight, as measured and determined by conventional light scattering techniques, in the range between about 700,000 and about 3,000,000, advantageously between about 1,000,000 and 2,000,000.

Advantageously, warp ends of yarn are sized in the practice of the present invention to prepare them for weaving by application of the styrene/maleic anhydride copolymer from aqueous solution by means of conventional slashing techniques.

Yarn that is finished or sized in accordance with the present invention with a high molecular weight styrene/maleic anhydride copolymer is adequately lubricated to minimize friction and has excellent resistance to abrasion upon passage through mechanical yarn handling apparatus, even when minimum quantities of the size are deposited on the yarn. This facilitates the weaving or knitting of the sized yarn into cloth or fabric without injury or operational difficulty. In addition, the yarn is not harmfully or objectionably influenced by either discoloration or diminishment of physical properties due to the presence of the styrene/maleic anhydride copolymer finish. Besides this, the copolymer finish is not injurious or cor-

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rosive to guides or other yarn contacting surfaces and elements in conventional yarn handling and cloth or fabric manufacturing equipment. Furthermore, yarn that is provided with the styrene/maleic anhydride copolymer finish of the present invention, especially alkali metal salts of the copolymer, may be scoured to a clean and finish-free condition by conventional techniques using the ordinarily employed detergent baths and scouring agents for such purpose. Yarn finished according to the invention is at least commensurate and may frequently be superior in these and other particulars to yarns finished or sized with conventional materials, such as the lower molecular weight copolymers of the same variety which are commercially available from the Monsanto Chemical Company under the trade designation "Stymer," even when significantly lower quantities of the presently contemplated finish are employed in comparison with the amounts of conventional finishes ordinarily utilized. A specimen of spun cotton yarn finished in accordance with the present invention is schematically represented in FIGURE 1 of the accompanying drawing.

The high molecular weight styrene/maleic anhydride copolymer finish of the present invention may be applied from the aqueous applying solutions at any desired temperature up to about 95° C. or even to the boil. In most cases, however, it is expedient to utilize the applying solutions at about room temperature and, to avoid excessive viscosity of the applying solution, to utilize concentrations less than about 10 percent by weight of the dissolved copolymer. When less than about 2 percent by weight of the copolymer is contained in the applying solution, it is frequently difficult to effect the desired pick-up of the copolymer on the yarn being finished. When the applying solutions are employed at elevated temperature, the concentration of the copolymer dissolved therein may be as high as 25 or more percent without incurring difficulties due to excess or intolerable viscosity.

The yarn may be finished so as to pick up or retain any desired quantity of the high molecular weight styrene/maleic anhydride copolymer as a finish. For purposes of most fabric construction, there is usually little benefit to be achieved when a finish pick-up greater than about 20 percent by weight, based on the dry weight of the yarn, is exceeded. Advantageously, the pick up may be between about 0.5 and 10 percent by weight. Oftentimes, an amount of the copolymer on the yarn that is in the neighborhood of 3 percent by weight may be found suitable, with even lower quantities being satisfactory for purposes of finishing continuous filament yarn. When yarn that has been mechanically spun from staple lengths is being finished, it may sometimes be advantageous to apply comparatively greater quantities of the high molecular weight styrene/maleic anhydride copolymer finish than may best be suited for filament yarn.

The finish application may be accomplished readily by immersing the yarn in the aqueous solution of the copolymer until the desired quantity of the finish has been assimilated or picked up by the yarn. The usual type of operation that is involved in conventional slashing procedures using ordinary slashing or sizing mechanisms may be employed with expedience for such purposes. If desired, however, the high molecular weight styrene/maleic anhydride copolymer finish may be applied to the yarn according to other known procedures for the application of textile finishes. Thus, as will be apparent to those skilled in the art, roller or wick finish applicators and liquid jet or spray devices and techniques may also be employed for application of the solution of the copolymer finish. If desired, air or other types of drying, as with the assistance of heated ovens or their equivalent, such as heat lamps, after applica-

tion of the solution may be employed to secure a desired consistency of finish on the yarn.

Any yarn in twisted or untwisted condition that consists of multiple or individual continuous filament lengths or is fabricated by being spun from staple lengths may advantageously be finished according to the invention. Thus, the high molecular weight styrene/maleic acid copolymer finish may be employed on yarn from such natural fibers as cotton and wool as well as upon yarn from other natural fibers of vegetable or animal origin. Likewise, the finish may be employed with great advantage on yarn from the various artificial and synthetic fibers that are available, including yarn from the various artificial cellulose materials, such as rayon produced by the viscose or cuprammonium process or yarn from cellulose acetate or other of the known fiber-forming cellulose esters and ethers. Likewise, yarn from the various synthetic, essentially hydrophobic, fiber-forming polymeric materials may also be finished with benefit in the practice of the present invention. This includes acrylonitrile polymer (particularly polyacrylonitrile) yarns, polyamide yarns (such as those prepared from the condensation of hexamethylene diamine and adipic acid, known as nylon "66," or from condensation of epsilon caprolactam, known as nylon "6," or the like) polyester yarns (such as polyethylene terephthalate and the like condensation polymers of polycarboxylic acids and polyhydric alcohols), polyolefin yarns (such as polyethylene, polypropylene, and the like non-aromatic, hydrocarbon olefin polymers), haloethylene polymer yarns (including the vinyl chloride polymers and copolymers and the vinylidene chloride polymers and copolymers), fiber-forming styrene polymer yarns and so forth.

The high molecular weight styrene/maleic anhydride copolymers employed for finishing yarn in the practice of the invention may advantageously be comprised of a copolymer of about equimolar proportions of each of the indicated constituents. Although, as indicated, it is beneficial to utilize the sodium salt of the copolymer as the finish employed in the practice of the invention, other alkali metal salts may also be used, such as the potassium or lithium salts of the copolymer. Likewise, excellent results are also obtained with analogous, essentially equimolar, high molecular weight copolymers of maleic anhydride and other monovinyl aromatic monomers generally equivalent to styrene that contain from 6 to about 10 carbon atoms in the aromatic portion of their molecule (including the carbon atoms in ring substituted alkyl substituents). Of these well known monomers, particular mention may be made of vinyl toluene, monochlorostyrene and the several dichlorostyrenes.

By way of further illustration, the efficiency of a high molecular weight styrene/maleic anhydride copolymer on 21s spun cotton yarns was determined in a series of tests in which the yarn was sized with a copolymer of about equimolar proportions of styrene and maleic anhydride having an average molecular weight of about 1,600,000 as determined by light scattering. The high molecular weight styrene/maleic anhydride copolymer finish was applied on the yarn by conventional slashing techniques using aqueous applying solutions at temperatures of 24-26° C. containing various concentrations of the dissolved copolymer therein. For purposes of comparison, samples of the finished cotton yarn were tested along with identical yarn samples that were finished with commercially available "Stymer S," which is the sodium salt of a copolymer of styrene and maleic anhydride (in about equimolar proportion) having an average molecular weight (by light scattering) of about 200,000. The "Stymer S" was applied from various applying solutions having different concentrations of the copolymer therein at the same temperature as utilized for the high molecular weight copolymer finish of the present invention.

Several samples of both the high molecular weight styrene/maleic anhydride copolymer finish of the present invention and the conventional "Stymer S" finished yarn, containing varied applied amounts of each type of finish, were subjected to abrasion tests in which the yarn was run to a "fuzz" point at which the component individual filaments in the yarn began to break and form fuzz balls in the yarn. Each test consisted of subjecting a plurality of taut ends of the finished yarn to the reciprocal abrading action of a pair of oscillating knife edges that were opposed to one another and in contact, in about perpendicular relative disposition, with both sides of the yarn. The tests were conducted on a modified version of an apparatus known as a "Duplan Cohesion Tester" (for rayon and raw silk) which is manufactured by Geier & Bluhm, Inc. of Troy, New York, and were performed in a generally analogous manner to the equipment manufacturers recommended procedure. The number of oscillations or cycles required to cause failure of the yarn size and fuzzing or break of fine strands of the yarn were observed in each of the tests. The results of the tests are set forth in the following tabulation and are also graphically illustrated in FIGURE 2 of the accompanying drawing, in which the "fuzz" point, as expressed in the number of cycles required for its accomplishment, is plotted against the quantity of finish on the yarn, expressed in percent by weight, based on the weight of the yarn. The high molecular weight copolymer finished yarn of the present invention is represented by the solid data points in the graph while the data points obtained on the yarn finish with the "Stymer S" are represented by the open cycles. For convenience in interpretation of the graph, an average or mean value line is drawn through each set of the represented data points.

Table.—Comparison of High Molecular Weight Styrene Maleic Anhydride Copolymer Finish With "Stymer" Finish on Cotton Yarn

| Size                             | Percent by Weight of Dissolved Solids in Applying Solution | Percent by Weight Pick-Up on Yarn | Fuzz Point in Cycles on Duplan Tester |
|----------------------------------|------------------------------------------------------------|-----------------------------------|---------------------------------------|
| "Stymer"-----                    | 5                                                          | 8.5                               | 157                                   |
| Do-----                          | 10                                                         | 17                                | 3,260                                 |
| Do-----                          | 20                                                         | 34                                | 6,266                                 |
| High molecular weight copolymer. | 2.5                                                        | 4.9                               | 303                                   |
| Do-----                          | 5                                                          | 9.9                               | 3,705                                 |
| Do-----                          | 10                                                         | 19.8                              | 5,479                                 |

As is apparent, the high molecular weight styrene/maleic anhydride finish was at least 2 to 3 times as effective in protecting the yarn from the abrasion as was the conventional, low molecular weight, "Stymer S" finish.

In additional tests, the high molecular weight copolymer finish was found to cause no discoloration of or to have no other deleterious effect upon the yarn, even when it was permitted to remain thereon even for a considerable period of time. Likewise, the high molecular weight copolymer finish was found to be as easy to scour from the yarn as the ordinary "Stymer" material.

In addition, similar samples of cotton yarn sized in accordance with the invention to obtain about 5 percent by weight (or more or less) of the finish film of the high molecular weight styrene/maleic anhydride copolymer on the yarn may be advantageously employed for both the warp and filling to achieve excellent square woven and other fabrics without operational difficulties that might arise if the finish were inadequate for the purpose. The resulting woven fabric is at least as good as similar fabric woven identically from like yarn that is sized with greater quantities of "Stymer S" or other presently employed commercial finishes for the yarn.

Excellent results similar to the foregoing may also be obtained when the high molecular weight styrene/

maleic anhydride copolymer finishes are employed for sizing yarn, including continuous filament and spun yarn, from textile fibers of polyacrylonitrile, nylon "66" (hexamethylene diamine/adipic acid), polyethylene terephthalate ("Dacron"), polyethylene, viscose rayon, cellulose acetate, polyvinylchloride, fiber-forming copolymers of vinylidene chloride and acrylonitrile, polyethylene and other natural or synthetic or artificial materials.

Similar excellent results are also obtained with cotton and other textile fiber yarns using equivalent finishes comprised of analogous copolymers of maleic anhydride and vinyl toluene or mono- or dichlorostyrene.

What is claimed is:

1. Method for finishing yarn to facilitate its construction into cloth and fabric which method comprises depositing on the surface of the yarn between about 0.5 and 20 weight percent, based on the dry weight of the yarn, of a finish comprised of a copolymer of a monovinyl aromatic monomer containing from 6 to about 10 carbon atoms in its molecule and maleic anhydride, said copolymer having a molecular weight between about 700,000 and 3,000,000 and containing about equimolar proportions of each constituent in its molecule.

2. The method of claim 1, wherein said monovinyl aromatic monomer is styrene.

3. The method of claim 1, wherein said monovinyl aromatic monomer is vinyl toluene.

4. Method for finishing yarn to facilitate its construction into cloth and fabric which method comprises depositing on the surface of the yarn between about 0.5 and 20 weight percent, based on the dry weight of the yarn, of a finish comprised of the sodium salt of a copolymer of about equimolar proportions of styrene and maleic anhydride having a molecular weight between about 700,000 and 3,000,000.

5. The method of claim 4, wherein between about 0.5 and 10 weight percent of said copolymer is deposited on the surface of the yarn.

6. Method for finishing yarn to facilitate its construction into cloth and fabric which method comprises applying to the yarn an aqueous solution containing between about 2 and 15 weight percent, based on the weight of the solution, of the sodium salt of a copolymer of about equimolar proportions of styrene and maleic anhydride having a molecular weight between about 700,000 and 3,000,000; and depositing on said yarn from said aqueous solution between about 0.5 and 20 weight percent, based on the dry weight of the yarn, of said copolymer on the surface of said yarn.

7. Textile yarn provided with between about 0.5 and 20 weight percent, based on the dry weight of the yarn, of a finish comprised of a copolymer of a monovinyl alkenyl aromatic monomer containing from 6 to about 10 carbon atoms in its molecule and maleic anhydride, said copolymer having a molecular weight between about 700,000 and 3,000,000 and containing between about equimolar proportions of each constituent in its molecule.

8. The finished yarn of claim 7, wherein the monovinyl aromatic monomer in said copolymer is styrene.

9. The finished yarn of claim 7, wherein the monovinyl aromatic monomer in said copolymer is vinyl toluene.

10. The finished yarn of claim 7, wherein the molecular weight of the copolymer is between about 1,000,000 and 2,000,000.

11. Textile yarn provided with between about 0.5 and 20 weight percent, based on the weight of the yarn, of a finished comprised of the sodium salt of the copolymer of about equimolar proportions of styrene and maleic anhydride having a molecular weight between about 700,000 and 3,000,000.

12. Cellulosic yarn finished in accordance with claim 11.

13. Cotton yarn finished in accordance with claim 11.

14. Yarn of a synthetic fiber-forming polymer finished in accordance with claim 11.

15. Acrylonitrile polymer yarn finished in accordance with claim 11.

16. Multiple filament yarn finished according to claim 11.

17. Mechanically spun staple fiber yarn finished according to claim 11.

18. Sized warp ends of yarn in accordance with claim 11.

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