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LUBRICATION AND CONDITIONING OF YARNS AND FILAMENTS

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This invention relates to the lubrication of textile yarns and filaments, and more particularly to the lubrication of yarns composed of organic derivatives of cellulose such as cellulose acetate.

In the manufacture and use of artificial textile filaments, fibers, or threads composed of derivatives of cellulose such as cellulose acetate, cellulose acetate propionate and other esters, it is customary to apply a lubricating fluid thereto during or after the spinning operation in order to impart certain desirable properties thereto. For example, yarns composed of cellulose acetate and other organic acid esters of cellulose have a tendency toward "hairing" or fluffing, which is due to breaking of some of the individual filaments during the spinning, winding, twisting and knitting operations through which they are required to pass. This results in protrusion from the main body of the yarn of innumerable fine filament ends which give it an undesirably woolly appearance. Furthermore, it is well-known that if the yarn is insufficiently pliable, it is liable to break, especially when subjected to twisting and also when the finished thread is subjected to the various mechanical operations involved in weaving or knitting. Various expedients have been proposed, not only to cut down the hairing or fluffing tendency of the yarn and to impart pliability or flexibility thereto, but to give the yarn an improved appearance or "feel".

For example, it has been proposed to apply various lubricating or conditioning agents, but many of such materials have serious drawbacks in that, either they have to be applied to the yarn from solvent media which have a too drastic solvent action on the yarn material, or they are of such character as to give rise to the formation of gummy or other undesirable deposits which adversely affect the appearance and usefulness of the yarn. In addition, many of the lubricating formulae mentioned in the prior art, especially those in which fugitive tints are applied to the yarn simultaneously with its lubrication, are undesirable from the standpoint of introducing an excessive amount of water into the yarn with the result that, upon evaporation of solvents and moisture therefrom, the yarn package has a loose, untidy appearance. This "soft package" phenomenon is one of the most serious problems with which the yarn manufacturer has to contend in the use of known yarn treating compositions.

Where the yarn is to be used for knitting, it is particularly important that the material be pliable in order that it may lend itself readily to the various rather complicated operations involved in this type of textile work. It has been found that yarns produced from materials such as cellulose acetate have been quite satisfactory for use in knitting operations for the plainer types of designs or stitches, but that when it is desired to produce novel effects involving more or less complicated designs, acetate yarn, for example, does not behave in a practical manner. In producing the ribbed effect technically known as "knit 3, float 3", for example, the result with ordinary untreated yarn is a fabric having pinholes, non-uniform width of rib, and in some cases a tendency to shrivel or roll together after the fabric is cut into sections.

This invention has as an object to provide a means and method for overcoming the above mentioned difficulties. A further object is to provide an improved technique for the lubrication of textile yarns and filaments, particularly those composed of cellulose organic acid esters such as cellulose acetate, whereby valuable properties are imparted to the material. A still further object is to provide a process for so treating yarn composed of cellulose acetate and other cellulose derivatives as to enable it to be employed in any textile operation where complicated designs or stitches are employed and particularly in knitting operations. Another object is to provide an improved lubricating and dressing composition adapted for the treatment of cellulose derivative yarn. Other objects will appear hereinafter.

These objects are accomplished by the following invention which, in its broader aspects, comprises provision of a treating fluid for yarn composed of a mixture of a lubricant and a special component hereinafter referred to as a "lubricating assistant" which induces pliability in the material of which the yarn is composed simultaneously with the lubricating operation. We have found that in order to obtain a yarn of the desired degree of pliability it is necessary to employ an agent which has a definite, even though slight, solvent or latent solvent action on the cellulose derivative material. While we offer no theory or explanation of the effect of this solvent component, it is our belief that it penetrates into the cellulose derivative material and in some manner opens it up in such a way as to admit or carry into the interior of the material minute amounts of the lubricant or of the solution of the lubricant and that this

is what gives rise to the increased pliability and other desirable properties of yarn treated therewith. Whatever the explanation, treatment of cellulose derivative yarn in accordance with our invention causes it to become extremely pliable and readily susceptible to textile operations, particularly circular knitting. In addition, we have found that the composition to be more specifically described herein, actually imparts to yarn treated therewith a markedly improved appearance and feel.

We wish to emphasize at this point that many, in fact most, of the ordinary solvents for the lubricants commonly employed in the textile industry are not suitable for use as ingredients of textile lubricating or conditioning compositions for the reason that they have too drastic a solvent action on the cellulose derivative material and give rise to the production of various adverse effects. We have, however, discovered a class of solvents, or as we prefer to style them, "lubricating assistants," which have the unique property, above mentioned, of penetrating and softening the cellulose derivative material of the yarn without adversely affecting it and of causing or assisting the lubricant per se to exert its lubricating effect. We have determined that such agents should comply with the four following requirements: (1) they should be capable of blending or mixing with lubricants such as animal, vegetable and mineral oils, (2) they should be partially or completely soluble in water, (3) they should have a relatively high boiling point; say, a minimum of 125° C. and should preferably boil above 185° C., (4) they should have a solvent, latent solvent, or at least softening action on cellulose organic acid esters. After extensive work with various compounds we have found that the high boiling esters of polyhydric alcohols, such as ethylene glycol, propylene glycols, glycerol, diethylene glycol

$(HOCH_2CH_2OCH_2CH_2OH)$,

triethylene glycol

$(HOCH_2CH_2OCH_2CH_2OCH_2CH_2OH)$

diglycerol

$(HOCH_2HOCHCH_2OCH_2CHOHCH_2OH)$

or the like; simple esters of polyhydric alcohols, such as ethylene glycol diacetate, glycerol triacetate (triacetin), diethylene glycol diacetate ($CH_3COOCH_2CH_2OCH_2CH_2OOCCH_3$), triethylene glycol diacetate

$(CH_3COOCH_2CH_2OCH_2CH_2OCH_2CH_2OOCCH_3)$

diglycerol tetrapropionate

$(C_2H_5COOCH_2C_2H_5COOCH$
$CH_2OCH_2CHOOCC_2H_5CH_2OOCC_2H_5)$

or the like; ester-alcohols, such as ethylene glycol monoacetate, diethylene glycol monoacetate

$(CH_3COOCH_2CH_2OCH_2CH_2OH)$

glycerol diacetate (diacetin) glycerol monoacetate (monoacetin), propylene glycol monoacetate or the like; ester-ethers, such as, the acetate of ethylene glycol monomethyl ether ($CH_3OCH_2CH_2OOCCH_3$), the acetate of diethylene glycol monoethyl ether

$(C_2H_5OCH_2CH_2OCH_2CH_2OOCCH_3)$

the oleate of diethylene glycol monoethyl ether, the acetate of diethylene glycol monobutyl or monomethyl ether, the acetate or lactate of ethylene glycol monoethyl ether, the acetate of diethylene glycol monomethyl ether, or the like; and the ester-ether-alcohols, such as the monoacetate of glycerol monomethyl ether

$(CH_3OCH_2CHOHCH_2OOCCH_3)$

or the like, meet the above requirements and function extremely well as lubricating assistants in accordance with our invention.

While we refer here principally to esters derived from acetic acid, we are not limited thereto, as almost any esters which can be prepared from polyhydric alcohols or derivatives of polyhydric alcohols may be employed, either alone or in mixtures of two or more. Of this broad class of esters of polyhydric alcohols, we have found that carbitol acetate (the acetate of diethylene glycol monoethyl ether), butyl carbitol acetate (the acetate of diethylene glycol monobutyl ether) and diethylene glycol diacetate are by far the most satisfactory and, in fact, occupy an almost unique position among these esters as lubricating assistants. Of these three compounds, carbitol acetate is to be preferred.

In the following examples and description, we have set forth several of the preferred embodiments of our invention, but they are included merely for purposes of illustration and not as a limitation thereof. Suitable compositions for the treatment of cellulose acetate and other types of cellulose derivative yarn are indicated below:

Formula I

	Parts by weight
Carbitol acetate	80
Blown olive oil	20

Formula II

	Parts by weight
Carbitol acetate	66
White mineral oil	17
Oleic acid	17

Formula III

	Parts by weight
Carbitol acetate	80
Neat's-foot oil	17.4
Oleic acid	2.6

Formula IV

	Parts by weight
Carbitol acetate	80
Olive oil	9
Mineral oil	9
Oleic acid	2

Formula V

	Parts by weight
Carbitol acetate	80
Blown olive oil	17.4
Oleic acid	2.6

Formula VI

	Parts by weight
Carbitol acetate	82.5
Blown olive oil	17.5

Formula VII

	Parts by weight
Carbitol acetate	80
Sulfonated olive oil	20

Formula VIII

	Parts by weight
Diacetin	75
Blown olive oil	25

Formula IX

	Parts by weight
Diethylene glycol diacetate	55
Butyl carbitol acetate	25
Blown olive oil	20

The above compositions may be applied to the yarns or filaments in the course of their production, that is, within the spinning cabinet in which the filaments are produced, or the compositions may be applied after the filaments have been completely formed and before or after twisting to thread form. Alternatively, our lubricating and dressing compositions may be applied before or during any type of textile operation in which such yarns are employed.

The actual application of the lubricating and dressing composition may be carried out in any convenient manner such as by means of a wick, roller, or other device dipping into a body of the liquid and then brought in contact with the yarn. For most purposes roller application is to be preferred, as it assures a steady and positive application of the composition to the yarn. However, in some cases the yarn may be drawn through a bath of the composition, or the liquid may be sprayed on the yarn, or otherwise applied thereto.

Although we have indicated definite amounts of carbitol acetate, and other esters of polyhydric alcohols, oils and other ingredients in the above formulae illustrating our preferred compositions, the proportion of the ester as well as of other materials may vary widely, depending upon the particular type of cellulose derivative yarn dealt with, the textile operations in which the yarn is to be employed and the various effects which it is desired to produce upon the material. In general, we prefer to use a fairly high proportion of ester when treating cellulose acetate yarn.

While we have referred to the use of specific oils in the above lubricating formulae, it will be apparent that many other oils may be employed. We may, for example, employ mineral, vegetable, animal or soluble oils or mixtures thereof. Typical examples of suitable oils are white paraffin mineral oils, olive oil, castor oil, whale oil, neat's-foot oil, coconut oil, palm nut oil, teaseed oil, and lard oil, as well as such oils or mixtures thereof rendered emulsifiable with water by incorporation therewith of soaps, sulphonated oils, sulphonated fatty alcohols, sulphonated mineral oils, sulphonated waxes, etc. in a manner known to those skilled in the art to which this invention relates.

As a matter of fact, one of the distinguishing features of the particular type of esters which we employ according to our invention is their good solvent power with respect to a wide variety of blown and unblown animal and vegetable oils, and mineral oils.

In some cases the lubricating assistant may be used with little or no addition of oil, since the esters to which we have referred herein, due to their inherent oiliness and comparatively high viscosity, can themselves act as lubricants. However, it is generally preferable to blend them with one or more other lubricants.

In connection with the use of oils, we have found that some are much more effective for certain purposes than others, and that the amount of oil in the lubricating or conditioning fluid is somewhat critical. For example, in circular knitting we have found that oxidized non-mineral oils, typified by blown olive oil to be especially valuable when used with carbitol acetate as the lubricating assistant. This is apparently due to their higher viscosity, as compared to the straight unblown or unoxidized oils, which gives an improved "drag" to yarn treated therewith. For circular knitting we prefer to employ a lubricating fluid composed of about 82.5% by weight of carbitol acetate and 17.5% blown olive oil, it having been found that a fabric of improved covering power (closer, more uniform weave) is obtained by the use of this amount of oil over a fabric treated with a composition in which 20% of the oil is employed. We have found that this improvement cannot be obtained by using a larger proportion of an unoxidized (lower viscosity oil), since this necessarily cuts down the proportion of the carbitol acetate or similar ester employed in the combination and thereby diminishes the desired softening action on the yarn.

The amount of lubricant deposited on the yarn varies rather widely depending upon the use to which the yarn is to be put. In general, we prefer to deposit on the yarn an amount of the lubricating composition representing about 15% of the weight of the material in the case of dull (pigmented) yarn and about 5% in the case of a bright (unpigmented) yarn.

Our invention will be more clearly understood by reference to the following examples:

Example I

An unpigmented (bright) yarn composed of cellulose acetate produced by the dry spinning method and composed of a plurality of filaments of relatively low denier, is treated, immediately after it leaves the spinning cabinet and prior to being wound or twisted, with the lubricating and conditioning fluid designated above as Formula I. The application of the fluid is carried out by causing the yarn as it passes to the winding device to contact with the surface of an applicator roll dipping in a bath of the fluid and carrying up a small amount of the material and depositing it on the yarn. About 5% of the fluid, based on the weight of the yarn, is deposited. The yarn thus treated is extremely pliable, has an excellent appearance and feel, and may be employed in any type of textile operation, including the most complicated types of knitting, without the production of pin holes, distortion, or other defects common to yarn which has not been previously treated or which has been treated with lubricating fluids from which a lubricating assistant such as that described herein is absent.

Example II

A pigmented or dull luster yarn composed of cellulose acetate and produced by the dry spinning of a solution of cellulose acetate in acetone containing a small percentage of a pigment such as titanium oxide is treated on the way to the usual cap spinning device by the application thereto of a lubricating and conditioning fluid having the composition indicated by Formula IV above, application of the fluid being carried out in the same manner as described in Example I. In this case about 15%, based on the weight of the yarn, is deposited on the material. The properties of the lubricated and conditioned yarn are substantially the same as those of the product produced in Example I. The product is entirely amenable to weaving, knitting, and various other textile operations and is particularly well adapted for circular knitting and in fact, for any type of knitting, even of the most complicated designs. After the yarn, treated as above described, has been knitted into a fabric, the lubricating and conditioning fluid may be readily removed therefrom by the usual scour baths.

While we have described our invention with particular reference to the treatment of yarns composed of cellulose acetate, the lubricating and conditioning fluids described herein are applicable to many other types of cellulose derivative yarns, such as those composed of cellulose formate, cellulose propionate, cellulose butyrate, cellulose acetate propionate, ethyl, methyl and benzyl cellulose and others, as well as to silk, wool, cotton, viscose, or mixtures thereof.

Although in the above examples, we have referred to the application of lubricating fluid to the yarn immediately after spinning, it may be applied before or during any textile operation in which the yarn is employed.

The amount of the lubricating and conditioning fluid deposited on the yarn will vary with the particular type of material of which the yarn is composed, the purpose for which the yarn is to be used and various other factors. In general, we prefer to use about 5 to 15% of the fluid, based on the weight of the yarn, although we may use considerably less than 5% in some cases, and considerably more than 15% in other cases. We prefer to deposit less of the fluid on bright yarn than on pigmented or dull luster yarn.

It will be apparent that our invention is characterized by numerous outstanding advantages. The yarn treated in accordance with our invention has an exceptionally high degree of pliability which renders it capable of being woven or knitted into a close fabric without pin holes, distortion, or other types of defects. Due to this exceptional pliability, the material is particularly susceptible to winding, twisting, and various other textile operations. The tendency toward hairing or fluffing is permanently eliminated and, due to the peculiar effect of the particular lubricating assistants which we employ, such as carbitol acetate, the material has a good appearance and an excellent hand or feel.

By the term "lubricating assistant" as used herein and in the claims, we refer to a material which has the power of penetrating or diffusing into the material of which the yarn is composed and of enabling the lubricating material itself, such as an oil, to diffuse into the yarn material to give it the desired characteristics. While we offer no theory or explanation of the results obtained by our process, particularly as to increased pliability and other characteristics, it seems probable that the effect produced is due to some sort of solvent action of the assistant on the cellulose derivative material or at least a diffusing action which permits the lubricant to penetrate the yarn material to produce its maximum softening and lubricating effect.

What we claim is:

1. The process of preparing yarns or filaments composed of an organic acid ester of cellulose for circular knitting and other textile operations which comprises applying thereto a conditioning fluid containing an oil and an ester of a polyhydric alcohol selected from the group consisting of the simple esters, the ester-alcohols, the ester-ethers, and the ester-ether-alcohols derived from such alcohols, said ester being derived from a fatty acid of not over ten carbon atoms.

2. The process of preparing yarns or filaments composed of an organic acid ester of cellulose for circular knitting and other textile operations which comprises applying thereto a conditioning fluid containing an oil and diethylene glycol monoethyl ether acetate.

3. The process of preparing yarns and filaments composed of cellulose acetate for circular knitting, and other textile operations which comprises applying thereto a conditioning and lubricating fluid comprising an oil and diethylene glycol monoethyl ether acetate.

4. A lubricating and conditioning fluid for rendering yarns and filaments composed of an organic acid ester of cellulose more amenable to circular knitting, and other textile operations composed of an oil and an ester of a polyhydric alcohol selected from the group consisting of the simple esters, the ester-alcohols, the ester-ethers, and the ester-ether-alcohols derived from such alcohols, said ester being derived from a fatty acid of not over ten carbon atoms.

5. A lubricating and conditioning fluid for rendering yarns and filaments composed of an organic acid ester of cellulose more amenable to circular knitting, and other textile operations composed of an oil and diethylene glycol monoethyl ether acetate.

6. A lubricating and conditioning fluid for rendering yarns and filaments composed of cellulose acetate more amenable to circular knitting, and other textile operations composed of an oil and diethylene glycol monoethyl ether acetate.

7. Yarns composed of organic derivatives of cellulose containing a lubricating and conditioning fluid comprising an oil and a lubricating assistant having the power of diffusing into, and thereby enabling the oil to diffuse into the yarn material, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects, said ester being derived from a fatty acid of not over ten carbon atoms.

8. Yarns composed of an organic acid ester of cellulose containing a lubricating and conditioning fluid comprising an oil and an ester of a polyhydric alcohol selected from the group consisting of the simple esters, the ester-alcohols, the ester-ethers, and the ester-ether-alcohols derived from such alcohols.

9. Yarns composed of an organic acid ester of cellulose containing a lubricating and conditioning fluid comprising an oil and diethylene glycol monoethyl ether acetate, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects.

10. Yarns composed of cellulose acetate containing a lubricating and conditioning fluid comprising an oil and diethylene glycol monoethyl ether acetate, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects.

11. The process of preparing yarns and filaments composed of an organic acid ester of cellulose for circular knitting and other textile operations which comprises applying thereto a conditioning fluid containing an oil and an ester selected from the group consisting of diethylene glycol monoethyl ether acetate, diethylene glycol monobutyl ether acetate and diethylene glycol diacetate.

12. The process of preparing yarns and filaments composed of cellulose acetate for circular knitting and other textile operations which comprises applying thereto a conditioning and lubricating fluid comprising an oil and diethylene glycol monobutyl ether acetate.

13. The process of preparing yarns and filaments composed of cellulose acetate for circular knitting and other textile operations which com-

prises applying thereto a conditioning and lubricating fluid comprising an oil and diethylene glycol diacetate.

14. A lubricating and conditioning fluid for rendering yarns and filaments composed of an organic acid ester of cellulose more amenable to circular knitting and other textile operations composed of an oil and diethylene glycol monobutyl ether acetate.

15. A lubricating and conditioning fluid for rendering yarns and filaments composed of an organic acid ester of cellulose more amenable to circular knitting and other textile operations composed of an oil and diethylene glycol diacetate.

16. Yarns composed of cellulose acetate containing lubricating and conditioning fluid comprising an oil and an ester selected from the group consisting of diethylene glycol monoethyl ether acetate, diethylene glycol monobutyl ether acetate, and diethylene glycol diacetate, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects.

17. Yarns composed of cellulose acetate containing lubricating and conditioning fluid comprising an oil and diethylene glycol monobutyl ether acetate, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects.

18. Yarns composed of cellulose acetate containing lubricating and conditioning fluid comprising an oil and diethylene glycol diacetate, said fluid being present in such amount that the yarn is capable of being knitted into a fabric of close construction substantially free of defects.

19. A lubricating and conditioning fluid for rendering yarns and filaments composed of an organic acid ester of cellulose more amenable to circular knitting and other textile operations containing 80 parts by weight of diethylene glycol monoethyl ether acetate and 20 parts by weight of blown olive oil.

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