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PROCESS OF MANUFACTURING RUBBER
IMPREGNATED FABRIC AND THE PROD-
UCT THEREOFEugene C. Gwaltney, Macon, Ga., assignor to
Bibb Manufacturing Company, Macon, Ga.No Drawing. Application October 16, 1935,
Serial No. 45,321

16 Claims. (Cl. 117-2)

The invention forming the subject matter of this application is a rubber impregnated heat-resistant cotton yarn and heat-resistant cotton cord, and fabrics such as is used in carcasses of rubber tires, in belting and in all products where tensile strength, insulation, resistance to heat caused by internal friction, increasing surface friction, or waterproofing, is desirable, and other fabrics having cotton yarn or cotton cord forming an important part of their content, and in use subjected to high temperatures, to rapid flexing and to strains and stresses. The invention also relates to processes of manufacturing this rubber impregnated yarn and cord and fabric.

It is well known in this art that heat acts injuriously upon cotton products; and, therefore, injures all goods made of cotton when the temperatures involved in their use become excessive. Automobile tires, for example, are practically made entirely of rubber and a highly specialized cotton cord, and offer an example of the injurious effects of heat upon goods of this character. It is generally agreed in the tire industry that the chief cause of failure in automobile tires is the heat developed by internal resistance to the flexing strains the cords undergo in service; and that this heat is sufficiently great to extract the moisture from the textile fabric of the tires.

It is well known that cotton yarn or cotton cord, as heretofore produced, when bone dry, loses around from 30% to 40% of its tensile strength as compared with its strength when containing its normal amount of moisture. It is the main object of the present invention to produce a cotton cord and other cotton products which maintain and retain their tensile strength substantially constant throughout all ranges of temperature to which they may be subjected in service.

The normal moisture content of cotton cords heretofore employed in the manufacture of tires and belting (used as a basis for testing the same) is about 6.5% by weight of the cord. It has been found experimentally that for each decrease of 1% in the moisture content, the tensile strength of the cord is decreased about 6%. In cords produced by applicant's process, the tensile strength is maintained substantially constant throughout all decreases of moisture content from normal to bone-dry; and in some cases has been actually increased. This remarkable result has been obtained by thorough liquid saturation of the fibres which make up the cotton yarns and cords; and by subjecting the saturated yarns to steps of twisting under tension, compressing and stretching, as hereinafter described.

It is well known in the cotton industry that raw cotton contains normally about 9% of moisture; and that the retention of approximately

this amount of moisture in the cotton is essential to the success of even normal processes of manufacturing cotton into its various textile products. In the course of converting cotton into various types of textiles, the heat generated by the friction of the machinery in the mill would cause a deterioration in the tensile strength of the cotton products by the removal of moisture therefrom, and would hinder the successful processing of cotton in the various textile products. To overcome this condition, cotton mills are equipped with means for artificially moistening the atmosphere thereof, to maintain in the cotton fibre, the moisture content necessary to insure the tensile strength and proper processing of the cotton throughout its manufacture in the mill.

It is also well known in this art that additional moisture injected into the cotton adds to its tensile strength, but the amount of moisture which can be injected artificially or otherwise into the cotton during the processing thereof, is limited by the injurious effect which excessive moisture has on the various processes of converting cotton into spun yarn and into cords and into woven fabrics. The additional amount of moisture is further limited by the fact that excessive moisture in cotton products will, in a short time, produce mildew and rot and thus destroy the tensile strength and wearing qualities of the cotton and of any product into which it may be made. Moreover, the buyers of cotton textiles object to purchasing these textiles when they contain more than a normal amount of moisture, certainly no more than was in the raw cotton as first introduced in the mill.

In the manufacture of the heat-resistant yarn and heat-resistant cord forming the subject matter of the present invention, it is desirable to accomplish two things with respect to the cotton and the products manufactured therefrom:

(1) The greatest amount of moisture possible, consistent with proper processing, must be introduced into the cotton while it is being processed; and

(2) The effect of increasing the tensile strength of cotton by the introduction of the extra moisture must be retained in the finished product, without the retention in that finished product of more than the normal amount of moisture—not exceeding the moisture content of the raw cotton as it entered the mill, which is the moisture content a customer naturally expects and finds acceptable.

In the U. S. application, Serial Number 43,454, filed October 3, 1935, for Heat-resistant yarn and heat-resistant cord and process for making same, there is disclosed a process for manufacturing cotton yarns and cords having substantially the same break throughout all changes in moisture

content from bone dry to normal. In carrying out that process, it was found that when yarn spun of cotton processed throughout the mill in the normal way was saturated, twisted, stretched and compressed, there was obtained a result in the finished yarn or in the finished cord having the following desirable characteristics:

1. The finished goods contain no more than the normal moisture content, which would be insufficient in amount to effect mildewing or rotting of the product;

2. In saturating yarn with moisture, the gum and oils inherent in the cotton fibre are softened, and when a number of these saturated yarns are twisted and plied under tension and are stretched and compressed the fibres adhere more closely to each other than is the case with cotton goods manufactured without the preliminary saturation, and the resultant yarn retains its tensile strength substantially constant throughout all changes of temperature to which it would be subjected in service.

3. Likewise when a number of the twisted saturated yarns are again twisted and compressed under tension into a cord and are stretched after the compressing, the resulting cord retains its tensile strength substantially throughout all changes of temperature to which it would be subjected in service.

It was found that single yarns could be saturated with liquids before twisting into plied yarn where plied yarn was to be the finished product, or that where the plied yarn was to be twisted into cord the plied yarns could be saturated before twisting them. It was found that the twisting could be done in the usual manner or under tension or stretch as hereinafter defined, provided the yarn was twisted before the excess moisture was removed therefrom. It was found that the tension or stretching process could be applied either to the plied yarn or to the cord manufactured by twisting together two or more plied yarns, and that such tension or stretching could be applied during the process of twisting or afterwards, and either before or after compressing. It was also found that the compressing could be applied either to the plied yarn or, if the plied yarn was to be manufactured into cord, to the cord manufactured therefrom. It was found also that the saturating and twisting processes increased the heat-resistant qualities of the yarn, and that such heat-resistant qualities were further increased when the tension or stretching process was used in addition to the saturating and twisting, and that the compressing process further increased such heat-resistant qualities.

In carrying out the process involved in the production of the heat-resistant cotton yarn or cord, the yarns are not merely wet; they are saturated. By "saturated" it is meant that the elemental cotton fibres have absorbed or taken up liquid to such an extent that the internal stresses or strains of the fibres become, or approach, zero, and the gums or waxes which inhere on or in the fibres are softened; in other words, that the substance of the fibre no longer has to contend with internal stresses, but is free to oppose resistance to stresses arising from the outside, and that the fibres and gums or waxes are thus fused to a greater extent than has heretofore obtained in the manufacture of yarns or cord. In other words, the fibres become set and are bonded with the natural gums and waxes.

When it is stated that the saturated cotton yarn

is twisted, it is to be understood that said yarn may be twisted in the usual manner or may be twisted under greater than normal tension or stretch. By "tension" or "stretch" is meant that the saturated yarn is subjected to a greater tension or stretch than is applied in the usual twisting operation, so that the elemental fibres of saturated yarn are brought into closer contact, one with the other, and are more closely bonded into a unified product than is caused by saturating and twisting alone. The higher the tension or stretch which is applied the higher is the heat-resistant quality. By "compression" is meant compression by the usual means employed in the industry to reduce the diameter of a plied yarn or cord.

To recapitulate, the steps of the process producing the heat-resistant yarn or cord comprise:

(1) A complete liquid saturation of yarns, either single yarns or plied yarns;

(2) A twisting of any desired number of the saturated yarns, which may be done in the usual manner or under tension;

(3) A cabling or twisting of any desired number of the previously twisted, saturated yarns to produce a cord or cable, and drawing the same, under tension, through a nipper or other device for compressing; and

(4) Stretching the cabled, twisted yarn to produce the finished cotton cord.

Where cabling is not desired, the steps of the process producing our heat-resistant yarn or cord comprise:

(1) A complete liquid saturation of single yarns;

(2) A twisting of any desired number of the saturated yarns in the usual manner or under tension and if twisted in the usual manner, subsequently stretching the yarns and compressing the same by drawing under tension through a nipper or other device for compressing.

The stretching and compressing may be carried out in any order; but the process consists of the saturation of the cotton yarn to soften the natural gum thereof, and thereby permitting a closer packing of the fibres together and bonding with the natural gum during the various steps of twisting, compressing and stretching. In the cord produced by this process, it is found that while the saturation and twisting increases the "bone dry" strength of the cord, the additional stretching increases it still further; and, when the stretched cord is compressed, the strength is still further increased. The comparative strengths under these different conditions, are set forth in the following table, which averages the results obtained by extensive tests in the laboratory of the assignee of this invention.

Average of laboratory tests

	1 ¹	2 ²	3 ³
Size.....	1.026	1.074	1.090
Gauge.....	33.25	32.25	32.00
Break (normal moisture).....	20.70	21.65	22.10
Stretch at 10%.....	5.83	3.85	3.72
Stretch at break.....	11.96	9.60	9.05
Bone-dry break.....	20.08	21.43	22.85
Stretch at 10%.....	6.05	5.25	5.08
Stretch at break.....	10.10	8.50	8.50

¹ Regular heat resistant saturated only.

² Saturated and stretched.

³ Saturated, stretched, and compressed.

It will be apparent from this table that where the yarns are saturated only, the bone-dry break is slightly less than the break at normal moisture

content; and that the stretch at bone-dry break is also less than at normal moisture content break. The same condition holds substantially when the cord is stretched in addition to being saturated. When the yarns are saturated, twisted, stretched and compressed, test #3 actually shows an increase in bone-dry break over the break at normal moisture content, and shows a decrease in stretch at bone-dry break.

In attaining the above results, the cord was subjected to a stretch barely short of the breaking point. This stretch was determined by subjecting the cords to tensions under which they broke, and reducing these tensions by small degrees to that tension just barely short of the breaking point. The stretch which any given yarn or cord will bear, will naturally vary with the size, quality, and structure of the yarn or cord.

The advantages resulting from the practice of this process in the production of heat-resistant yarns and cord are apparent, when it is considered in connection with the established fact that the tensile strength in yarn and cords produced by prior processes decreases a matter of about 6% for every 1% decrease in moisture content from the normal moisture content for testing of about 6.5%. As a result of this discovery, we are able, by the process described, to produce a yarn, twine, cord, or other fabric composed of cotton fibres and cotton yarn that will resist the deteriorating and destroying effects of high temperature; which products can be incorporated in various articles of manufacture designed for use under conditions where high temperatures are either produced in the normal conditions of use of the articles, or where the product is to be used under conditions subjecting it to high temperatures. As a result, it is evident that such articles will have a longer life of usefulness than has been previously obtained by any known process of manufacturing cotton fibres into such products and articles.

In the specification and in the claims of this case, the word "yarn" or "yarns" means any single yarn or any plied yarn composed of any number of single yarns plied or folded together; and the word "cord" means any number of plied yarns twisted into a cord or cable.

The present invention is an improvement on the invention disclosed in said copending application Serial No. 43,454. In the manufacture of automobile tires, they must be subjected to a vulcanizing process in which the cotton materials used in the carcass of the tire are subjected to a temperature approaching 300° F. When said tires are in use at high speeds, the heat generated in said tires also approaches 300° F. It is well known that ordinary tire cords after being subjected to such heat are never as strong as they were prior thereto. In further experiments involving the use of latex as the saturating agent, I have found that after subjecting the yarn or cord to temperatures comparable to those to which said yarn or cord is subjected in vulcanization and in use in automobile tires, if the yarn or cord is permitted to recover its normal moisture content that its strength is greater than it was before its subjection to such heat and that the percentage of its recovery of strength is much greater than is that of a cord not saturated with latex. There is set out below a table of tests showing the recovery value of cord manufactured in the normal way, of cord manufactured as disclosed in copending application Serial No. 43,454,

and of cord manufactured by the present invention:

	1	2	3	4
	Percent	Percent	Percent	Percent
Tire cord *	100	96.2	95.7	89.8
Tire cord *	100	101.5	98.3	96.3
Latex saturated tire cord *	100	104.8	103.2	101.5

* Manufactured in the usual manner.

* Manufactured as disclosed in application Serial No. 43,454.

* As disclosed in this application.

1. Cord conditioned in a standard atmosphere.
2. Cord heated to 300° F. for two hours and conditioned in a standard atmosphere.
3. Cord heated to 300° F. for six hours and conditioned in a standard atmosphere.
4. Cord heated to 300° F. for twelve hours and conditioned in a standard atmosphere.

In carrying out the experiments with latex as a saturating agent, the same steps of saturating, twisting, stretching under tension barely short of the breaking point, and compression, were employed, as in the case where other liquids than latex were used for saturating purposes.

Where latex has heretofore been applied to cotton materials a complete penetration by the latex has not been accomplished and the cotton materials have not become a component part of the rubber, but there has been a tendency for the cotton materials and the rubber to separate under heat, flexing, strains or stresses, which permitted the cotton materials to slip from their intended position so that the strength of the rubber article so manufactured has been impaired. I have found, in addition to the other advantages set out, that cotton material manufactured by my process overcomes this objection by reason of the fact that the latex has penetrated to the very heart of the cotton material and when the cotton material and the rubber with which it is combined is vulcanized the latex impregnating the fibres of the cotton material fuses with the adjacent rubber so as to form a homogeneous mass and make the cotton a component part of the mass which prevents the separation of the cotton material and rubber under heat, flexing, strains or stresses.

In my copending application Serial No. 44,300 filed October 9, 1935, I have disclosed an apparatus peculiarly adapted for saturating cotton yarns and cords with latex, and for controlling the percentages of rubber to be retained in the finished products. The invention is not to be considered as limited to processes involving the saturation of fibrous yarns and cords by any particular process or apparatus, notwithstanding the fact that the aforesaid latex saturating apparatus is the only one provided with means for thoroughly impregnating fibrous materials and controlling the percentage of latex to be retained in the finished yarns or cords.

The latex-impregnated, heat-resistant yarns and cords are designed to be manufactured into vulcanized rubber articles, such as automobile tires, rubber belting and similar articles. If found desirable, or necessary, vulcanizing materials may be added to the latex bath for impregnating the yarns or cords. Usually, however, it will not be necessary to add such vulcanizing materials. The usual coating of rubber applied to yarns, cord or fabric, will ordinarily carry sufficient vulcanizing ingredients to permeate the latex of the impregnated yarns, cords or fabric and effect

the vulcanization thereof in the usual process of manufacturing vulcanized rubber articles.

As used herein, the term "latex" means rubber latex, a water dispersion of latex, and any dispersion, emulsion or solution of rubber or other gums, or any combination of such substances. The commercial product includes a small percentage of ammonia to preserve it and prevent coagulation in transit and storage. The small amount of ammonia in commercial latex has been found sufficient to maintain the surface tension of the latex at such a point as to give instant penetration of the yarns without the use of additional "wetting" agents.

Having thus described my invention, what I claim is:

1. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with latex, twisting the saturated undried yarns under tension just short of breaking point, and stretching the twisted yarns, or cord.

2. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with latex, and twisting the saturated undried yarns under tension just short of breaking point.

3. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with latex, twisting the latex saturated undried yarns under tension just short of breaking point, and stretching and compressing said twisted yarns or cords.

4. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with latex, twisting the saturated undried yarns under tension just short of breaking point, and compressing said twisted yarns or cord.

5. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarn with latex, cabling said plied yarn while saturated, under tension just short of breaking point, and stretching the cabled yarn.

6. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarn with latex, and cabling said plied yarn while saturated under tension just short of breaking point.

7. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarn with latex, cabling said plied yarn while saturated, under tension just short of breaking point, stretching and compressing the cabled yarn.

8. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarn with latex, and cabling said plied yarn while saturated under tension just short of breaking point and compressing the cabled yarn.

9. The process of manufacturing rubber articles having cotton yarns as a part thereof, which consists in impregnating the yarns with latex, twisting the impregnated undried yarns under tension just short of breaking point and combining said yarns with rubber to construct the rubber article and vulcanizing the rubber content of such article.

10. The process of manufacturing rubber articles having manufactured cotton materials as a part thereof, which consists in impregnating the individual yarns in such materials with latex, twisting the impregnated undried yarns under tension just short of breaking point, and combining the materials manufactured therefrom with rubber to construct the rubber article and vulcanizing the rubber content of such article.

11. The process of manufacturing rubber articles having cotton yarns as a part thereof, which consists in impregnating the yarns with latex, twisting the impregnated undried yarns under tension just short of breaking point, stretching the twisted yarn and combining said yarns with rubber to construct the rubber article and vulcanizing the rubber content of such article.

12. The process of manufacturing rubber articles having manufactured cotton materials as a part thereof, which consists in impregnating the individual yarns in such materials with latex, twisting the impregnated undried yarns under tension just short of breaking point, stretching the twisted yarn, and combining said yarns with rubber and combining the materials manufactured therefrom with rubber to construct the rubber article and vulcanizing the rubber content of such article.

13. The process of manufacturing rubber articles having cotton yarns as a part thereof, which consists in impregnating the yarns with latex, twisting the impregnated undried yarns under tension just short of breaking point, stretching the twisted yarn, compressing the twisted and stretched yarn, and combining said yarns with rubber to construct the rubber article and vulcanizing the rubber content of such article.

14. The process of manufacturing rubber articles having manufactured cotton materials as a part thereof, which consists in impregnating the individual yarns in such materials with latex, twisting the impregnated undried yarns under tension just short of breaking point, stretching the twisted yarns, compressing the twisted and stretched yarns, and combining the materials manufactured therefrom with rubber to construct the rubber article and vulcanizing the rubber content of such article.

15. A heat resistant rubber impregnated cotton yarn, the natural gums and waxes of which have been softened by saturation with rubber latex and re-hardened, and having substantially constant tensile strength during all changes of moisture content from normal to bone dry, and having substantially lower stretch and diameter than normally processed rubber coated cotton yarn containing the same quantity of cotton per unit length.

16. A heat resistant rubber impregnated cotton cord, the natural gums and waxes of which have been softened by saturation with rubber latex and re-hardened, and having substantially constant tensile strength during all changes of moisture content from normal to bone dry, and having substantially lower stretch and diameter than normally processed rubber coated cotton cord containing the same quantity of cotton per unit length.

EUGENE C. GWALTNEY.