Patented Dec. 21, 1937 2,103,218

UNITED STATES PATENT OFFICE

2,103,218

HEAT-RESISTANT YARN AND HEAT-RESISTANT CORD AND PROCESS FOR MAKING SAME

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No Drawing. Application October 3, 1935, Serial No. 43,454

22 Claims. (Cl. 117—2)

The invention forming the subject matter of this application is a heat-resistant cotton yarn and heat-resistant cotton cord, particularly designed for use in automobile tires, belting, 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 a process of manufacturing this yarn and cord.

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 petitioners' 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 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 our efforts to produce a yarn or cord which

would maintain its tensile strength substantially constant throughout the various temperature ranges to which it may be subjected we discovered that when yarn spun of cotton processed throughout the mill in the normal way was saturated, twisted, stretched and compressed, we 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.

We found that we could saturate the single yarn before twisting it into plied yarn where the plied yarn was to be the finished product, or that where the plied yarn was to be twisted into cord we could saturate the plied yarn before twisting it. We 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. We 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 compressin. We 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. We 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" we mean that elemental cotton fibres have absorbed or taken up liquid to such an extent that the internal stresses or strains of the fibers 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 we state that the saturated cotton yarn is twisted we mean that said yarn may be twisted in the usual manner or may be twisted under greater than normal tension or stretch. When we refer to "tension" or "stretch" we mean 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 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" we mean 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 our 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, we have 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	#2	#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.

What we claim is:

1. The process of manufacturing heat resistant cotton cord which consists in twisting single cotton yarns into a ply, saturating the plied yarns to soften the natural gums and waxes of the cotton fiber, and twisting while wet the saturated plied yarns under tension just short of breaking point to fuse the fibers with the softenend gums and waxes retained therein.

2. The process of manufacturing heat resistant cotton cord which consists in twisting single cotton yarns into a ply, saturating the plied yarns to soften the natural gums and waxes of the cotton fiber, twisting the saturated plied yarns under tension just short of breaking point to fuse the fibers with the softened gums and waxes retained therein, and compressing the cord resulting from the saturation, twisting and stretching of the plied yarns.

3. A heat resistant cotton yarn in which the cotton fibers are compacted by twisting and stretching while the natural gums and waxes of the fibers are softened by saturation, and having substantially constant tensile strength during all changes of moisture content from normal to bone dry, and having a substantially lower stretch and diameter than normally processed cotton yarn containing the same quantity of cotton per unit length.

4. A heat resistant cotton cord in which the cotton fibers are compacted by twisting and stretching while the natural gums and waxes of the fibers are softened by saturation, and having substantially constant tensile strength during all changes of moisture content from normal to bone dry, and having a substantially lower stretch and diameter than normally processed cotton cord containing the same quantity of cotton per unit length.

5. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with non-cotton-destroying and non-coating liquid, twisting the wet saturated yarns, and stretching the wet twisted yarns or cord under tension just short of breaking point.

6. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with non-cotton-destroying and non-coating liquid, and twisting the wet saturated yarns under tension just short of the breaking point.

7. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with non-cotton-destroying and non-coating liquid, twisting the wet saturated yarns, stretching the wet twisted yarns under tension just short of the breaking point, and compressing said stretched yarns or cords.

8. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in saturating cotton yarns with non-cotton-destroying and non-coating liquid, twisting the wet saturated yarns under tension just short of the breaking point, and compressing said twisted and tensioned yarns or cord.

9. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarns with a non-cotton-destroying and non-coating liquid, cabling said wet plied yarns to form a cord, and stretching said cord under tension just short of the breaking point.

10. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarns with a non-cotton-destroying and non-coating liquid, and cabling the wet plied yarns under tension just short of the breaking point.

11. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarns with a non-cotton-destroying and non-coating liquid, cabling said wet plied yarns to form a cord, stretching the wet cabled cord under tension, just short of the breaking point, and compressing said stretched cord.

12. The process of manufacturing a heat-resistant cotton yarn or cord, which consists in twisting the single yarns into a ply, saturating the plied yarns with a non-cotton-destroying and non-coating liquid, cabling said wet plied yarns under tension just short of the breaking point to form a cord, and compressing said cord.

13. The process of manufacturing a heat-resistant cotton cord which consists in twisting single yarns of cotton to form plied yarns, saturating the plied yarns with non-cotton-destroying and non-coating liquid, twisting the wet plied

yarns to form a cord, and stretching the plied yarns during the twisting thereof under tension just below breaking point.

14. The process of manufacturing a heat-resistant cotton cord which consists in twisting single yarns of cotton to form plied yarns, saturating the plied yarns with non-cotton-destroying and non-coating liquid, twisting the plied yarns to form a cord, stretching the plied yarns during the twisting thereof under tension just below breaking point, and compressing the twisted and stretched cord.

15. A heat resistant cotton yarn, the natural gums and waxes of which have been softened and rehardened, 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 cotton yarn containing the same quantity of cotton per unit length.

16. A heat resistant cotton cord, the natural gums and waxes of which have been softened and rehardened, 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 cotton cord containing the same quantity of cotton per unit length.

17. A heat resistant cotton yarn, the natural gums and waxes of which have been softened by saturation and rehardened, 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 cotton yarn containing the same quantity of cotton per unit length.

18. A heat resistant cotton cord, the natural gums and waxes of which have been softened by saturation and rehardened, 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 cotton cord containing the same quantity of cotton per unit length.

19. Tensioned cotton thread or cord, the individual yarns of which are stretched to substantially their breaking point and permanently maintained in a stretched condition by the rehardening of the previously softened natural gums and waxes of the cotton around the individual yarns and fibers thereof.

20. The method of treating cotton yarns, threads, cord and the like which comprises: saturating said yarns, threads, cord and the like to soften the natural gums and waxes thereof; stretching the saturated yarns, threads, cords and the like substantially to the breaking point while the said gums and waxes are softened, to place the individual elements composing said yarns, threads, cord or the like under substantially uniform tension; and permanently setting the yarn, thread, or cord or the like in a stretched condition by hardening the natural gums and waxes around the individual yarns and fiber.

21. The process of manufacturing heat resistant cotton yarns, threads, cords and the like which consists in saturating said yarns, threads, cords and the like to soften the natural gums and waxes thereof; and twisting said saturated yarns, threads, cords and the like, while the said gums and waxes are softened, under tension just short of the breaking point, to fuse the cotton fibers with the softened gums and waxes retained therein.

22. The process of manufacturing heat resistant cotton yarns, threads, cords and the like which consists in saturating said yarns, threads, cords and the like to soften the natural gums and waxes thereof; and twisting said saturated yarns, threads, cords and the like, while the said gums and waxes are softened, under tension just short of the breaking point, to fuse the cotton fibers with the softened gums and waxes retained therein and compressing the threads or cords resulting from the saturation and twisting under tension of said saturated yarns, threads, cords and the like.

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