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APPARATUS FOR MEASURING TORQUE IN YARN

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FIG. 1.

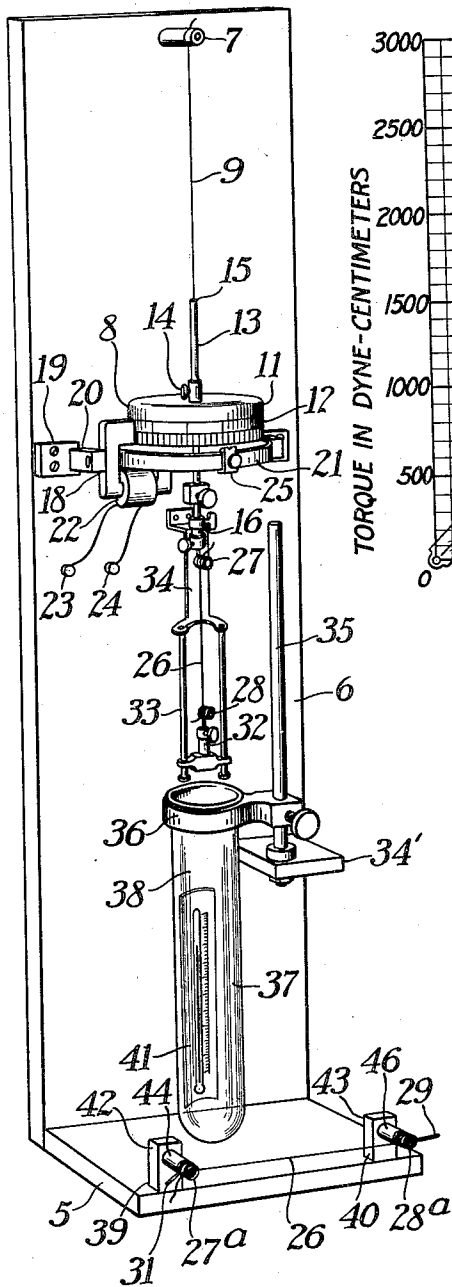


FIG. 2.

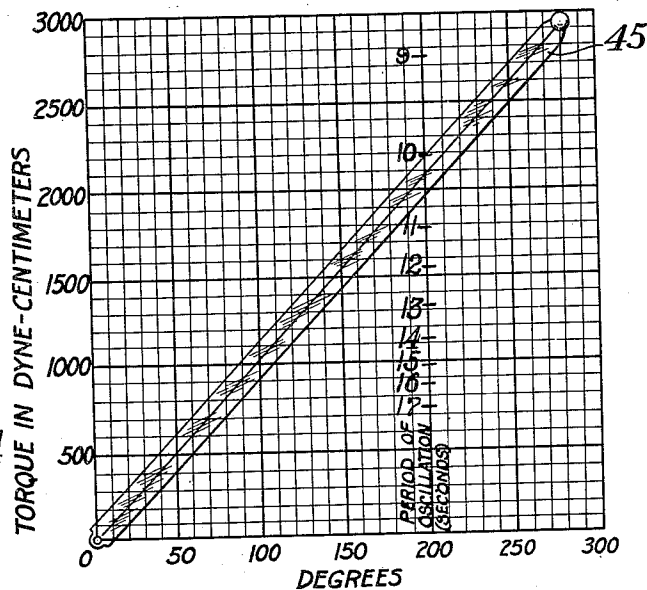
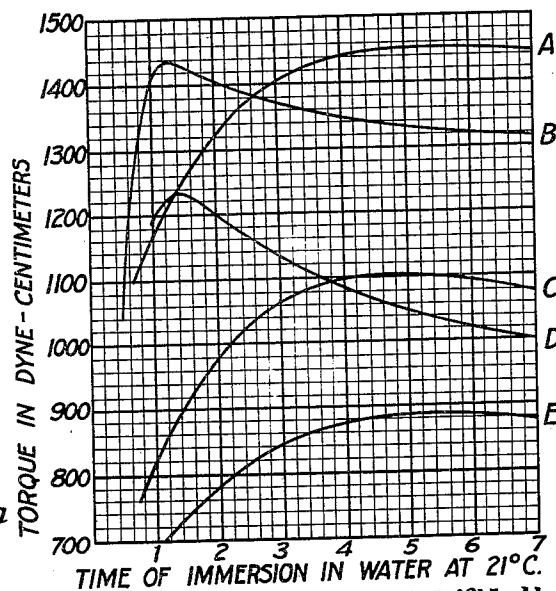


FIG. 3.



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APPARATUS FOR MEASURING TORQUE IN YARN

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4 Claims. (Cl. 73—51)

This invention relates to the manufacture of crepe fabrics and more particularly to apparatus for measuring the potential torque of a twisted yarn employed in making crepe fabrics when the yarn is subjected to a torque releasing medium.

In the experimental development of cellulose acetate crepe yarns, and in its quantity production, it is desirable to know whether a given type of yarn will produce a good pebble without the necessity of employing the lengthy process of weaving a sample of the yarn into cloth and subjecting the cloth to the "boiling off" operation. This is especially true since, until my investigations, several of the factors which affect the character of the pebble in crepe yarn were not understood and consequently not adequately controlled. In some cases the employment of yarn susceptible of being made into excellent crepe fabrics, thru lack of means for accurately determining its inherent crepeing propensity, resulted in a crepe fabric of inferior quality.

Heretofore, in connection with the manufacture of crepe materials various theories have been advanced as to the reasons for the production of the so-called crepe effect in cloth. A commonly accepted theory is that the cockled or crinkled crepe effect is primarily due to the shrinkage of certain of the twisted yarns of a suitable material when they are immersed in a liquid or treated with other special processes.

Attempts have been made by investigators in accordance with the "shrinkage" theory to measure the creping ability of silk and rayon crepe based on the contraction of the yarn in a hot soap solution before it is made up into cloth. However, when it comes to defining more precisely the mechanism of shrinkage, the literature either omits the question or explains it as a "lateral swelling of the filaments and hence a shrinkage." The generally accepted explanation of creping is a hazy notion that the yarn shrinks in the same way as a tent rope shrinks when wet and that the pebble is a "crinkling, cockling and crumpling due to the shrinkage."

I have found, however, that a true shrinkage mechanism cannot cause shrinkage of the order of 30-40%, which is observed when the crepe is "boiled off" nor can shrinkage alone produce the surface distortion known as pebble, and that consequently the shrinkage tests previously used in the art cannot be relied upon as indicators of the pebbled appearance which the material will have when completely processed.

I have found "shrinkage" is due to the fact that the process of "boil off" makes the straight form of the filling thread, as it exists in grège goods, an unstable form and that a helical form is the stable form of less potential energy which it takes up during the process. The pebble is no random chance buckling or cockling but a pe-

riodic and regular distortion of warp threads as they follow the filling threads into their new form. The appearance of the pebble, I have discovered, depends on the pitch and diameter of the helix formed, on the resistance to the warp to bending, and on the number of coincident threads of like twist and pick count.

The shrinkage is the consequence of the original straight form going over into a helical form, the length along the center of the helix being, of course, shorter than the length along the helical curve, which remains about the same as the length of the yarn in the original grège goods, there being no appreciable shrinking of the yarn itself. That it bears little relation to pebble is proved by the fact that the same "shrinkage" may be achieved by different combinations of helix pitch and diameter, each combination resulting in a different pebble character.

The process of wet twisting sets up certain restoring forces in the yarn which try to untwist it. As the yarn dries out after twisting, these restoring forces are completely balanced by other forces of a different type, characterized by being dissipated by water and reappearing as the water is removed. Thus the crepe yarn as it exists in the grège goods behaves like untwisted yarn, for the twist is set or locked. This yarn contains potential energy of torsion, stored in intra or intermicellar bonds unaffected by the presence of water. The process of boil off releases this potential energy and causes the development of a torque which would untwist the yarn were it removed from the fabric. Being woven in the cloth, however, it cannot untwist but its tendency to do so produces the pebble effects depending on the amount of potential torque existing in the yarn.

This effect is comparable with and may be explained by the theory of the mathematics of the resistance to bending offered by a metal rod. The best description to be found in the literature is that by A. G. Greenhil, Proceedings Institute Mechanical Engineering, 1883 and discussed by Love, Mathematical Theory of Elasticity 4th ed. While I do not wish to be limited to this theory, it appears from my work that it is a good basis on which to study and determine the potential torque of yarns.

Since the assumption of a helical form is the basis of crepe pebble, a better measure of creping quality is one which measures the tendency of the twisted yarn to assume the helical form upon "boil off". As my research has shown the torque of the softened twisted yarn is directly related to this tendency and hence to its creping ability.

An object of the present invention is, therefore, a device for accurately indicating the creping characteristics of yarns.

Another object of the invention is a novel ap-

paratus for determining the degree of torque in crepe yarns.

Still another object of the invention is a device for determining the degree of torque in yarns made without employing tension during twisting.

In accordance with the invention these and other objects are attained by wet twisting one or more yarns, from which crepe can be made, a predetermined number of times, drying the yarn, and measuring the potential or residual torque of the yarn.

To establish a standard of comparison similarly twisted yarns containing the same potential torque are woven into cloth in the desired manner and submitted to a standard "boil off" process and the crepe and pebble appearance noted.

I have found that there is a definite correlation between the amount of releasable torque in the yarns and the pebble or crepe effects in the finished material and that by regulating the amount of potential torque various crepe effects are possible of reproduction. Preferably I measure the potential torque of the yarn in my novel torque measuring apparatus which is provided with means for releasing the torque and for registering the released force.

The invention will be more clearly understood from the following detailed description and drawing in which:

Fig. 1 is a view in elevation of my preferred torque measuring device;

Fig. 2 is a chart giving the yarn torque in dyne centimeters from the rotation of the torque measuring scale.

Fig. 3 is a graphical representation showing the relation between the amount of torque and time of immersion in the torque releasing medium to the resulting pebble.

Referring to Fig. 1 there is shown the torque measuring apparatus mounted on a base support 5, and a vertical support 6. On the vertical support 6 is mounted a supporting member 7 from which the torque indicating device 8 is suspended by a standard torsion wire 9. The torque indicating device 8 comprises a cylindrical drum 11 having a scale 12 on its circumference, and supporting rod 13 passing through its center and fastened thereto by thumb screw 14. At the upper end of the rod, 13, as shown at 15, the standard torsion wire 9 is fastened. It will be understood that other standard torsion means such as a rod or tape may be used in place of a wire. On the lower end of rod 13 is fastened a double collar and thumbscrew device 16. Associated with cylindrical drum 11 is an electromagnet 18 which is held out of contact with the drum 11 by supporting members 19 and 20. The magnet is energized by the associated coil 22 by attaching a suitable source of current to the binding posts 23 and 24. A zero point is located by an indicator 25 which is mounted on a circular supporting member 21. The zero point indicator can be adjusted by loosening its associated thumbscrew and moving the indicator to the right or left as desired.

The yarn 26 to be tested for potential torque is held between the turns of spiral springs 27 and 28. The positioning of the yarn in springs 27 and 28 is described in more detail hereinafter. The straight ends 29 and 31 of the springs being fastened in the collar and thumbscrew devices 16 and 32 respectively, the latter of which is attached to a frame-like member 33 which in turn is fastened to supporting member 6 by a strap 34. The framelike member 33 prevents the lower end

of the thread from untwisting thereby causing the released torque to be exerted at the opposite end of the thread and to turn the torque indicating device 8 against the opposing force of the standard torsion wire 9 and to indicate the amount of torque on the scale 12.

A ring stand support 34' and supporting rod 35 is attached to vertical support 6. A suitable ring member 36 is associated with rod 35 and can be positioned up and down the rod as desired. A glass tube 37 (or other such receptacle) is held in the ring member directly under the thread holding apparatus. The tube contains a suitable torque release medium 38, for example water, and by raising the tube the apparatus is immersed in the liquid and the torque released.

The operation of placing the strand of yarn to be tested in the yarn holding springs may be simplified by employing the auxiliary spring holding members 39 and 40 which may be mounted on the support 5. These members comprise a support member 42 and 43 a threaded rod 44, and 46 respectively on which the springs 27a and 28a may be partially screwed. The yarn is then forced between the helical turns of the spring and tightly clamped thereby. As will be clear in the drawing, by maintaining these springs at a constant distance apart a standard length of yarn can be placed between the yarn holders quite easily. In general substantially no tension is exerted on the yarn it being only drawn enough to take up any slack in the yarn. The springs do not have to be unscrewed, since they are only turned on posts 44 and 46 a short distance and, owing to the shallow thread on the screws and the pliability of the springs, they can be easily slid off the posts without unscrewing. As will be understood, this is only one of the many expedients which might be employed to hold the springs while the yarn is placed thereon.

A satisfactory method of measuring the torque of crepe threads comprises placing four parallel crepe threads between the spring holders 27a and 28a and measuring their torque. The torque measurements given hereafter refer to measurements on four such parallel yarns. For example, a suitable 150 denier crepe yarn may be noted as having a torque of 1600, which means that four parallel strands develop a torque of 1600 dyne centimeters. The torque measured on a single strand is 400 dyne centimeters. In obtaining these and the other measurements given hereafter, I employed a .004 inch diameter steel piano wire and the length of the yarn was approximately 10 centimeters.

The straight ends of the springs (as shown at 27 and 28) are then placed in the holders 16 and 32, care being taken to place substantially no position tension on the yarn.

The torque releasing liquid is brought to a desired temperature, for example 20 to 25° C., which is indicated on the thermometer 41 and the thread is immersed in the liquid by raising up tube 37. Since the lower end of the yarn is not free to turn but the upper end is, the released torque will be exerted at the upper portion of the apparatus and turn the indicator drum 11 a certain number of degrees. To prevent violent oscillation, the electromagnet 18 may be actuated to serve as a magnetic damping device. While I prefer to employ a magnetic damping device, I do not wish to be limited to this arrangement for I may also employ other suitable damping mechanisms such as mechanical damping devices.

The chart shown in Fig. 2 permits the reading

of the yarn torque in dyne centimeters from the angular rotation of the drum. This chart is fitted with movable arm 45 and a scale of period of oscillation of the drum. This allows the wire suspension to be changed in length without any recalculation of torsional constants.

To set the movable arm 45 of the chart at the proper place, the period of oscillation of the drum as it hangs from the wire 9 is measured and the arm set at that value on the scale for the period of oscillation.

To obtain the period of oscillation, the wire and drum are raised above magnetic damping coil and set turning. The time of ten complete vibrations divided by ten gives the period of oscillation with sufficient accuracy. In turning, the clamp 16 used to hold the upper spring 27 should be removed. As above suggested, the arm 45 is then moved so that its indicating line will intersect the indicating line of the scale of the period oscillation at the determined period.

When the yarn to be tested is placed as above described in the testing position in the apparatus and is immersed in the liquid in tube 37, the released torque will rotate drum 11 and the degree of rotation can be noted on scale 12. This reading can be found on the abscissa chart and the point of intersection on the indicating line on arm 45 will determine the torque reading on the ordinate.

If yarns are encountered which give deflections too large for the chart scale, the wire should be shortened until the deflections fall between 100 and 300 degrees. It will be understood that more than one strand of yarn may be employed for the test, for example, in some instances it may be desirable to employ four strands of yarn together instead of a single strand.

In setting the zero index, a piece of untwisted (half turn) yarn should be clamped in the instrument in the usual way and the damping coil turned on. The rest portion of the disc under these conditions is the true zero. It will be found that with crepe yarns in place, before they are immersed in water, the disc will not be at the true zero. This is because the weight of the lower clamp stretches the yarn somewhat and tries to untwist it. This displacement however, may be disregarded and consistent results are obtained by using the zero point obtained as above described with untwisted thread.

For usual torque measurements the tube 37 is filled with water and maintained at a temperature of 20-25° C. The torque developed during actual boil off conditions is lower than that developed in water but the two are approximately proportional. Since the use of water at room temperature is both simpler and more precise, torque values will be referred to this procedure.

I have discovered by employing my novel torque measuring device that the torque value which a 100 denier yarn should have to produce good pebble in crepe should be over 500 dyne centimeters after five minutes in the water (four strands of yarn), and preferably should be about 700 dyne centimeters. For a 150 denier yarn the potential torque value should be over 1300 dyne centimeters and preferably about 1400 dyne centimeters. For a 200 denier yarn the lower value is about 1600 dyne centimeters and the optimum value about 1900 dyne centimeters. A yarn which exhibits good torque at first and then rapidly falls away will not produce good pebble because this falling off of torque is accentuated in the boil off liquor.

The curves in Fig. 3 in which torque is plotted against time of immersion in water at 21° C. are based on tests on 150 denier yarn and show examples of tests on good and poor creping yarns. Curve A yarn will produce excellent pebble; curve B yarn will produce good pebble, curve C and D yarn produce poor pebble and curve E yarn produce almost no pebble.

Since the torque obtained depends on the previous conditioning of the yarn, for consistent results all yarns employed should be conditioned at the same relative humidity and temperature. To show the effect of moisture on the torque, a yarn was measured thirty minutes after removal from the twisting, after standing twenty hours in 60% relative humidity, and after standing twenty hours over calcium chloride. The torque values were 1100, 1450, and 1530 dyne centimeters, respectively.

It will be understood that the above described testing device may also be used in making yarns from other cellulose organic acid esters, in addition to cellulose acetate, for example cellulose acetate propionate and cellulose acetate butyrate, as well as from cellulose ethers and other like materials. By employing my invention for predetermining the surface characteristics of crepe fabrics I have found that superior and easily duplicable crepe materials can be made both from natural and artificial yarns, such as cellulose acetate yarns. Whereas, up to the present invention no consistent control of the pebble was known, primarily because the methods of control were based on erroneous theories, this invention permits very consistent control and materially aids in the production of crepe fabrics.

What is claimed is:

1. In a measuring device for measuring the potential torque in twisted yarns, standard torsion means, a scale for indicating angular rotation of said standard, means for attaching one end of the yarn to be measured to said standard, means for fixedly holding the other end of the yarn and means for releasing the potential torque whereby said standard means is rotated.

2. In a measuring device for measuring the potential torque in twisted yarns, standard torsion means comprising a wire, a rotatable scale attached thereto, rotatable clamping means associated with said scale for supporting one end of the yarn to be tested, fixed clamping means for holding the opposite end of said yarn, and means for releasing the potential torque whereby said standard means is rotated.

3. In a measuring device for measuring the potential torque in twisted yarns, standard torsion means comprising a steel wire, a rotatable drum indicator suspended therefrom, a rotatable clamp associated therewith for supporting one end of the yarn to be tested, a fixed clamp for holding the opposite end of said yarn, and a container holding a liquid for releasing the potential torque of said yarn when it is immersed therein whereby said standard means is rotated.

4. In a measuring device for measuring the potential torque in twisted yarns, standard torsion means comprising a steel wire, a rotatable scale attached thereto and free to oscillate, clamping means comprising a coiled spring associated with said scale for supporting one end of the yarn to be tested, fixed clamping means also including a coiled spring for holding the opposite end of said yarn, and means for releasing the potential torque whereby said standard means is rotated.

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CERTIFICATE OF CORRECTION.

Patent No. 2,154,631.

April 18, 1939.

JAMES G. McNALLY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 51, for the word "quality" read ability; page 2, second column, line 59, for "position" read positive; page 3, first column, line 27, after "abscissa" insert of the; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of September, A. D. 1939.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.