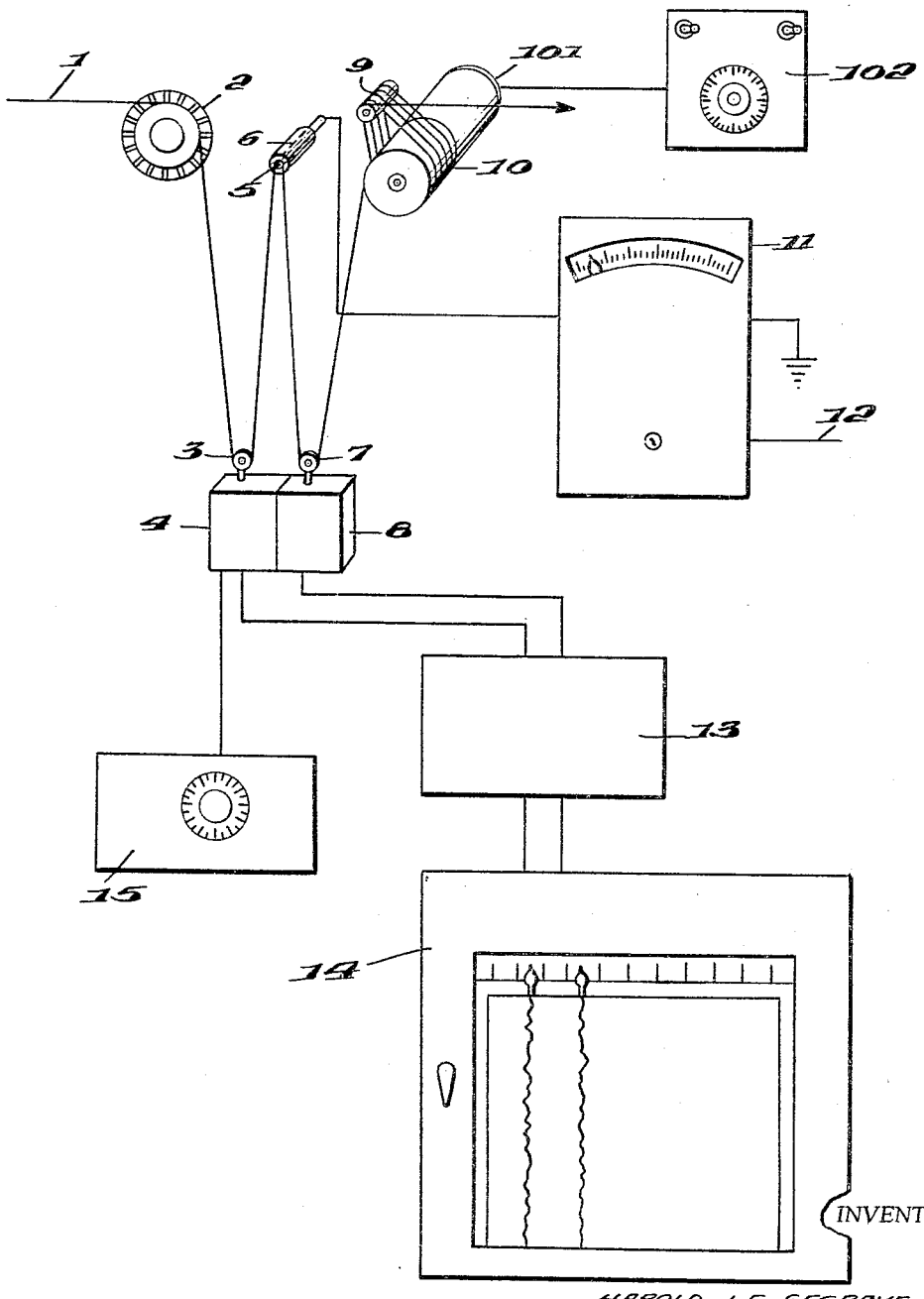
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METHOD FOR SIMULTANEOUSLY MEASURING FRICTIONAL PROPERTIES AND STATIC GENERATION RATE OF YARN

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METHOD FOR SIMULTANEOUSLY MEASURING FRICTIONAL PROPERTIES AND STATIC GENERATION RATE OF YARN

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This invention relates to a method for measuring factors affecting textile processibility of yarn and, more particularly, to a method for the simultaneous measuring of frictional properties and static generation rate.

The resistance of running yarn to passage over a guide surface or over another yarn is of great importance to the efficiency of textile processing and to the quality of the resultant products. A proper level of resistance (or friction) is essential to proper textile processing. Too little resistance may well result in loss of process control and can lead to non-uniform fabrics whereas an excessive level of friction may lead to broken filaments. Moreover, a uniform level of tension on the yarn must be maintained in order to avoid variations in response to given textile machine settings, a possible result being unacceptable unevenness in the final fabric.

With respect to the static generation rate, most synthetic yarns and animal fibers tend to develop an electrostatic charge when processed through the usual textile operations. Also, for a given type of fiber, such charges are of the same sign which, of course, results in individual filaments tending to repel each other and leads to flaring of the individual filaments in continuous filament yarn with the concomitant loss of control, mechanical damage and non-uniform fabric product. In textile processing of staple, static charge leads to loss of filaments from the yarn, non-uniform drafting and an uneven final yarn.

Control of both friction level and static generation can be had by such methods as application of textile finishes to the yarn, selection of the optimum guiding surfaces and varying the surface characteristics of the yarn itself. Convenient means to establish directly the effect of changes in the above-mentioned factors on the friction level and static generation would be extermely advantageous to textile processers.

Accordingly, an object of this invention is to provide a method for simultaneously measuring yarn friction levels and static generation rate over the entire range of yarn speeds and tension levels normally encountered in textile processing. Other objects will appear hereinafter.

The objects of this invention are accomplished by a method which comprises, in general, forwarding yarn at a controllable, predetermined rate of speed within a predetermined speed range, placing a predetermined input tension on the yarn, measuring said predetermined input tension, passing said yarn over a stationary, snubbing test surface, measuring and recording the static charge developed by the yarn passing over the test surface, measuring the output tension on the yarn at a point after the yarn has passed over the test surface and recording the measured input and output tensions.

The accompanying drawing illustrates a block diagram of apparatus to accomplish the novel method of this invention.

Referring to the drawing, yarn **1** from a source not shown, is threaded over pretensioner **2**. The pretensioner can be made in accordance with the principles illustrated in chapter 11 and more particularly page 216, of Friction Textiles (Butterworth's Scientific Publications, 1959). Such a pretensioner may internally comprise a ring of a permanent magnetic material (rotor) which rotates with

a pulley in the field of a strong fixed magnet. This causes hysteresis in the rotor, which is same at all speeds. The tension level is varied by changing the distance of the permanent magnet from the rotor, the value of the induced magnetic field being thereby changed and producing a corresponding braking effect. Yarn **1** then passes around roller guide **3** of input tension measuring strain gauge **4** which can be constructed in accordance with the principles disclosed in chapter 11 of Friction Textiles. Yarn **1** then passes around stationary, snubbing test surface **5**, which is mounted in an electrical insulator **6**, and then around roller guide **7** of output tension measuring strain gauge **8**. The yarn then passes through several wraps around separator roll **9** and forwarding roll **10**, driven by a conventional DC motor **101** whose speed is controlled over a speed range of 10:1 by conventional variable-transformer-rectifier **102**, and finally to take-up means not shown. Additional range in speeds can be obtained by use of forwarding rolls **10** of varying diameters. DC source **15**, which is continuously adjustable over the range of 0 to 12 volts, activates strain gauges **4** and **8**. Yarn speed is measured by an electrical tachometer not shown. The static charge developed in the yarn as it slides across the test surface **5** results in an equal carge of opposite sign in test surface **5**, which charge is bled to ground through micro-microammeter **11**, which provides an indication of the amount of current flow. Alternatively, if desired, the amplified signal indicated at **12** may be fed to a suitable recorder to provide a permanent record of the current generated during testing. The strains measured by strain gauges **4** and **8** are fed to dual DC amplifier **13** and the amplified signal is recorded on a conventional strip-chart recorder **14**. For measurement of yarn-to-yarn friction, test surface **5** is replaced by a small package of yarn, preferably wound with a reciprocating yarn traverse to provide a non-circumferential lay-down of the yarn.

The operation of the apparatus hereinbefore illustrated can be readily understood. The yarn, being advanced at a controlled rate of speed, passes into a pretensioner which places a predetermined tension on the yarn. This predetermined tension is measured by means such as a strain gauge and the yarn then passes around a snubbing stationary test surface after which the tension is again measured. The friction level can be easily ascertained by use of the belt equation which the textile art has long recognized as being applicable to snubbing surfaces. This equation is as follows: $T_2=T_1^{\alpha f}$ wherein T_2 is delivery tension, T_1 is input tension, α is the angle of wrap on the snubbing, stationary pin and f is the coefficient of friction of the yarn over the snubbing surface at the speed of yarn travel employed (Marks, Mechanical Engineers' Handbook, 5th edition, page 228). Since T_1 and T_2 have been been measured and the angle of wrap (α) can easily be ascertained, friction level can be readily computed. The static generation rate is directly measured by measuring the amount of current developed in the test surface as the yarn passes over.

The extremely wide range of precisely controlled speeds provided by the novel method of this invention is essential to a complete understanding of the frictional and static generating properties of yarns during all stages of textile processing. The slowest speeds, i.e., from about 0.001 yard/minute to about 100 yards/minute, are necessary to provide a prediction of fiber-to-fiber interactions during staple carding and drafting operations. The higher speeds, i.e., from about 50 yards/minute to about 500 yards/minute, are necessary to furnish an indication of performance of continuous filament yarns in such operations as winding and weaving. Similarly, it is necessary to be able to place, on the yarn, tensions within the

range of from about 2 grams/denier to about 30 grams/denier, the higher tensions generally being more useful in the measurement of friction at extremely low speeds. Empirical relationships can then be developed between processing performance in specific textile operations and the characteristics of friction and static generation at the appropriate levels of speed by utilizing the novel method of this invention. Such empirical relationships then provide a means to evaluate the effect of changes in textile processing such as, for example, type of finish, amount of finish applied, surface roughness of the fibers comprising the yarn and type of guide surface.

With respect to the specific elements hereinbefore described in the apparatus to carry out the method of this invention, it should be obvious that many different types can be advantageously employed. Any means of driving the yarn-forwarding roll may be employed which is capable of maintaining a constant speed over the range found to be required in a given study. An obvious alternative to the canted, or skewed, idler roll in combination with the forwarding roll illustrated in the preferred embodiment is an idler roll in direct contact with the forwarding roll so as to form a nip for positive control of yarn speed. In this instance, it would be advantageous to select a resilient surface for one roll, although precisely finished and aligned surfaces are capable of positively forwarding yarn without benefit of a resilient surface. Any convenient means may be employed to take up the yarn from the forwarding roll, such as an air jet which maintains a low, but constant tension on the delivered yarn, a friction-driven take-up roll or reel, etc.

Because of the many obvious variations which are possible without departing from the spirit and scope of this invention, it is to be understood that the invention is not to be limited by the specific disclosures but only in accordance with the appended claims.

What is claimed is:

1. A method for the simultaneous measurement of frictional properties and static generation rate of yarns over substantially the entire range of tensions and speeds utilized in the textile processing yarns which comprises forwarding said yarn at a controllable, predetermined rate of speed within a predetermined speed range, placing on said yarn a predetermined input tension within a predetermined tension range, measuring said predetermined input tension, passing said yarn over a stationary, snubbing test surface, measuring and recording the static charge developed by said yarn passing over said stationary, snubbing test surface, measuring the output tension on said yarn at a point after said yarn has passed over said stationary, snubbing test surface and recording said measured input and output tensions.

2. The method of claim 1 wherein said predetermined speed range is from about 0.001 yard/minute to about 500 yards/minute and said predetermined tension range is from about 2 grams/denier to about 30 grams/denier.

3. The method of claim 2 wherein said controllable predetermined rate of speed is in the range of from about 0.001 yard/minute to about 100 yards/minute.

4. The method of claim 2 wherein said controllable predetermined rate of speed is in the range of from about 50 yards/minute to about 500 yards/minute.

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