Jan. 16, 1968 H. F. BROWN 3,363,459

MULTIFILAMENT YARN INTERLOCKING ANALYZER

Filed Sept. 22, 1964 2 Sheets-Sheet 1

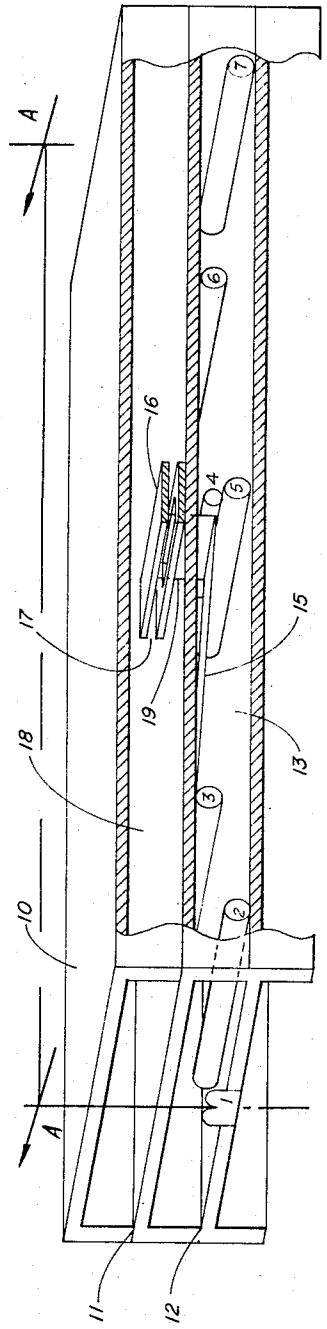


FIG. 1.

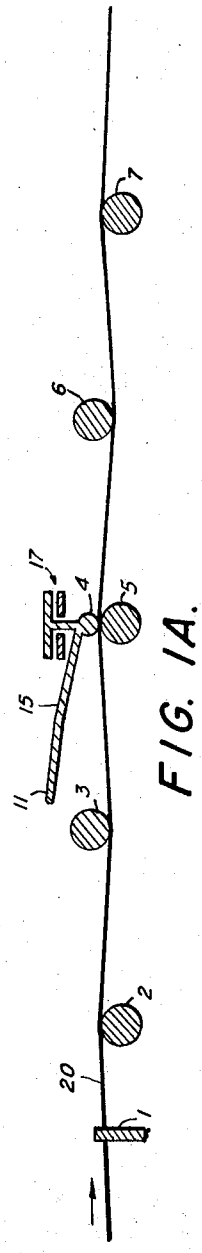


FIG. 1A.

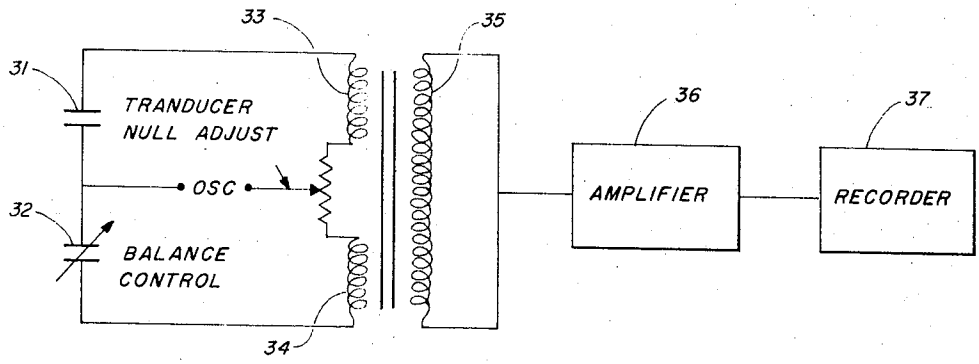
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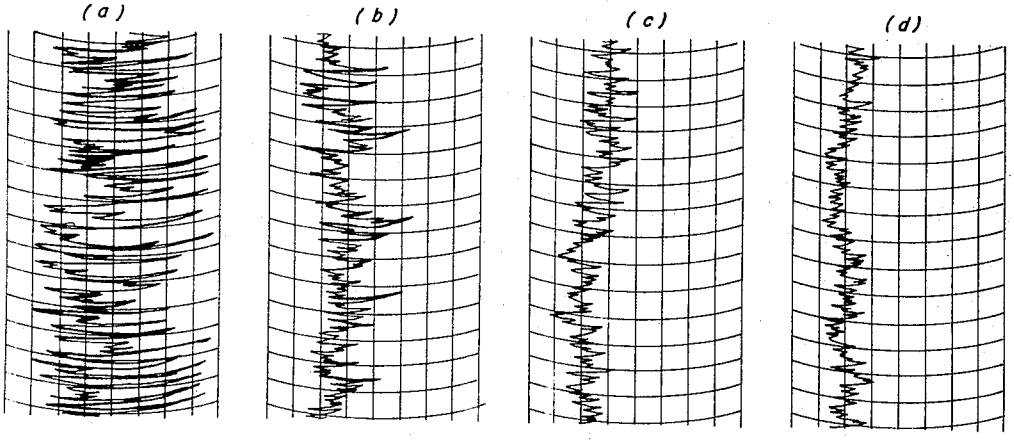
MULTIFILAMENT YARN INTERLOCKING ANALYZER

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BRIDGE CIRCUIT FOR ANALYZER

FIG. 2.



TIGHT INTERLOCKING	MEDIUM INTERLOCKING	LOOSE INTERLOCKING	LOW OR ZERO INTERLOCKING
(SEVERE FLASHINESS)	(MODERATE FLASHINESS)	(MINOR FLASHINESS)	— —
FLASH FACTOR: .23	FLASH FACTOR: 1.00	FLASH FACTOR: 3.00	— —

FIG. 3.

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MULTIFILAMENT YARN INTERLOCKING ANALYZER

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4 Claims. (Cl. 73—160)

This invention relates to a measuring device for use on multifilament textile strands and the like yarn products. More particularly, it concerns a capacitive pickup analyzer for use in determining the internal interlocking and other data concerning internally interlocked multifilament yarns.

My co-workers and others have developed several types of multifilament yarn referred to in the trade as internally interlocked, entangled, twined filament and probably by other terminology. Such types of yarn while in some instances differing in external appearance and in the appearance of the fabric woven therefrom do have a common feature. This feature is that within the body of the yarn, frequently zero twist yarn, some of the filaments are entangled or interlocked to some extent imparting internal coherency to the yarn. The internal locking and entanglement usually is not observable by visual external inspection of such yarns.

Examples of some of these types of textile products having the interlocking of the filaments may be noted in more detail by reference to my co-workers' U.S. Patents 2,904,050, 2,956,328, 3,099,064, 3,103,098 and pat ents of others such as 2,985,995 and 3,083,523 as well as other patents and publications.

For certain purposes respecting such type filamentary textile product it may be desirable to have data concerning the amount of interlocking, the frequency, geometry, probable fabric appearance and similar information. That is, before making such type of yarn into a fabric or other product or for matching one batch of such yarn with another batch or for other reasons it may be useful to have data on such type yarn in advance of fabricating the yarn into a cloth or other type product.

Certain ways of measuring this type entanglement in such type yarn have been proposed. For example, the aforesaid U.S. Patent 2,985,995 describes several test methods in detail. One of the simpler methods involves the use of a stylus or hook pulled along the yarn until a zone of interlocking is encountered. Some of the methods referred to or which are otherwise known involve complicated or expensive equipment. A method known as the balanced air system is accurate and reliable but somewhat limited in speed. A so-called electronic entanglement tester gives desirable results for 100 denier and higher but is considered too complex for production testing.

Hence, it is apparent that the development of a tester or analyzer of the class indicated which is useful for yarn of all deniers yet is simple of design, operation and reasonably economical of construction represents a highly desirable result. After extended investigation I have discovered such type of device for analyzing interlocked multifilament yarn of the class indicated, which device described herein is believed simpler and better than presently available equipment for the stated purpose.

In the broader aspects of my invention I have found that when yarn is drawn over a guide, untwisted yarn has a tendency to spread into a band or ribbon while twisted yarn will remain in a bundle. The higher the twist, the more dense the bundle will appear to be. Also, the height of this bundle will increase as compared with the ribbon aforementioned as the degree of twist increases. I have further found that a somewhat analogous effect occurs

with the so-called interlocked or entangled yarns as above referred to. That is, the density and thus the height of the yarn bundle increases somewhat with an increase in internal entanglement. While this may not be visually observable or otherwise readily noted particularly with small denier yarn bundles, such change in bundle dimension as height increase, occurs to an extent that it may be sensed by a suitably sensitive measuring device.

In the present invention I have discovered such an analyzing device which gives various useful information about the multifilament strand being tested. For a more complete understanding of my invention reference is made to the attached drawing forming a part of my application.

In the drawing FIG. 1 is a side elevation view partly in section of the pickup or yarn sensing unit.

FIG. 1A is a partial cross-section of FIG. 1 along line A—A showing the line of travel of a yarn product through the yarn sensing unit.

FIG. 2 is a diagrammatic illustration of a circuit hookup which may be used in connection with the sensing device of FIG. 1.

FIG. 3 comprises a plurality of charts illustrating recordings from the apparatus combination of FIGS. 1 and 2.

Referring to FIG. 1 the over-all housing for the sensing device is designated **10**. The housing may be hinged or otherwise suitably constructed at **11** and **12** so that the housing may be opened or disassembled for access to the several parts therewithin.

As is best shown in FIG. 1A, within the lower part of the housing, namely chamber **13**, there is positioned in spaced relationship the several cylinders or rollers or like yarn bearing surfaces **2**, **3**, **4**, **5**, **6** and **7** across which the yarn **20** is directed. It will be noted these parts are spaced in a staggered relationship so that the yarn passes over or under one roll device then over or under the next. However, roll parts **4** and **5** are in immediate adjacent relationship as will be discussed hereinafter. All of these rolls or guides are constructed of low friction metal or ceramic. In other words, the minimum of friction on the yarn passing thereover and against is preferred. A stationary guide member likewise of ceramic or other low friction material is positioned at **1** to center the feed of the yarn strand to and through the unit.

Turning now to the parts **4** and **5**, roll **5** is fixed and otherwise the same or similar to the rolls **2**, **3**, and **6**. However, roll or rod **4** is movable and attached to a leaf spring **15** and to plate **16**. This attachment is by projecting member **19**. Plate **16** serves as one plate of the overall capacitor or transducer **17** contained in the upper chamber **18**.

The operation of the parts just referred to are fairly apparent from the drawing but will be briefly discussed as follows: The yarn strand to be analyzed is passed through the guide system **1**, **2** and **3** referred to and between the two tangentially parallel parts **4** and **5**. As the strand is passed through the guide system it is banded or flattened into a band. Rod **4** is movable and as above indicated is attached to plate **16** which serves as one plate of the transducer. As a zone of interlocking moves through these adjacently positioned tangentially parallel parts the yarn bundle increases in dimension, namely height, and thus the movable rod **4** is at least minutely moved more than the movement occasioned by the average or normal dimension of the strand which interlocking, therefor, in turn moves one plate of the capacitor.

Referring now to FIG. 2 the electrical portion of the analyzer will now be considered. It consists of two arms, **31** and **32**, of a hybrid bridge circuit with two arms contained inside a commercially available A.C. amplifier and formed by two inductances **33** and **34**.

The arms are (1) a balancing capacitor **32** and (2) a variable capacitor **31** which serves as the transducer for the measurement of entanglement. An audio-frequency oscillator running at 4 kc. feeds the bridge circuit. The two inductances are wound on a common iron core so that currents flowing through them produce flux which oppose each other. A further coupling winding **35** exists on the same iron core; and when the current flowing through one arm of the bridge circuit is greater than the current in the other, a 4 kc. voltage appears on the coupling winding. This occurs whenever the bridge is unbalanced. The 4 kc. signal is amplified by a variable gain amplifier **36**, rectified, and fed into a D.C. amplifier which drives a recorder **37**.

Any high quality commercially available capacitance sensitive amplifier and recorder may be used. In general I prefer an amplifier having the following construction and characteristics: A circuit arrangement in which the two capacitances in the sensing head form part of a bridge network as exemplified by FIG. 2, conventional full wave rectifier (power supply), voltage stabilizer, two stage variable gain A.C. amplifier, diode detector for rectification of the A.C. signal, D.C. amplifier section, built-in meter, and recorder output.

The choice of the recorder will be governed to some extent by the manner in which it is desired that the data be delivered. In other words, if a permanent record or chart is desired, then a recorder such as described above is employed. Such recorders have the following construction: voltage range 4, 8, 20 volts full scale, 100 c.p.s. frequency response, pen bias (full scale), chart speed 25 mm./sec. If merely a causal inspection of data is desired then a visual recorder such as the built-in meter on the commercially available MANRA Electronic Unit No. 1 may be used.

Reference is now made to FIGS. 3*a*, *b*, *c* and *d* which depicted some of the recordings produced by the apparatus of the present invention. These recordings differ depending on the degree of interlocking or entanglement, frequency and the like pertaining to the yarn passed through the device of the present invention. A further understanding of FIG. 3 will be apparent after consideration of the several examples to be set forth below. These several examples will also provide a further understanding of the utilization of the new apparatus of the present invention.

Example I

In this example the multifilament yarn tested was zero twist acetate yarn of a denier per filament of 3.95 and a total denier of 150. The average number of filaments making up the yarn was 38. The yarn had been processed under conditions generally within the ranges set forth in the table below to impart considerable internal interlocking to the yarn. The particular conditions and methods used to interlock the multifilaments is not a limitation on the present invention and any previously used or currently used procedures may be used to provide the yarn strands for the analyzing tests herein.

Table

Jet	No. 92.
Type insert	Steel.
Air pressure	15.
Tension	15 gm.

The interlocked yarn of this example was run through the sensing device of FIG. 1. The relatively high degree of interlocking in this yarn acted upon rolls **4** and **5**, which movement was transmitted to the plate of the transducer. The signal was amplified and recorded providing a chart such as depicted in FIG. 3*a*.

From an inspection of this chart the following information is apparent: From the multiplicity of rather high peaks it was apparent there was a high degree of, or relatively tight, interlocking. From other predetermined data

with respect to which the chart had been correlated it was known from the chart that the spacing of the interlocking was of the order of 1 inch.

Fabric appearance can be correlated from the flash factor which is the ratio of spacing to amplitude or tightness. The flash factor referred to in FIG. 3 has the following significance. FIG. 3 represents tight, medium, loose, and zero entanglement. When these samples were woven as filling and graded for flashiness, the results were as indicated in parenthesis on FIG. 3. Since these gradings agreed with the flash factor, it is concluded that the flashiness is directly proportional to the tightness of entanglement and inversely proportional to the spacing of entanglements. Several series of yarn have been analyzed, and there has been a high degree of correlation (80–90 percent) between the flash factor and fabric grading in each series.

Example II

In accordance with this example the same type of yarn as used in Example I was processed. However, the processing conditions were altered somewhat so that a lesser or moderate amount of internal interlocking was accomplished. The resultant yarn was then run through the analyzing device of the present invention producing a chart as depicted in (*b*). As may be observed from this chart *b*, the interlocking was moderate and the geometry and uniformity were good.

Example III

In this example the same kind of yarn as in the preceding examples was initially processed for testing. However, the conditions for processing were maintained so that only loose or a small amount of entanglement was imparted to the processed yarn. The resultant yarn was run through the analyzer of this invention giving a chart as depicted in (*c*); this chart was compared with chart (*d*) which concerned the same kind of yarn but unprocessed and having zero interlocking. From a result of this study and comparison the following observations are made.

The high peaks present in the interlocked samples 3*a*, 3*b*, and 3*c* and the lack of these peaks in the zero interlocked sample 3(*d*) along with the observation that the multiplicity and relative height of the peaks increase proportionately from the loosely interlocked sample to the tightly interlocked sample clearly establishes the ability of the present invention to discriminate between the degree of interlocking as well as between zero interlocked and interlocked filaments.

Example IV

In this example the conditions of operation and other factors were similar to preceding examples excepting that the yarn processed and tested was a modacrylic yarn. The chart resulting was similar to those produced when testing acetate yarn.

Example V

The yarn processed and tested in accordance with this example was a polyester zero twist multifilament yarn of the following type, a denier per filament of 2.12 and a total denier of 70. The average number of filaments making up the yarn was 33.

The results of the test indicated that the interlocking present in this sample was more sparse than other types of yarn tested.

Example VI

In accordance with this example a polyolefin multifilament yarn was processed and tested. It was observed from the charts that the degree of interlocking with this type of yarn was somewhat lower and different than with the other types of yarns worked with.

It is thought apparent from the foregoing description that there has been provided a relatively simple and economical but effective apparatus and method for analyzing frequency, geometry and other properties concern-

ing interlocked type yarns and the like textile products. Certain changes may be made in my invention exemplified by items such as the several mentioned hereinafter. Linear variable differential transformer, strain gage, crystal pickup, or any transducer that transforms displacement to an electrical signal may be used.

Although the invention has been described in detail with reference to preferred embodiments thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined by the appended claims.

I claim:

1. An apparatus for analyzing the frequency, geometry, and degree of interlocking between the strands of a multifilament textile product comprising:

(a) a housing within which is defined a path of movement for said multifilament textile product;

(b) a plurality of guide means mounted in said housing so as to deflect and band said multifilament textile product as it passes along said path, said banding being proportional to the interlocking characteristics of said multifilament textile product;

(c) a movable means mounted within the housing and adjacent to one of said guide means so that said multifilament textile product will continually be gaged between said movable means and the adjacent guide means; and

(d) sensing means interconnected with said movable means and further connected to a recording means in such a manner as to sense and directly record variances in the uniformity of said multifilament textile product.

2. The apparatus according to claim 1 wherein said movable means is biased towards the one said guide means.

3. The apparatus according to claim 1 wherein the sensing means is comprised of a hybrid electrical bridge circuit, one arm of said circuit including a transducer which is interconnected with said movable means.

4. A method for analyzing the frequency, geometry, and degree of interlocking between the strands of a multifilament textile product comprising the steps of:

(a) subjecting the multifilament textile product to a banding action whereby that portion of the multifilament textile product which is not highly interlocked will be banded to a higher degree than that portion which is highly interlocked;

(b) sensing the degree to which the multifilament textile produce is banded; and

(c) recording the degree of banding in the multifilament textile product which is sensed.

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